Volume 1 of 2

Final Feasibility Report and Environmental Impact Statement

# Rio Salado Oeste

# Salt River-Phoenix, Arizona

Prepared by:

US Army Corps of Engineers

Los Angeles District

South Pacific Division

City of Phoenix

**September 2006**

# 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 Rio Salado Oeste, Salt River study area in Phoenix, Arizona, to examine the measures and alternatives developed, and to present a recommended plan. This 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 remain. Today, the study area consists of a highly disturbed riverbed with minimal extant native vegetation.

This 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. It 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. Assessments of the impacts of each alternative are also presented in Chapter 5. Chapter 6 identifies and describes the coordinated implement able solution that best meets the planning objectives of a comprehensive ecosystem restoration through the study area.

This study effort is a joint partnership of the City of Phoenix and the Corps of Engineers, Los Angeles District. A wide variety of management measures were identified for use in developing full-scale alternatives.

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 5A is the plan that reasonably maximizes net ecosystem restoration benefits by having the maximum amount of restoration benefits compared to costs. Therefore, Alternative 5A 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 $164,950,295 ($153,776,850 for ecosystem restoration and $11,173,445 for recreation). Based on the requirements of WRDA 1986, cost-sharing for ecosystem restoration features including all lands, easements, rights-of-way, relocations, and disposal areas (LERRDs) would be 65 percent Federal and 35 percent non-Federal. 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. Thus, the Federal share is currently estimated at $105,541,675 ($ 99,954,952.50 for ecosystem restoration and $5,586,722.50 for recreation). The cost for all operations and maintenance would be the responsibility of the non-Federal sponsor. Annual operation and maintenance for the ecosystem restoration project and recreation is currently estimated at $2,083,000 and $800,000 respectively. In addition, all water rights and costs associated with providing water to the project shall be borne by the non-Federal sponsors. The value of this water has been estimated at $817,000 annually.

The recommended plan provides a habitat value of 847 AAFCU's, or an increase in 267 AAFCU's over without-project conditions. This is a 46 percent increase with project implementation.

The analysis presented in this report shows that the recommended plan is feasible and would provide environmental restoration benefits that serve the public interest. Therefore, it is recommended that the Recommended Plan described herein for ecosystem restoration be authorized for implementation as a Federal project, with such modifications as in the discretion of the Chief of Engineers that may be advisable, and subject to cost sharing and financial arrangements satisfactory to the President and Congress.

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**(under separate cover)**

# CHAPTER I
# STUDY AUTHORITY

This report was prepared as an interim response to the following authorities provided by Congress. It presents the findings of a feasibility study of the Rio Salado Oeste, Salt River, Arizona. The Salt River is a significant tributary to the Gila River in the State of Arizona (Figure I-1).

- The first authority is given by Section 6 of Public Law 761, dated June 28, 1938, known as the Flood Control Act of 1938, which reads in part as follows:

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

- The second and most recent authority is provided by a Resolution of the Committee on Public Works and Transportation, U.S. House of Representatives, adopted May 17, 1994 (Docket 2425) (Figure I-2) which states:

  "*...the Secretary of the Army is requested to review the 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.*"

The Energy and Water Appropriations Act, 2000, Public Law 106-60 appropriated funds for investigations of civil works project prior to construction. A reconnaissance level review of the Salt River (Rio Salado Oeste) was conducted under that authorization. The results and conclusions of the reconnaissance phase were presented in the *Rio Salado Oeste, Salt River, Phoenix Arizona Section 905(b) Report September 2000*. The recommendation of this report was that there was a Federal interest in proceeding to a second, feasibility phase of the General Investigation. The Corps of Engineers Headquarters certified the reconnaissance report on November 8, 2000, giving the Los Angeles District authority to move into the feasibility phase.


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Gila River
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PIMA
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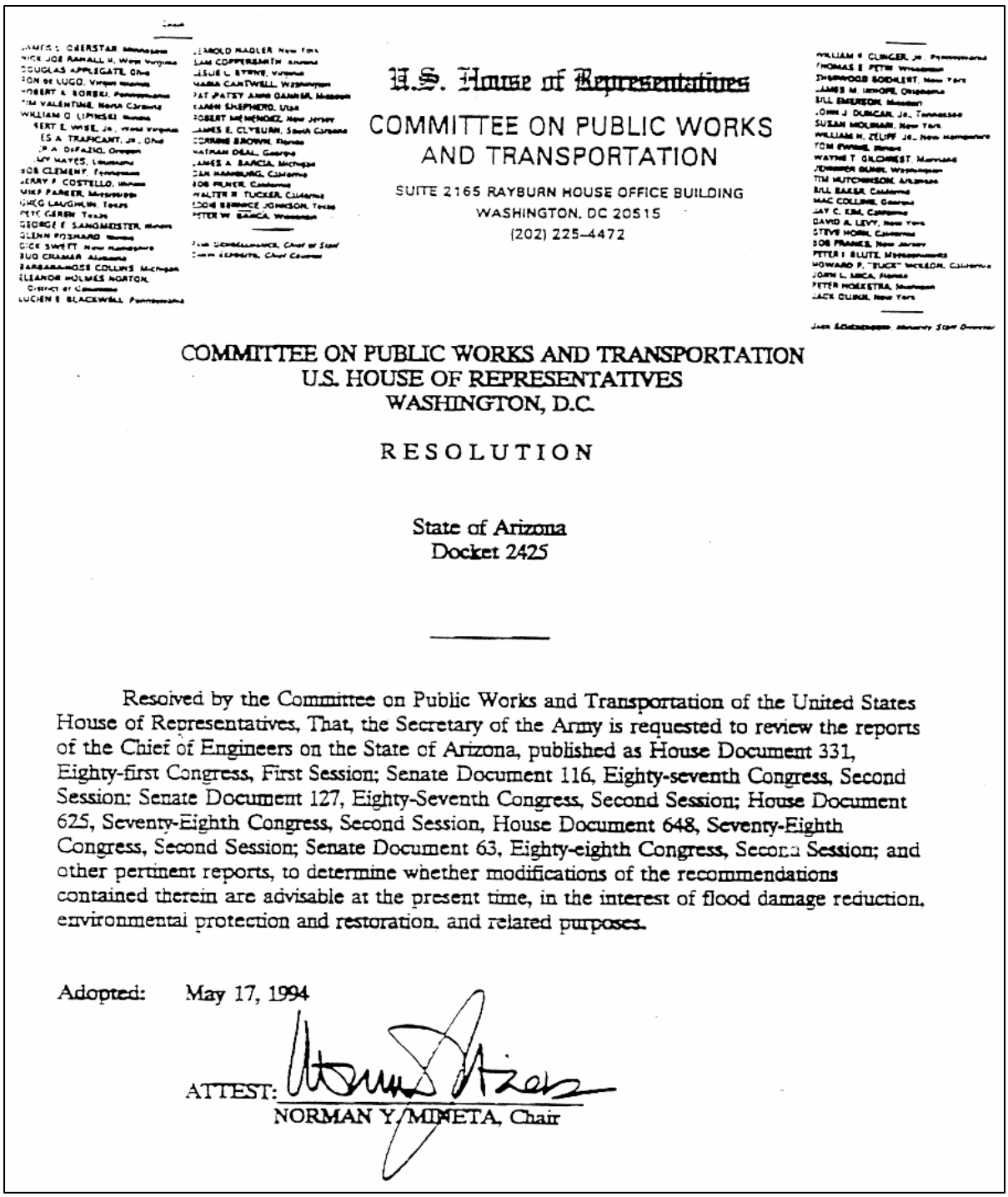
VICINITY MAP
Figure I-1
December 2004
Rio Salado Oeste
US Army Corps
of Engineers

**Figure I-2: HR 2425**



U.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:

NORMAN Y. MINETA, Chair

# CHAPTER II
# STUDY INFORMATION

## 2.1 STUDY PURPOSE AND STUDY SCOPE

The Rio Salado Oeste Study is being conducted by the U.S. Army Corps of Engineers (USACE), Los Angeles District and the City of Phoenix, with the cooperation of the Flood Control District of Maricopa County (FCDMC). The purpose of this study is to identify whether there is a Federal interest in implementing a project along the Salt River from 19th to 83rd Avenues in Phoenix. This study is to identify feasible flood damage reduction and ecosystem restoration alternatives that are technically feasible, economically practicable, sound with respect to environmental considerations, and publicly acceptable. The City of Phoenix, as the non-Federal sponsor, supports the proposed project purpose to provide flood damage reduction, 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, for each alternative, what is expected to happen if that 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 between alternatives.

Alternative plans are being developed and evaluated to meet the objectives stated above. 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

- 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 City of Phoenix 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 groundwater 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 and effluent discharge.

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. The Nature Conservancy lists desert riparian woodland as a very rare although significantly important cover type and describes restoration of riparian systems in the Sonoran Desert as critical. (Marshall et al 2000).

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 populations 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 is land available for restoration. As long as these conditions remain unchanged, there is 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 region. In addition to restoration there are opportunities to reduce future flood damages and improve recreation opportunities associated with the restored floodplain.

## 2.3 STUDY AREA

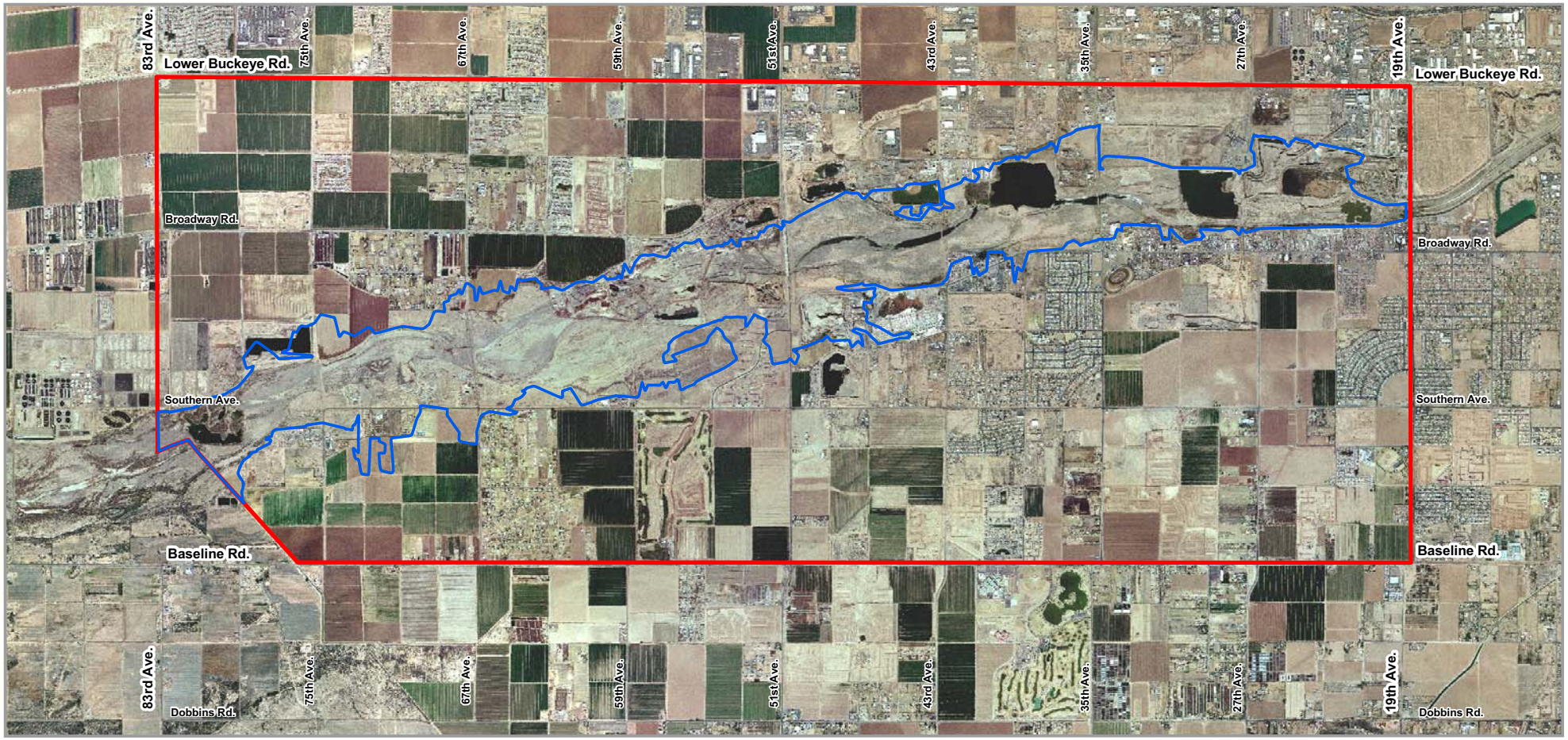
The study area is geographically located in Maricopa County, Arizona, and is entirely within the City of Phoenix (see Figure I-1). The study area is approximately 8 miles long extending from 19th Avenue on the east to 83rd Avenue on the west, and from Lower Buckeye Road on the north to approximately Baseline Road on the south. While this is a large study area extending beyond the riverbanks, any implementation of project features would be associated with the river floodplain. Alternatives considered within the study are all within that implementation area. The project implementation area extends from 19th Avenue on the east and 83rd Avenue on the west, and is the area within the 100-year floodplain of the Salt River. The study area is approximately 4 miles wide and consists of approximately 20,480 acres. The project implementation area is, on average, approximately 1 mile wide and consists of approximately 3,315 acres. Figure II-1 displays the study area and project implementation areas.

The Rio Salado Oeste Project is one of four ecosystem restoration projects that are in various stages of progress, from the planning phase to construction. The projects are being conducted by the Corps and various local sponsors along the Salt River, downstream of Granite Reef Dam. Figure III-1 depicts the locations of these projects with respect to the Rio Salado Oeste Project. Additional description of those projects will follow in Chapter III.

## 2.4 HISTORY OF THE INVESTIGATION

In response to the study authority, the reconnaissance phase of the study was completed in 2000. This reconnaissance phase resulted in the finding that there was a Federal interest in continuing

to a feasibility phase. The Feasibility Cost Share Agreement (FCSA) with the City of Phoenix was signed in June 2001 and the feasibility phase was initiated.





**Legend**

- Project Study Area
- Project Implementation Area

# PROJECT STUDY AREA AND PROJECT IMPLEMENTATION AREA

**Figure II-1**

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US Army Corps of Engineers

March 2006

**Rio Salado Oeste**

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## 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. 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. 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 VI)

The final product of this feasibility study is a Feasibility Report and 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 Corps 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.

### 2.5.1 Environmental Operating Principles

The Corps of Engineers has reaffirmed its commitment to the environment by formalizing a set of "Environmental Operating Principles" applicable to all its decision-making and programs. These principles foster unity of purpose on environmental issues, reflect a new tone and direction for dialogue on environmental matters, and ensure that employees consider conservation, environmental preservation, and restoration in all Corps activities. By implementing these principles, the Corps will continue its efforts to develop the scientific, economic, and sociological measures to judge the effects of its projects on the environment and to seek better ways of achieving environmentally sustainable solutions. The principles are described in Engineering Circular 1105-2-404, "Planning Civil Work Projects under the Environmental Operating Principles," 1 May 2003.

- Achieve Environmental Sustainability. An environment maintained in a healthy, diverse, and sustainable condition is necessary to support life.
- Consider Environmental Consequences. Recognize the interdependence of life and the physical environment. Proactively consider environmental consequences of Corps programs and act accordingly in all appropriate circumstances.
- Seek Balance and Synergy. Seek balance and synergy among human development activities and natural systems by designing economic and environmental solutions that support and reinforce one another.
- Accept Responsibility. Continue to accept corporate responsibility and accountability under the law for activities and decisions under our control that affect human health and welfare and the continued viability of natural systems.

- Mitigate Effects. Seek ways and means to assess and mitigate cumulative effects to the environment; bring systems approaches to the full life cycle of our processes and work.
- Understand the Environment. Build and share an integrated scientific, economic, and social knowledge base that supports a greater understanding of the environment and effects of our work.
- Respect Other Views. Respect views of individuals and groups interested in Corps activities; actively listen, and learn from their perspective in the search to find innovative win-win solutions to the nation's problems, solutions that also protect and enhance the environment.

# CHAPTER III
# PRIOR STUDIES, REPORTS, AND EXISTING WATER PROJECTS

The Resolution of the Committee on Public Works and Transportation adopted May 17, 1994 (Figure I-2) requested review of 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." Although six specific reports are listed none are relevant to this study area, those include:

- House Document 331, 81st Congress. Gila River and Tributaries Below Gillespie Dam, Ariz.
- Senate Document 116, 87th Congress. Gila River and Tributaries in the Vicinity of Tucson, Arizona.
- Senate Document 127, 87th Congress. Gila River, Arizona, Camelback Reservoir
- House Document 625, 78th Congress. Bill Williams River and Tributaries, Arizona
- House Document 648, 78th Congress. Little Colorado River, Arizona and New Mexico.
- Senate Document 63, 88th Congress. Little Colorado River, Winslow, Arizona.

Other pertinent reports, however, are described below. 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, and identifies existing projects and structures located within the area.

## 3.1 PRIOR STUDIES AND REPORTS

The Salt River has been extensively utilized for irrigation since prehistoric times. In the 1800s, settlers reestablished many historical irrigation canals. Since then, the Phoenix metropolitan area has established itself around the river. The Salt River has presented many opportunities and challenges, and has been studied extensively.

Various agencies and engineering consulting firms have conducted or published over 50 studies and reports on the Salt River since 1980. The topics of the reports or studies include water resources, flood control, recreation and urban development, and environmental assessment. A sample of the prior studies and reports is presented by topic below, and in effect provide a history of water resources studies in the area. The findings in these reports and the chronology of change within the Salt River corridor are important and essential in describing the changes over time and in outlining the importance of this project.

### 3.1.1 Water Resources Studies or Reports

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

In 1978, the Corps of Engineers 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 related to flood control, wastewater, floodwater conservation, and fish and wildlife recreation. The study focused especially on the 16-mile reach between 27th Avenue in Phoenix and Country Club Drive in Mesa.

In 1981, the Corps of Engineers investigated water and related land resources issues in the Phoenix Metropolitan area, including issues of water quality, flood control, water conservation, and fish and wildlife enhancement. At that time, none of the projects proposed by local agencies were found to warrant Federal interest, with the exception of flood control along the Salt and Gila Rivers.

The 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 tax authority for the District. However, the District did conduct several studies. A published memorandum in 1982 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 control options for a regional redevelopment of the Salt River. Sources for domestic water include obtaining Central Arizona Project (CAP) allotment, and obtaining water rights from surface and groundwater from lands within the district. The source identified for aesthetic and recreational water was poor-quality groundwater. Flood management plans were based on an existing condition scenario and on an upstream flood control design condition.

Carr, Lynch Associates, a private engineering consulting firm, also conducted a study in 1982, which evaluated the potential water sources and flood control 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, and water supply and flood control.

In 1992, the Corps of Engineers completed the *Central Maricopa County Reconnaissance Study*. This study describes and analyzes 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, these problems. Twenty-three flooding problems were identified within Central Maricopa County. Two areas determined to be of Federal interest were a flood control project on the Dysart Drain near Luke Air Force Base, and a water quality and environmental restoration project on the Salt River near 91st Avenue. That project (Tres Rios) was not recommended to proceed 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, Maricopa County Parks and Recreation, FCDMC, and the U.S. Environmental Protection Agency (EPA). The study evaluates methods for reclaiming water from sewage effluent from the 91st Avenue Regional Wastewater Treatment Plant (WWTP) and develops plans for using the reclaimed water directly or through exchange mechanisms. The 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 completed a geomorphic assessment of the Salt River for the Corps. The assessment supports a reconnaissance-level geomorphologic evaluation of the Lower Salt River and a portion of the Gila River. The study discusses environmental history, hydrologic system, geomorphic system, and engineering features of the Salt River.

The City of Phoenix completed a report in 1994 that summarizes resulting problems and issues that are part of the setting of the present river as it passes through the city. The report includes resources and activities that will be the basis of the area's restoration.

In 1995, the Corps completed the reconnaissance phase of the Rio Salado, Salt River, Arizona Project. The report included an assessment of the problems and opportunities and an evaluation of alternatives for a 33-mile portion of the Salt River. A preliminary environmental assessment and a detailed habitat evaluation of the study reach were included.

In April 1998, the Corps completed the feasibility report and EIS for the Rio Salado, Salt River, Arizona Project. The report identified plans that would provide environmental restoration benefits and serve the public interest. The project is currently in the final phase of construction with anticipated completion in 2006/2007.

In April 2000, the Corps completed a feasibility report and EIS for the Tres Rios, Arizona Project. The study examined a portion of the Salt River and Gila River from 83rd Avenue downstream to the Agua Fria River, and selected a plan that includes environmental restoration and flood control components. The project is currently in the design phase.

### 3.1.2 Flood Control Studies or Reports

In 1981, the Corps prepared a document as a result of severe flooding along the Salt and Gila Rivers. The flood damage reduction measures presented include discussion on flood proofing, relocation, floodplain regulations, preparedness planning, channel excavation, and evaluation of hydraulic structures.

In 1989, Simons, Li & Associates, Inc., a private engineering consulting firm, prepared a report on the channelization of the Salt River through Tempe, Arizona. The study addresses issues related to channel design, determines appropriate hydraulic design criteria, and presents several alternative design concepts. The engineering analysis includes the evaluation of alternative river

sections, alignments, and profiles. In addition, the study identifies potential impacts due to the proposed changes.

The Corps of Engineers completed the Salt-Gila Reconnaissance Report in 1989. The study focuses on the flooding problems and associated solutions downstream from the confluence of the Verde and Salt Rivers to Gillispie Dam. It was determined that no analyzed solution was economically justified; therefore, the study did not proceed to the feasibility phase.

In 1994, the Corps 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 and 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 there was no Federal interest in participating in installation of bank stabilization at this location. With Federal Emergency Management Agency (FEMA) funding, the Salt River Pima-Maricopa Indian Community initiated construction of bank stabilization of two of the landfill sites, which were studied.

The FCDMC completed a land use and structures inventory in 1994. The inventory was published in a report that listed the various structures, utilities, and land use conditions along the Salt and Gila Rivers from Granite Reef Dam to Gillespie Dam.

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

The 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. The plan addresses much of the land to the north of the project area and the potential for flooding problems due to interior drainage (http://www.fcd.maricopa.gov/Projects/DurangoADMP/).

The FCDMC has also completed the Laveen ADMP. The study area is in the southwestern portion of the metropolitan Phoenix area within Maricopa County, Arizona, and comprises 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 Community 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. (http://www.laveenadmp.com/)

### 3.1.3 Recreation and Urban Development Studies or Reports

In 1983, the Rio Salado Development District completed an economic analysis of the impacts that a redeveloped Salt River would have on the economy of metropolitan Phoenix. The study quantifies, on an annual basis, new public dollar revenues derived from increased property and sales tax revenues and income generated by a redevelopment project from the sale and/or lease of publicly owned land in the project area. Conclusions from this study indicated that over a fifty-year period, redevelopment of the Salt River corridor would provide $7.6 billion in public revenues and $2.4 billion in private benefits to the metropolitan region and the State of Arizona.

In 1985, Carr, Lynch Associates 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, development of its banks, and cultural and educational uses. This master plan was never implemented.

In 1989, the City of Phoenix completed the South Village Redevelopment Plan. The plan established that redevelopment activities in this area of Phoenix must begin with rehabilitation and redevelopment of the Salt River as it passes through Phoenix.

In 1991, the City of Phoenix Planning Department completed an estimate of what the City would be like in the year 2015. The estimate included discussion of the future role of the Salt River.

In 1994, the City of Phoenix conducted an economic analysis that included a listing of development activities necessary to initiate and sustain economic development within the Salt River area of Phoenix. The analysis determined that the key to redevelopment outside of the river corridor was redevelopment of the river itself.

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.

The Rio Salado Beyond the Banks Area Plan was completed by the City of Phoenix and became effective December 17, 2003. The plan is a policy document for future investment in and revitalization of the area. The plan boundaries are Interstate 17/Interstate 10 (I-17/I-10) freeways on the north, Broadway Road on the south, 19th Avenue on the west, and 32nd Street on the east. The area is being revitalized to realize its full potential from its proximity to Rio Salado, Downtown Phoenix, Sky Harbor International Airport, other job centers, and regional transportation linkages. It connects to the restored Rio Salado as an attractive recreational and environmental amenity; provides an attractive mix of land uses abutting the Rio Salado; builds on existing neighborhoods, area history, and cultural identity; provides infill housing to support seven city employment centers; employs a growing and increasingly skilled workforce; and creates a vibrant place that attracts area residents and visitors to a wide variety of recreational, environmental, and commercial activities

The Estrella Planning Area land use plan (Maricopa County, 1992a) regulates planning and development activities within its jurisdiction of unincorporated Maricopa County. Within the study area, this includes the land uses extending north from and including the Salt River. There are also islands of land incorporated within the city throughout portions of the Estrella Planning Area. The Estrella Planning Area is currently very rural in character and is an island of farming activity surrounded by more urban-type development. The area along the north of the Salt River is occupied by agricultural, agribusiness, gravel mining, and vacant land uses, with isolated industrial and residential development.

### 3.1.4 Environmental Assessment Studies or Reports

In 1987, Dames & Moore, a private engineering consulting firm, completed an investigation of the waste sites within the Salt River bed. The study was performed for the Rio Salado Development District. The study area extended completely through the Phoenix metropolitan area. The study recommends a plan for the complete investigation and remediation of waste sites and provides an order-of-magnitude cost estimate for the implementation of the plan. Sixty-three landfills or dumpsites were identified. The projected costs for investigation and remediation of waste sites range from $49,500,000 to $90,800,000.

In 1994, as a part of the Rio Salado Reconnaissance Study, the Corps of Engineers completed an environmental evaluation. The evaluation presents a brief synthesis of present conditions, active and passive location of landfill sites, potential mitigation of upper aquifer contamination, preservation and/or reconstruction of ecological habitats, and potential opportunities for water resources recreation based on demand and economic feasibility. The study area covered 33 miles of the Salt River through the metropolitan Phoenix area. Included in the evaluation was a field reconnaissance conducted to determine the present habitat values of the vegetation within the Salt River. A total of 29 sites were assessed during the field study.

In 1998, the Corps of Engineers completed an EIS for the Rio Salado Environmental Restoration Project. The EIS and feasibility report were prepared for an ongoing project on the Salt River immediately upstream from the study area.

In 2000, the Corps of Engineers prepared an EIS for the Tres Rios Feasibility Study, another ongoing project on the Salt River. The EIS evaluated the effects of a proposed environmental restoration and flood control project immediately downstream on the Salt River.

In 1997, CH2MHILL prepared the "Salt-Gila River Baseline Ecological Characterization" for the City of Phoenix in their effort to implement a full-scale constructed treatment wetland system at the 91st Avenue WWTP. The characterization includes information for the Salt River area between 75th Avenue to the east and Buckeye Diversion Dam to the west.

The Laveen Planning Area land use plan (Maricopa County, 1992b) regulates planning and development activities for approximately 30 square miles of unincorporated Maricopa County south of the banks of the Salt River. The area is generally characterized by rural ranchettes, cultivated farmland, and dairy farms, with a small urban area within the city in the northeastern portion of the planning area. The area, along the south banks of the Salt River, is currently vacant, with a minor amount of developed land and agricultural land uses nearby. Currently, industrial development and a considerable number of auto-wrecking and salvage operations are located in the northeast quadrant closest to the City boundaries (primarily along Broadway) and have had an influence on development in the area. The properties in the area are zoned for Rural Residential, Industrial, and Special Use.

The City of Phoenix General Plan (City of Phoenix, 2001) regulates planning and development activities within incorporated areas of the city in the vicinity of the study area. Additionally, the General Plan considers areas currently outside the jurisdictional political boundaries (unincorporated county lands) for potential future annexation. Through goals, policies and recommendations, the General Plan provides a short- (within the next 10 years) and long-range (10 to 20 years) comprehensive direction for the growth, conservation, and redevelopment of all physical aspects of the city.

As part of the strategic growth concepts adopted by the City of Phoenix, the Estrella and Laveen areas are two of the major target growth areas identified in the General Plan, and are within the study area. The Rio Montana Plan (2000), prepared for the eastern portion of Laveen, identifies "encouraging development and redevelopment along the Rio Salado that will be compatible with the Rio Salado Habitat Restoration Project" as one of the major issues that is unique to the area. Additionally, the Estrella Plan (1999) identifies "encouraging development along the Rio Salado that will be compatible with the new residential character village" as one of the major issues that is unique within the area (City of Phoenix, 2001).

The City of Phoenix recently completed the Rio Salado Pathway feasibility study evaluating the linkage between 28th Street in Phoenix and Priest Drive in Tempe. The pathway is an accessible, shared-use path on the south bank of the river along the 4-mile stretch adjacent to Phoenix Sky Harbor Airport. The long-term vision is of an established linear park that would provide connectivity between various projects on the river corridor.

### 3.1.5 Studies/Projects Currently Underway

#### *3.1.5.1 South Mountain Corridor Study*

The Arizona Department of Transportation (ADOT) is currently conducting the South Mountain Corridor Study (http://www.dot.state.az.us/ROADS/SouthMtn). The South Mountain Freeway was included in the Regional Freeway System Plan that was approved by Maricopa County voters in 1985. The EIS will first consider whether there is a purpose and need for a project, and if so, will examine the potential social, economic, and environmental impacts of each reasonable alternative, along with ways to lessen those impacts. Currently, several alternatives have been advanced for further study. Several remaining alternatives include crossing the river and project area somewhere between 59th and 91st Avenues. It is assumed that there is potential for a future freeway to cross the project area at some point in the future but that crossing should not adversely affect the Rio Salado Oeste Project. Construction funding for the project is included in the Regional Transportation Plan for 2009-2015.

#### *3.1.5.2 Va Shly'ay Akimel Salt River Feasibility Study*

USACE is currently partnering with the Salt River Maricopa Indian Community and City of Mesa in a feasibility study upstream on the Salt River. The study area encompasses a 14-mile reach of the Salt River extending from immediately downstream of the Granite Reef Dam to the Pima Freeway State Route 101 (SR101). The study efforts are directed toward improving and increasing fish and wildlife habitat values and diversity for threatened and endangered species with potential incidental benefits associated with flood damage reduction, recreation, and water quality and supply. The feasibility study was completed in late 2004 and the Chief's Report was submitted in January 2005. A design agreement and plan are being developed and design on the project is expected to begin in 2006.

#### *3.1.5.3 35th Avenue Bridge Improvements*

The City of Phoenix has designed and is planning improvements to the 35th Avenue Bridge crossing the Salt River within the study area. The purpose is to improve the safety and operation of traffic along 35th Avenue between Broadway Road and Lower Buckeye Road and to provide an all-weather crossing over the Salt River. The existing 35th Avenue Bridge across the Salt

River was built in 1983 as an emergency repair project to replace a bridge that was washed out by flooding. It was built as a half-bridge and designed to accommodate the 35-year flow event, and was planned to be widened and lengthened in the future.

Currently a design for widening is in progress. The proposed work includes construction of a new 5-lane, 8-pier, 9-span precast concrete I-girder bridge with cast-in-place concrete deck slab to replace the existing two-lane bridge. The bridge will be constructed upstream of the current bridge, which will be demolished after traffic is rerouted onto the new bridge. Old fill material on the north and south sides of the river will be excavated and replaced by the new bridge abutments. Rock protection will be placed at the bridge abutments to protect the new bridge. Additional fill will be removed from the river bed to allow the new bridge to convey the 100-year discharge.

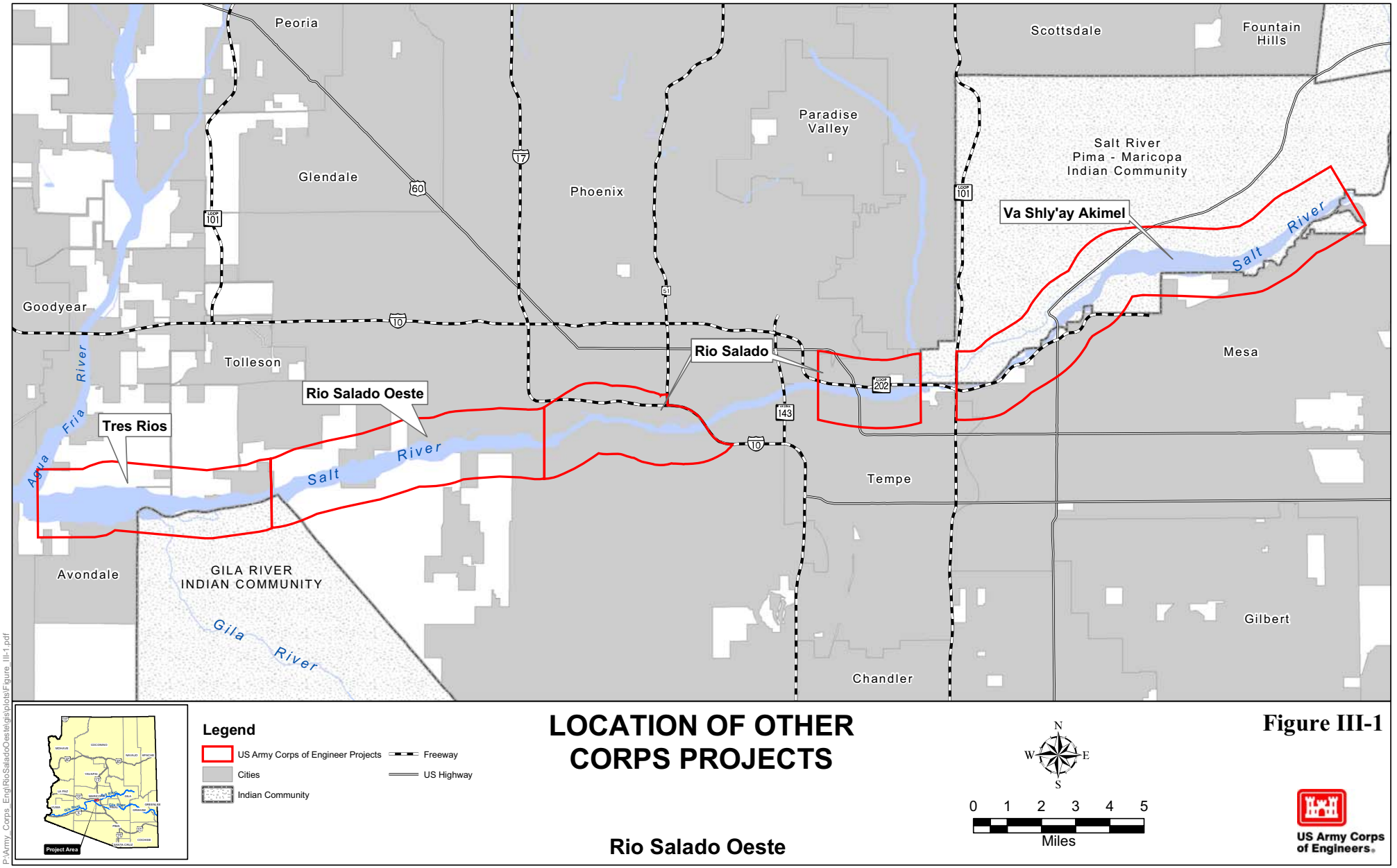
Modifications to this bridge have been considered as part of the future without- and future with-project conditions in planning for the Rio Salado Oeste Project. The new structure would likely be in place prior to construction of any proposal resulting from this feasibility study.

#### *3.1.5.4 Rio Salado Marsh*

The City of Phoenix purchased approximately 250 acres of riverbed between 35th and 51st Avenues and is developing a plan to allow the removal of overburden (river soils and aggregate) in a manner that allows aggregate to be removed while leaving a river cross section suitable for restoration. It is anticipated that conditions conducive to marsh land formation will occur as well as improvements to flood control. The assumed future condition of this reach will include removal of approximately 5.03 million tons of material and an active channel of varying width from 300 to 600 feet. The channel will match the elevation of the existing thalweg through the reach, and will be bordered by terraces approximately 500 feet in width. Effects of this on the water surface elevations will be discussed later in this report.

## 3.2 EXISTING AND ONGOING WATER PROJECTS

The following projects and structures are located within the Salt River watershed. Figure III-1 shows the location of the Rio Salado Oeste Project relative to these other projects.




# LOCATION OF OTHER CORPS PROJECTS

## Rio Salado Oeste

**Figure III-1**

US Army Corps of Engineers

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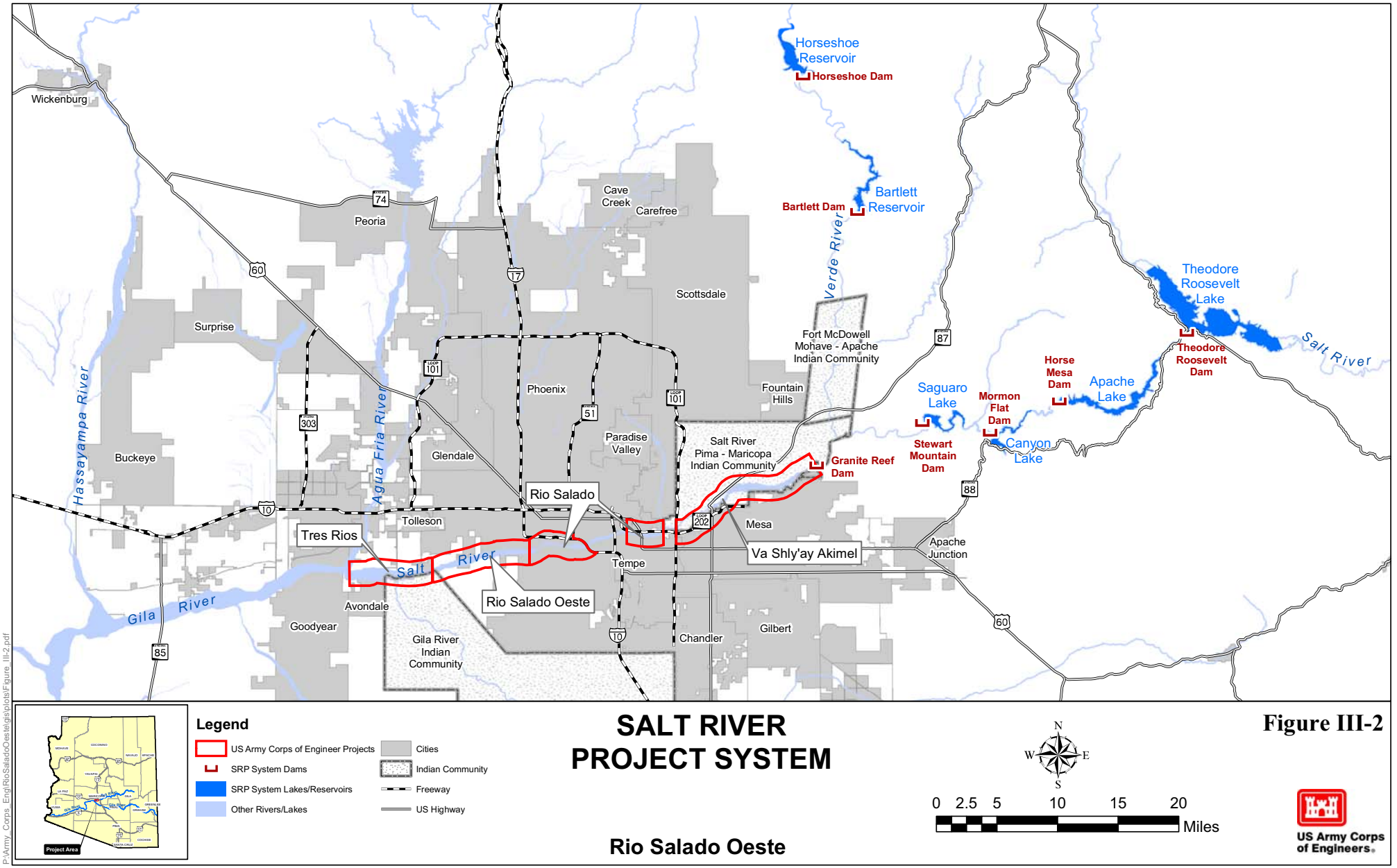
### 3.2.1 Salt River Project System

Flows in the Salt River are controlled by a series of upstream dams built by USBR and operated by the Salt River Project (SRP) (Figure III-2). The SRP system comprises 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 control. The modifications to the dam began in 1989 and were completed in 1996. The 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 WWTP 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 Sub-regional Operating Group (SROG). 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 the 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. This project is immediately downstream of the Rio Oeste study area.




# SALT RIVER PROJECT SYSTEM

## Rio Salado Oeste

**Figure III-2**

US Army Corps of Engineers

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### 3.2.3 Salt River Channelization

In 1996, ADOT and the FCDMC 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 a 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. The dams are located approximately 2 miles apart at the Center Parkway alignment and just upstream of the confluence with Indian Bend Wash. The lake contains approximately 3,500 acre-feet (ac-ft) of 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 place it back into the lake.

### 3.2.5 Rio Salado Project

Upstream of the Rio Salado Oeste Project on the Salt River is the Rio Salado Project. It is a Corps and City of Phoenix project currently under construction. The project area is broken into two reaches, Tempe and Phoenix. The Tempe reach includes a section of Indian Bend Wash and the confluence with the Salt River and restoration of approximately 150 acres of various habitat types. The Phoenix Reach extends from 28th Street west to the 19th Avenue Bridge, which is the upstream extend of the Rio Salado Oeste study area. The Phoenix reach includes restoration of approximately 550 acres. It includes construction of a low-flow channel in the river bottom, and establishment of open water, wetland marsh, cottonwood/willow, open edges, and mesquite habitat on the river bottom and over banks. The recreational elements associated with this project include trails, scenic overlooks, interpretive centers, gathering areas, parking, restrooms, and shade structures. At the time of writing this document most of the Phoenix reach is completed with the last phase of construction anticipated in 2006/2007.

### 3.2.6 Tres Rios Project

Immediately downstream of the study area is another Corps and City of Phoenix ecosystem restoration and flood damage reduction project. The project extends approximately 9 miles from the 91st Avenue WWTP to the confluence of the Gila and Agua Fria Rivers. This project is currently in design with the levee under construction.

The recommended plan is characterized by:

- A regulating wetland to even out diurnal variations in treatment-plant discharge
- Constructed wetlands arranged linearly along the north bank of the river
- A pipeline from the overbank wetland leading to riparian corridors west of El Mirage Road
- Open water/marsh areas within the channel west of El Mirage Road
- Distribution of dewatering well water from the treatment plant to large open water/marsh creation areas along the south side of the river
- Flood control levees

### 3.2.7 Laveen Area Drain Conveyance Corridor

The Laveen Area Drain Conveyance Corridor is part of the Laveen Area Drainage Master Plan and enters the project area at approximately 83rd Avenue. This is a joint project between the FCDMC, City of Phoenix, Maricopa County Department of Transportation, and SRP.

The project includes the design and construction of a conveyance channel capable of containing a 100-year flood event in the vicinity of the existing Maricopa Drain, which runs from 43rd Avenue to the Salt River for a length of approximately 5.8 miles. A flood detention basin at 43rd Avenue and Southern Avenue will mitigate peak flood flows getting to the conveyance channel. The peak discharge at the outfall of the channel for the 100-year storm event is estimated to be 2800 cfs.

Based on previous evaluations of flood hazards within this area, significant floodwater from large storm events ponds along the existing Maricopa Drain. This project will eliminate the potential flood hazard and reduce and/or eliminate potential flood damages. This project consists of channel excavation, road crossings, grade-control structures, tiling and filling in portions of the existing Maricopa Drain, and construction of an earthen low-flow channel. The channel and

basin will be grass-lined to reduce and/or eliminate erosion and sediment transport and to provide landscaping and aesthetics for multiple uses. The project is in construction and is expected to be completed in 2006.

### 3.2.8 43rd Avenue/Southern Avenue Basin

The 43rd Avenue and Southern Avenue Detention Basin was originally included as part of the South Phoenix Drainage Improvement Project. The detention basin has been designed by the FCDMC. The detention basin site has been acquired by the FCDMC, and is located at the southeast corner of 43rd Avenue and Southern Avenue. The basin includes an inlet structure, an inlet spillway, an outlet spillway, and an outlet structure, which will carry flood water to the existing 43rd Avenue storm drain, which outfalls to the Salt River. The basin was constructed as part of the Laveen Area Conveyance Channel Project. Construction was cost-shared between the FCDMC, City of Phoenix, and Maricopa County Department of Transportation.

The basin has 5:1 side slopes and is surfaced with grass for erosion control and aesthetic purposes. The City of Phoenix plans to use the basin as a park facility. The city will own, operate, and maintain the basin upon completion of construction. This project is scheduled to complete construction in the summer of 2006.

### 3.2.9 Durango Regional Conveyance Channel and 75th Avenue Storm Drain

The Durango Regional Conveyance Channel (DRCC) and 75th Avenue Storm Drain Project includes the construction of a storm drain along 75th Avenue from Interstate 10 to the Salt River, construction of a detention basin, construction of approximately 1 mile of channel, and construction of a first flush basin. The DRCC was identified in the Durango ADMP. The City of Phoenix and the FCDMC combined two projects, allowing downsizing of the DRCC project features. The City is the lead for design of the project. The City will be the lead for construction of the storm drain and the FCDMC will be the lead for construction of the DRCC. The storm drain is being designed to convey the 10-year flood, and the DRCC is being designed for the 100-year flood. The combined project will reduce flooding along 75th Avenue and in the area north of the railroad. The detention basin will also serve as a City park. Portions of this project are in construction with others scheduled to begin construction in the Spring of 2006.

# 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 Rio Salado Oeste study area. The future without-project condition is defined as that condition expected to exist in the absence of any action taken (by the Federal Government) to solve the stated problems and is also described as the No Action Alternative. The future without-project condition forecast provides a description of anticipated actions external to the project and the anticipated consequences of these actions.

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 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 without-project conditions is considered in order 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 resource and recreation studies, and economic analysis.

## 4.1 HISTORIC CONDITIONS

Historically, gallery forests of cottonwoods and willows covered hundreds of miles along the lower reaches of rivers like the Salt River in the desert southwest. Optimal conditions for these forests were found along the Lower Salt River prior to 1900. Cottonwood and willow forests are found in depositional environments where fine-grained alluvial soils are located on floodplains. These forests commonly occur with other riparian assemblages because fluvial processes (floodplain aggradation and channel meandering) create environmental gradients and mosaics (e.g., water table depth, inundation frequency), which favor diverse riparian species assemblages.

The Lower Salt River was originally a perennial stream fed by snowmelt from the mountains to the east and the highlands to the northeast. Its clear, streaming waters contrasted greatly with the muddy, sluggish Gila River to the south and west. Flows in the river had a distinct seasonal

pattern, with highest flows occurring in December and January and lowest flows in October. The river had many channel meanders, sand bars, and backwater areas that were conducive to riparian growth.

Prior to dam construction in the early 1900s, the Salt River riparian vegetation was dominated by cottonwood, willow, and the various species of mesquite. This suite of vegetation is considered to be representative of the natural "climax community" of species that would be found in an undisturbed riparian corridor along the Salt River. Mesquites 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 mesquites, 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, walnut, and alder trees grew along the margins of the river exhibiting the highest percent of annual recruitment in the secondary channel, and mesquite, creosote bush, Palo verde, and bursage 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. There were several species of fish in the waters, similar to those found in the Gila River.

Large, dense mesquite forests or bosques are found adjacent to natural and created water retention basins, 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 1 mile long and 600 feet wide), but these are small compared to pre-development bosques, which extended for miles. Mesquite bosques usually are found in the drier habitat areas 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.

Beginning in the early 1900s, the historical conditions of the Salt River were altered by manmade activities, including two significant Federal water projects. First, USBR constructed the SRP system, a series of dams in the Salt and Verde River watersheds. The water supply and hydropower benefits that the dams provided led to the economic development of the Phoenix

metropolitan area. Metropolitan Phoenix has grown from a settlement that supplied food and animal feed to the U.S. Army outposts and mines in the area to its current population of 3.2 million people. Though the SRP project has contributed to the economic success of the Phoenix metro area, the extent of the resulting environmental impacts to the Salt River Basin has only recently begun to be studied and understood, leading to the corrective efforts of this and similar restoration studies and projects.

Due to dams and diversions, perennial flows on the Salt River have ceased. This has caused detrimental environmental impacts to natural wildlife habitat and riparian communities along the Salt River. The elimination of natural base flows reduced Salt River flows to summer or fall rainfall-related flood events. The groundwater table beneath the river dropped. The soil moisture in the riverbed was virtually eliminated, significantly reducing or eliminating microbial and biochemical processes and nutrient cycling, which directly contributed to the rapid decline and loss of the native cottonwoods, willows, and riparian ecosystem of the Salt River Basin. Most areas of the Salt River are barren today and have been significantly impacted by sand and gravel extraction operations. The vegetation observed in the Salt River corridor today is mostly limited to salt cedar, an invasive non-native species with little habitat value, and fragments of poor-quality native riparian vegetation.

## 4.2 EXISTING/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 forms the basis against which alternative plans are developed, evaluated, and compared. The term baseline is also used to refer to the existing conditions at the time of a measurement, observation or calculation and will be used occasionally throughout this report.

### 4.2.1 Geology, Topography, and Geomorphology

Within the study area, the Salt River flows through a major valley with a relatively flat floor of deep alluvium. Soils in the vicinity of the channel are of the hyperthermic torrifluvents association, a group of soils that are well drained to excessively well drained on nearly level or

gently sloping surfaces. They are often sandy to gravelly, but may include lenses of finer particles. These soils are often redistributed by water flows associated with nearby active channels.

Metropolitan Phoenix 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 mountains (ranges). From the end of the Pliocene until recent (Holocene) time, the basins, including the Salt River Valley, filled with unconsolidated and occasional semiconsolidated sediment eroded from the ranges. The thickest accumulations of Valley alluvium formed during the early to middle Quaternary period.

The alluvium of the Salt River Valley is in the final stages of development, as evidenced by the numerous low-lying isolated hills (inselbergs) that project above the valley surfaces. These hills represent peaks of former mountain ranges that are now almost completely buried by alluvial material.

The mountain ranges that border the project area consist mostly of Tertiary-age sedimentary and volcanic rocks that 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. The Tertiary rocks are made up of volcanic basalt, andesite, rhyolite, sedimentary sandstone, siltstone, and conglomerate.

The Phoenix basin consists of Quaternary sediments that constitute the valley fill. These consist mostly of poorly to well-consolidated (cemented) and unconsolidated gravel, sand, silt, and clay, representing several environments and ages of deposition. The total thickness of the alluvial material ranges from near 0 feet along the mountain fronts to nearly 10,000 feet under the valley interior. The valley fill materials tend to be of a coarser consistency near the mountain fronts and finer in the interior of the valley. Near the Salt River, the valley fills have been eroded as the river formed terraces during its evolution.

The predominant surface materials within the 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. Thick layers of alluvium and terrace 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.

Salt River Valley terrace deposits lie exposed above the Salt River channel in locations throughout the project area. The terraces consist of thick, well-cemented to non-cemented sand and gravel and are considered older than the alluvium within the confines of the Salt River. However, contacts between the two types of deposits are gradational at depth, which means they are undifferentiated and both remain of Quaternary age. The terrace and alluvial deposits in turn overlie thick Tertiary sedimentary and volcanic rocks beneath the basin and interface with Tertiary rocks along mountain ranges and inselbergs. The very thick Precambrian basement complex underlies basin terrace and alluvium at maximum depths of greater than 3,300 feet.

Two major soil associations are found within the project study area. Within and immediately adjacent to the river is the Carrizo-Brios Association, with the Gilman-Estrella-Avondale Association to the south. The Carrizo-Brios Association is characterized by deep, excessively drained soils and nearly level to gently sloping, gravelly sandy loams and sandy loams in stream channels on low-stream terraces. The Gilman-Estrella-Avondale Association is characterized by deep, well-drained soils and nearly level loams and clay loams on valley plains and low stream terraces (Maricopa County, 1992).

Flood flows are probably the most important events in the transportation of sediment along the Salt River. Sediment transported in a scour and fill setting by flood flows tends to move in waves or pulses, rather than at a constant rate through time. In essence there are slugs of sediment moving downstream periodically during flow events. Prior to damming of the river, smaller flow events moved sediment (fine sands, silts, and clays) by incising downward into the larger slugs of sediment found in the channel. However, incision and movement of sediment by these smaller events do not compare to the order of material moved during a flood event.

The Salt River through this reach has been relatively stable but still the riverbanks have moved laterally by as much as one-half mile in some locations during the 130-year record. Much of the lands along the south side of the river have been recovered from the active braided channel

system during the period of historical photos. The meander belt varies from approximately 2 miles in width at 19th Avenue to approximately 4 miles in width at 91st Avenue. Lateral migration would not be expected to exceed these limits.

The river is constrained upstream from 19th Avenue by levees constructed as part of earlier projects. The soil cement levees end just downstream from the 19th Avenue Bridge and the river is unconstrained by levees until just above the 91st Avenue WWTP. River alignment is fixed to some extent by bridges located at 35th Avenue, 51st Avenue and additional proposed bridges for a future freeway crossing in the middle section of this reach. The 35th Avenue Bridge is very small and provides a significant constriction to flows. The other bridges have much larger openings and provide less flow constriction. The recent historical evidence examined here indicates that the project reach is in quasi-equilibrium, although adjustments to bank and thalweg lines within the historical meander belt are possible.

Results of a sediment transport analysis show that sediment dynamics are more significant in the proximity of mining operations. The study also revealed that downstream of 35th Avenue the reach experienced mainly erosion while upstream of 35th Avenue the main process was deposition.

For additional information concerning geology of the study reach, please refer to Appendix A, Hydrology and Hydraulics, and Appendix E, Geotechnical Evaluation.

### 4.2.2 Hydrology

#### *4.2.2.1 **Surface Water Hydrology***

The Salt River drains 14,500 square miles of mountainous desert terrain in central and eastern Arizona and is the largest tributary to the Gila River. The river rises in the White Mountains of eastern Arizona and flows generally westward to its junction with the Verde River, a northern tributary that drains the edge of the Colorado Plateau near Flagstaff, Arizona. From this junction near the City of Mesa, the Salt River flows westward across the broad Salt River Valley to its confluence with the Gila River, about 14 miles west of the Phoenix Sky Harbor Airport. The Phoenix metropolitan area is near the center of the Gila River basin and lies within the lower Salt

River Valley. After the junction with the Salt River, the Gila River continues westward and joins the Colorado River near Yuma, Arizona.

Annual average rainfall in the lower Salt River Valley is approximately 8 inches; rainfall at the highest elevations of the watershed ranges up to 14 inches annually (U.S. Geological Survey [USGS], 1991). Rainfall is less than the evapotranspiration rate in all months of the year. Precipitation is derived primarily from two types of weather systems: summer thunderstorms and regional storms. Summer thunderstorms in July and August develop from the flow of subtropical air masses from the Gulf of Mexico. These two months are responsible for the majority of the total annual rainfall. Regional storms from the Pacific Ocean generate gentle, widespread showers during the fall and winter months. Summers are hot, with daily temperatures exceeding 100°F from mid-June through August. Mean daily temperatures in the summer range from 65°F to 104°F. The relative humidity is low, ranging from approximately 20 percent to 50 percent. Winters are mild, with mean daily temperatures ranging from 35°F to 70°F.

Little data exist to document the pre-development, seasonal flow fluctuations in the Salt River. In the pre-settlement era prior to 1900, the river was one of the few perennially watered riparian areas of the Sonoran desert, with highly productive cottonwood, willow, and mesquite habitats. Analyses of pre-development conditions indicate that Salt River stream flow infiltrated and recharged groundwater upstream of Indian Bend Wash near Scottsdale. Groundwater discharged to the channel to provide perennial base flow in downstream sections of the channel (USGS, 1991). Under 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, in light of the length of periods without flow in a river that is perennial under natural conditions.

*Dam System*

During the 20th century, the Phoenix area changed from a mainly agricultural region to a mainly 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 river use 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. See table 3.2-1 for a listing of the dams on the Salt, Verde, and Agua Fria and Gila Rivers.

The Salt River Project (SRP) operates six storage dams on the Salt and Verde Rivers and one diversion dam just east of the City of Mesa. Granite Reef Diversion Dam (Granite Reef) does not have any storage capacity. The purpose of this facility is to divert water released from the reservoirs 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 supply the Phoenix Metropolitan Area with water for agricultural and municipal and industrial (M&I) use. Stored water is allocated based on water rights associated with the land in the SRP service area.

All Salt River dams have hydrogenation capacity. Safety of Dams modifications (completed in 1996) to Theodore Roosevelt Dam include a zone for flood control. The total space for water-supply storage behind these dams is 2,025,798 acre-feet (ac-ft) including the cities' new conservation storage, with an additional 556,196 ac-ft for flood damage reduction at Roosevelt Dam. The Roosevelt Reservoir is the largest reservoir of the SRP reservoir system. It stores runoff from about 5,800 square miles of the Salt River watershed.

Downstream of the Stewart Mountain Dam, the Verde River discharges into the Salt River. The drainage area of the Verde River is about 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 Salt River), which provide an additional 287,403 ac-ft of storage. New Waddell Dam is located on Agua Fria River northwest of Phoenix and downstream of the study area.

**Table IV-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, mods 1994 | 812,100 |
| Bartlett | Verde | Bartlett Lake | 1939 | 178,186 |
| Horseshoe | Verde | Horseshoe Lake | 1949, mods 1951, 1995 | 109,217 |
| Stewart Mountain | Salt | Saguaro Lake | 1930 | 69,765 |
| Mormon Flat | Salt | Canyon Lake | 1938 | 57,852 |
| Horse Mesa | Salt | Apache Lake | 1927, mods 1992 | 248,138 |
| Roosevelt | Salt | Roosevelt Lake | 1911, mods 1996 | 1,653,043 |
| Coolidge | Gila | San Carlos Lake | 1928, mods 1994 | 1,222,000 |
| Painted Rock | Gila | Painted Rock Lake | 1959 | 2,500,000 |

The dams have significantly altered the natural hydrologic regime of the lower Salt River and have changed both the magnitude and timing of flows. The system of dams has eliminated perennial flow and steady, high winter flows. 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. During normal times, SRP releases water from the reservoirs to meet water needs in the Valley. When the reservoirs approach full capacity, a point which SRP is always fully aware, releases above the water order may b initiated. Water released in excess of the water order typically flows over or around Granite Reef Dam and flows into the normally dry Salt River channel. The actual amount is dependent upon numerous variables including: available storage space, forecasts, downstream impacts and constraints, and desired future storage levels. The Granite Reef Diversion Dam is located about three 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 Salt River), and the South Canal (for the area south of Salt River). The canal system generally follows the topographic contour of the the Phoenix metropolitan area in order

to provide gravity flow delivery of water to agricultural, municipal and industrial users. There are no releases during climatically drier years, as occurred between 1942 and 1964. Except for storm water runoff, groundwater emergence and effluent, the Salt River is dry during those times.

**Figure IV-1: Flows in the Salt River on January 19, 2005 (as seen looking NE from an area adjacent to the 51st Avenue Bridge.)**

*Discharge*

Before 1938, an average of 413,000 ac-ft of water flowed through the channel (USACE, 1998). The estimated pre-development, average annual watershed yield was about 1,250,000 ac-ft (USGS, 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 (USACE, 1998).

Hydrologic modeling used to develop a water-control plan for 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 (USACE, 2000). The resulting frequency of spills is approximately once every 3 years. When water is spilled over Granite Reef Diversion Dam, the flow is typically sustained for several days or more, and 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.

Beginning on New Years Eve 2004, SRP began releasing water from Bartlett Dam to accommodate storage for rainfall and snowmelt from the Verde River watershed. The highest recent discharge occurred on February 13, 2005, of approximately 35,000 cfs as recorded by the USGS gauge at 51st Avenue (http://waterdata.usgs.gov/az/nwis/rt).

*Storm Water*

Storm water enters the Salt River at numerous locations in the study area and has the potential to degrade the surface quality of water in the system. 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 will 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 Arizona Pollutant Discharge Elimination System (AZPDES) permits require each industrial site to have 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.

#### *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. Similar quality issues exist for all water sources in the lower Salt River, namely contamination by VOCs and various metals, ions, nutrients, and herbicides.

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 WWTPs and other industries contributes to both surface and subsurface flows. Thus, contaminants do not remain in one part of the system and may affect all water sources. Refer to Table IV-2 for a list of contaminant categories and specific contaminants expected at the Oeste location.

Salt River flows maintain high amounts of mineral content and total dissolved solids (TDS). When flood flows do occur, they commonly violate quality standards for fecal coliform bacteria. 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. The Verde water tends to lower the overall TDS content in flows downstream of their confluence. The quality of water would be sufficient to support native fish species; however, elimination of the base flows does not allow it.

**Table IV-2: Types of Water Contaminants in the Lower Salt River**

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

Source: Graf et al., 1994

Additional discussion of surface water quality can be found in Appendix D, Groundwater Quality and Hydrogeology Report, and Appendix F, Modified Phase I Environmental Site Assessment (ESA).

#### *4.2.2.3 **Groundwater Hydrology***

Prior to development of the Phoenix metropolitan area and construction of upstream reservoirs, the Salt River was a perennial stream. The river was a significant source of groundwater recharge in some areas and a recipient of groundwater discharge in other areas. (See Table IV-3

for estimated predeveloped groundwater hydrology budgets for Salt River Valley. As the area began to be settled, irrigation to support crops was obtained by diverting the stream flow into canals. By the 1900s, much of the Salt River Valley was waterlogged due to recharge from canal seepage and deep percolation combined with a lack of groundwater pumping. Beginning in the 1920s, substantial groundwater pumping began for irrigation and to control shallow groundwater levels. Following World War II, advances in drilling and pump technology allowed extensive pumping from deep aquifers to occur. The result of the groundwater pumping practices was extensive overdraft.

**Table IV-3: Estimated Pre-Development Groundwater Budget for Salt River Valley**

| Source of Inflow | Volume (ac-ft/yr) |
|---|---|
| Stream channel recharge | 100,000 |
| Groundwater inflow | 30,000 |
| Mountain front recharge | 10,000 |
| Total inflow | 140,000 |
| Groundwater discharge to stream channel | 60,000 |
| Evapotranspiration | 76,000 |
| Total outflow | 140,000 |

The groundwater supply beneath the study area is regulated by the Arizona Department of Water Resources (ADWR). To aid in monitoring, ADWR differentiates between groundwater basins. The subsurface geologic conditions in the study reach are within the Phoenix Active Management Area (AMA) of ADWR.

URS Corporation (URS), a private Architectural/Engineering firm conducted a groundwater quality and hydrogeology study for the Rio Salado Oeste Project (April 2002). The current groundwater condition in the study area was presented in the URS study report. According to the report, groundwater generally occurs under unconfined conditions within the Upper Alluvial Unit (UAU). Groundwater flow in the eastern third of the study area (east of 39th Avenue) is generally from the south to north-northwest toward the Roosevelt Irrigation District well field located along or north of Lower Buckeye Road between 19th and 35th Avenues. The groundwater gradient is steepest to the north with values as high as 0.008 ft/ft in the vicinity of 35th Avenue and Lower Buckeye Road. The groundwater-flow direction in the western two thirds of the study area (West of 39th Avenue) ranges from northwest to west. The groundwater gradient flattens to the west with values as low as 0.002 ft/ft. Static water level is relatively

shallow, ranging from 20 to 50 feet below ground surface within the Salt River channel to 60 to 80 feet below ground surface north and south of the river.

Fluctuations in static water level can be as much as 20 to 30 feet on an annual basis due to agriculture pumping demands, and have declined as much as 25 feet in the last five years (Dames & Moore, 1991; Parsons Engineering Science, 2001). Hydrographs of selected wells show this decline is most pronounced in the eastern portion of the site near the Roosevelt Irrigation District well field. The selected wells provided static water levels from both ends of the study area that have the most complete water level records. Contributing factors that may cause the fluctuations are water discharge from the 35th Avenue water treatment plant outfall during winter months that produces groundwater mounding, and related radial flow during periods of discharge and basin-wide groundwater pumping and storm water runoff into the Salt River.

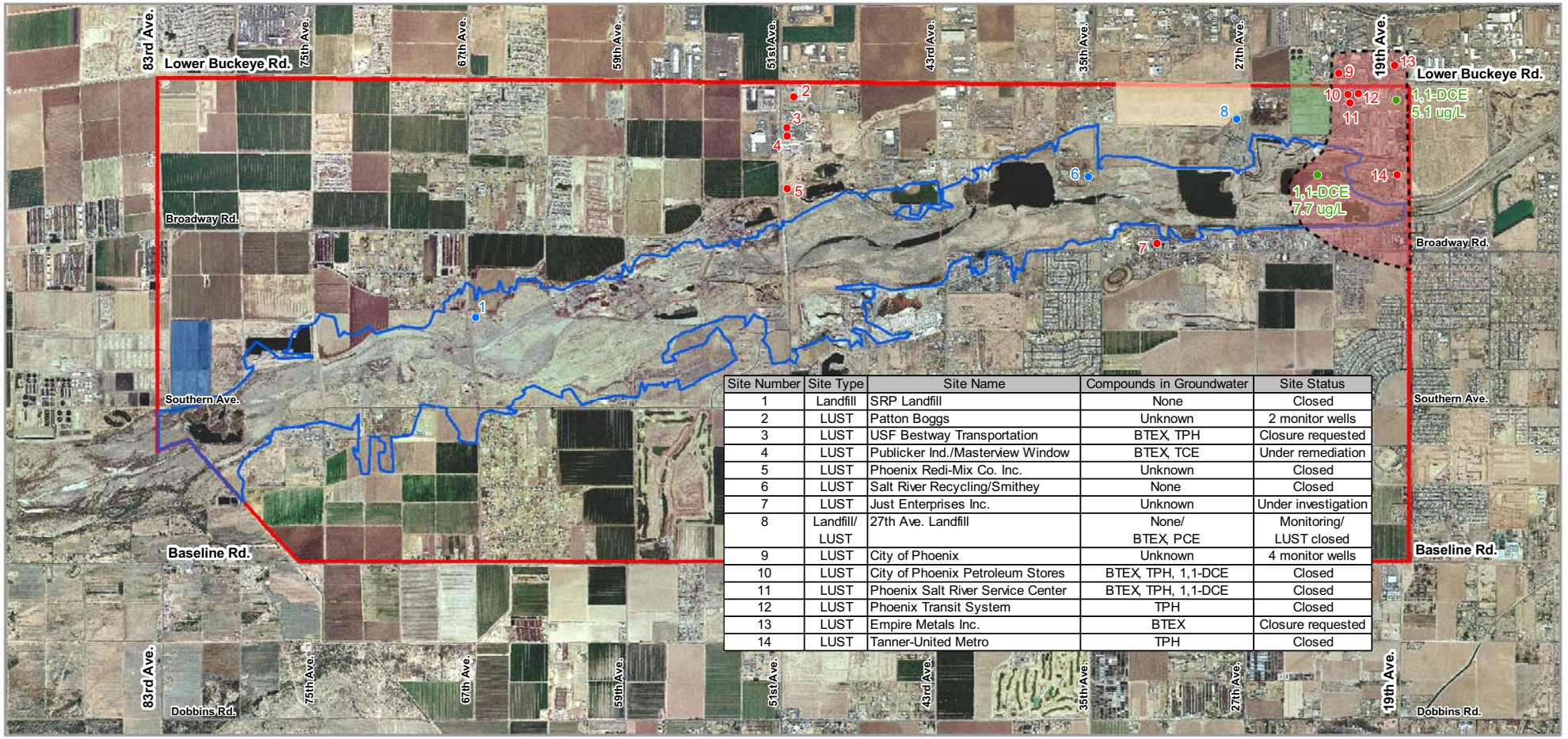
A groundwater contour map of the study area was prepared using ADWR well data from 1997 because it represented the most complete data set available. ADWR collected many water levels from both production and monitoring wells in the month of October, at the end of the pumping season. Water levels represent static values prior to significant precipitation. Some data outside of the study area were incorporated while contouring to fill data gaps. The hydrographs were prepared and reviewed to validate whether the contour map is representative of current conditions. In general the selected wells show a consistent water level decline without radical changes in gradient direction. Therefore, while the groundwater elevation has declined approximately 10 to 20 feet since 1997, the current contours are likely to be similar to the 1997 contours (URS, 2002). For additional information concerning the groundwater hydrology please refer to Appendix C, Groundwater Modeling.

#### *4.2.2.4 **Groundwater Quality***

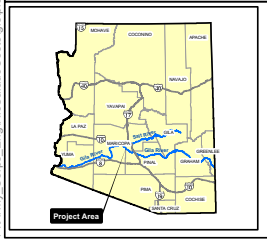
When groundwater pumping was initiated in the Phoenix metropolitan area in the 1920s, the groundwater quality, although high in minerals, was considered to be of very good quality. Today, there are a number of groundwater problems in the Salt River Valley. The problems associated with inorganic chemical constituents include high levels of chloride, TDS, nitrates, and salinity. The problems associated with trace organic constituents include the pesticide dibromochloropropane and volatile halocarbons. Most of the regional problems are currently

limited to groundwater in the UAU. Areas of groundwater quality concern are summarized in the April 2000 URS report and depicted on Figure IV-2. Those sites include landfills and Leaking Underground Storage Tank (LUST) sites. There are also two superfund sites in the study area.

Groundwater in the eastern half of the study area has lower TDS than other portions but has been impacted by petroleum releases of several Underground Storage Tanks (USTs) and may have elevated concentrations of 1,1-DCE. In the southwestern part of the study area data indicate elevated concentrations of TDS and nitrates.




| Site Number | Site Type | Site Name | Compounds in Groundwater | Site Status |
|---|---|---|---|---|
| 1 | Landfill | SRP Landfill | None | Closed |
| 2 | LUST | Patton Boggs | Unknown | 2 monitor wells |
| 3 | LUST | USF Bestway Transportation | BTEX, TPH | Closure requested |
| 4 | LUST | Publicker Ind./Masterview Window | BTEX, TCE | Under remediation |
| 5 | LUST | Phoenix Redi-Mix Co. Inc. | Unknown | Closed |
| 6 | LUST | Salt River Recycling/Smithey | None | Closed |
| 7 | LUST | Just Enterprises Inc. | Unknown | Under investigation |
| 8 | Landfill/ LUST | 27th Ave. Landfill | None/ BTEX, PCE | Monitoring/ LUST closed |
| 9 | LUST | City of Phoenix | Unknown | 4 monitor wells |
| 10 | LUST | City of Phoenix Petroleum Stores | BTEX, TPH, 1,1-DCE | Closed |
| 11 | LUST | Phoenix Salt River Service Center | BTEX, TPH, 1,1-DCE | Closed |
| 12 | LUST | Phoenix Transit System | TPH | Closed |
| 13 | LUST | Empire Metals Inc. | BTEX | Closure requested |
| 14 | LUST | Tanner-United Metro | TPH | Closed |




## Legend

- Project Study Area
- Project Implementation Area
- 27th Ave. Landfill
- Possible extent of 1,1-DCE plume
- 23rd Ave. Wastewater Treatment Plant
- 91st Ave. Wastewater Treatment Plant
- Wells with elevated concentrations of 1,1-DCE
- Sites with known or probable groundwater contamination
- Groundwater investigation sites with no known impacts

# AREAS OF GROUNDWATER QUALITY CONCERN

**Figure IV-2**

March 2005

Source: Groundwater Quality and Hydrogeology Report, (URS 2002a)

## Rio Salado Oeste

N W E S

0 5,000 10,000

Feet

US Army Corps of Engineers

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The Groundwater Quality and Hydrogeology Report and Modified Phase I Environmental Site Assessment (ESA) are included in Appendix D and Appendix F, respectively, and include much more detailed discussion of water quality.

### 4.2.3 Hydraulic Conditions

An existing Flood Insurance Study HEC-RAS model from the confluence with the Gila River (River Mile [RM] 199.82) to about 12th Street (RM 214.14) was provided by FCDMC. This model will be referred to as the FEMA model. The FCDMC also provided aerial photographs from 1993 and 1999, an ArcInfo coverage with contours with a 4-foot interval developed for the Salt/Gila River Master Plan (1992), an ArcInfo coverage with the cut lines of 100 of the FEMA model cross sections, and an ArcInfo Triangular Irregular Network (TIN) of the study area including raw data in point files and breakline format also created for the Salt/Gila River Master Plan (1992). The line coverage included cross sections from RM 202.09 to RM 211.12. Cross section 202.09 is located approximately 1,100 feet downstream of 91st Avenue, while cross section 211.12 is about 2,150 feet downstream of 19th Avenue.

The hydraulic model was used to generate water surface profiles and inundation boundaries for a series of frequency flood events ranging from 5- to 500-year return periods. Small flows are generally contained in the main channel, and only the large flows (100-year and 500-year) occupy significant portions of the floodplains outside the river banks.

### 4.2.4 Water Supply

Since the source of water that provided for the habitat that historically existed on the Salt River has been altered by upstream dams and adjacent development, alternative water sources would be necessary to implement restoration alternatives. Possible sources for that water supply include flood flows, stormwater runoff, effluent, and groundwater. Decisions pertaining to water supply extend beyond source, quality, quantity, and cost but also include existing legal agreements and water rights that apply to both surface and groundwater.

#### *4.2.4.1 **Effluent***

The City of Phoenix Water Services Department has identified the potential availability of an average 8 mgd of reclaimed water from the 23rd Avenue WWTP. It was recommended that the capacity to handle as much as 20 mgd to accommodate large diurnal variations in flow should be incorporated into the water supply system. Project planning should also account for "no-flow" periods of up to 12 hours. Note: 1 mgd = 1.55 cfs or 3.07 ac-ft/day.

#### *4.2.4.2 **Storm Water***

Although highly dependent on rainfall and not necessarily a consistent source, storm water runoff must be considered in project planning. Table IV-4 provides initial information pertaining to storm water outfalls, their locations, and sizing. While the outfalls listed in Table IV-4 are present in the study area not all of them currently reach the river channel. The Interior Drainage Report in Appendix B includes a detailed description of potential storm water runoff to the study area.

**Table IV-4: Storm water Outfalls within the Study Reach**

| Outfall # | Site Location | Pipe Size | Comments |
|---|---|---|---|
| SR01 | 51st Avenue and Salt River - North Side | 96 inch | |
| SR02 | 43rd Avenue and Salt River - North Side | 90 inch | |
| SR03 | 35th Avenue and Salt River- North Side | 75 inch | |
| SR04 | 27th Avenue and Salt River- North Side | 72 inch | 23rd Ave. WWTP discharges |
| SR05 | 25th Avenue and Salt River- North Side | 102 inch | |
| SR06 | 22nd Avenue and Salt River- North Side | 78 inch | |
| SR30 | 27th Avenue and Salt River- South Side | 108 inch | FCDMC first flush sample sta. |
| SR47 | 51st Avenue and Salt River- North Side | 48 inch | |
| SR48 | 45th Avenue and Salt River- South Side | 48 inch | |
| SR49 | 67th Avenue and Salt River- North Side | 96 inch | FCDMC first flush sample sta. |
| SR58 | 35th Avenue and Salt River- N/E Side | 60 inch | |
| SR59 | 2333 W. Durango (23rd Ave. WWTP east side of 35th Avenue and Salt River) - North Side | 48 inch | Part of SR05 conveyance system |

Storm water may prove sufficient to support ephemeral wetlands or even riparian habitat in portions of the study area. Table IV-5 on the next page provides a summary of outfalls that provide storm water flows to the river channel and that will be considered to potentially provide source water for restoration features. The modification of storm water outfalls to capture runoff to support habitat will be discussed further later in this report.

## Table IV-5: Storm water Outfalls and Estimated Average Runoff in Acre-Feet (AF)

| No. | Site Location | Jan (AF) | Feb (AF) | Mar (AF) | Apr (AF) | May (AF) | Jun (AF) | Jul (AF) | Aug (AF) | Sep (AF) | Oct (AF) | Nov (AF) | Dec (AF) | Annual (AF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SR01[1,2] | 51st Avenue and Salt River - North Side | 23.9 | 24.7 | 31.6 | 8.0 | 4.4 | 4.7 | 29.6 | 34.3 | 30.7 | 23.3 | 23.6 | 35.7 | 274 |
| SR02[1,2] | 43rd Avenue and Salt River - North Side | 23.9 | 24.7 | 31.6 | 8.0 | 4.4 | 4.7 | 29.6 | 34.3 | 30.7 | 23.3 | 23.6 | 35.7 | 274 |
| SR03[1,2] | 35th Avenue and Salt River- North Side | 19.5 | 20.2 | 25.7 | 6.5 | 3.6 | 3.8 | 24.2 | 28.0 | 25.1 | 19.0 | 19.3 | 29.1 | 224 |
| SR04[1,2] | 27th Avenue and Salt River- North Side | 29.6 | 30.7 | 39.2 | 9.9 | 5.4 | 5.8 | 36.8 | 42.6 | 38.1 | 29.0 | 29.3 | 44.3 | 341 |
| SR05[1,2] | 25th Avenue and Salt River- North Side | 10.9 | 11.3 | 14.4 | 3.6 | 2.0 | 2.1 | 13.5 | 15.6 | 14.0 | 10.6 | 10.8 | 16.3 | 125 |
| SR06[1,2] | 22nd Avenue and Salt River- North Side | 48.8 | 50.5 | 64.5 | 16.3 | 9.0 | 9.5 | 60.6 | 70.1 | 62.8 | 47.7 | 48.2 | 72.9 | 561 |
| SR07[1,2] | 19th Avenue and Salt River- North Side | 6.9 | 7.1 | 9.1 | 2.3 | 1.3 | 1.3 | 8.5 | 9.9 | 8.8 | 6.7 | 6.8 | 10.3 | 79 |
| SR30[1,2] | 27th Avenue and Salt River- South Side | 17.1 | 17.7 | 22.6 | 5.7 | 3.1 | 3.3 | 21.2 | 24.5 | 22.0 | 16.7 | 16.9 | 25.5 | 196 |
| SR31[1,2] | 19th Ave, South Bank | 20.1 | 20.8 | 26.6 | 6.7 | 3.7 | 3.9 | 25.0 | 28.9 | 25.9 | 19.6 | 19.9 | 30.0 | 231 |
| SR48[1,2] | 45th Avenue and Salt River- South Side | 142.7 | 147.6 | 188.6 | 47.6 | 26.2 | 27.9 | 177.1 | 205.0 | 183.7 | 139.4 | 141.0 | 213.2 | 1640[3] |
| SR49[1,2] | 67th Avenue and Salt River- North Side | 48.5 | 50.2 | 64.1 | 16.2 | 8.9 | 9.5 | 60.2 | 69.7 | 62.5 | 47.4 | 48.0 | 72.5 | 558 |

1. Monthly storm water runoff distributions were assumed to follow the monthly pattern of rainfall.
2. Annual runoff volumes were computed from the drainage area versus average annual runoff relationships developed for the Rio Salado Study.
3. 1640-acre feet based upon drainage area; however, it is anticipated that runoff from this will decrease with modification in design/construction.

#### *4.2.4.3 **Flood Flows***

The Salt River is dry most of the time due to the upstream dams that were constructed for water supply to agriculture and the Phoenix valley. Although the river is subject to flooding, flood water can only be considered a possible supplemental water supply for a restoration project. Discharge-frequency values are provided in Table IV-6 and more detailed information on flood flows can be found in Appendix A, Hydrology and Hydraulics. The 100-year floodplain is shown on Figure IV-3.

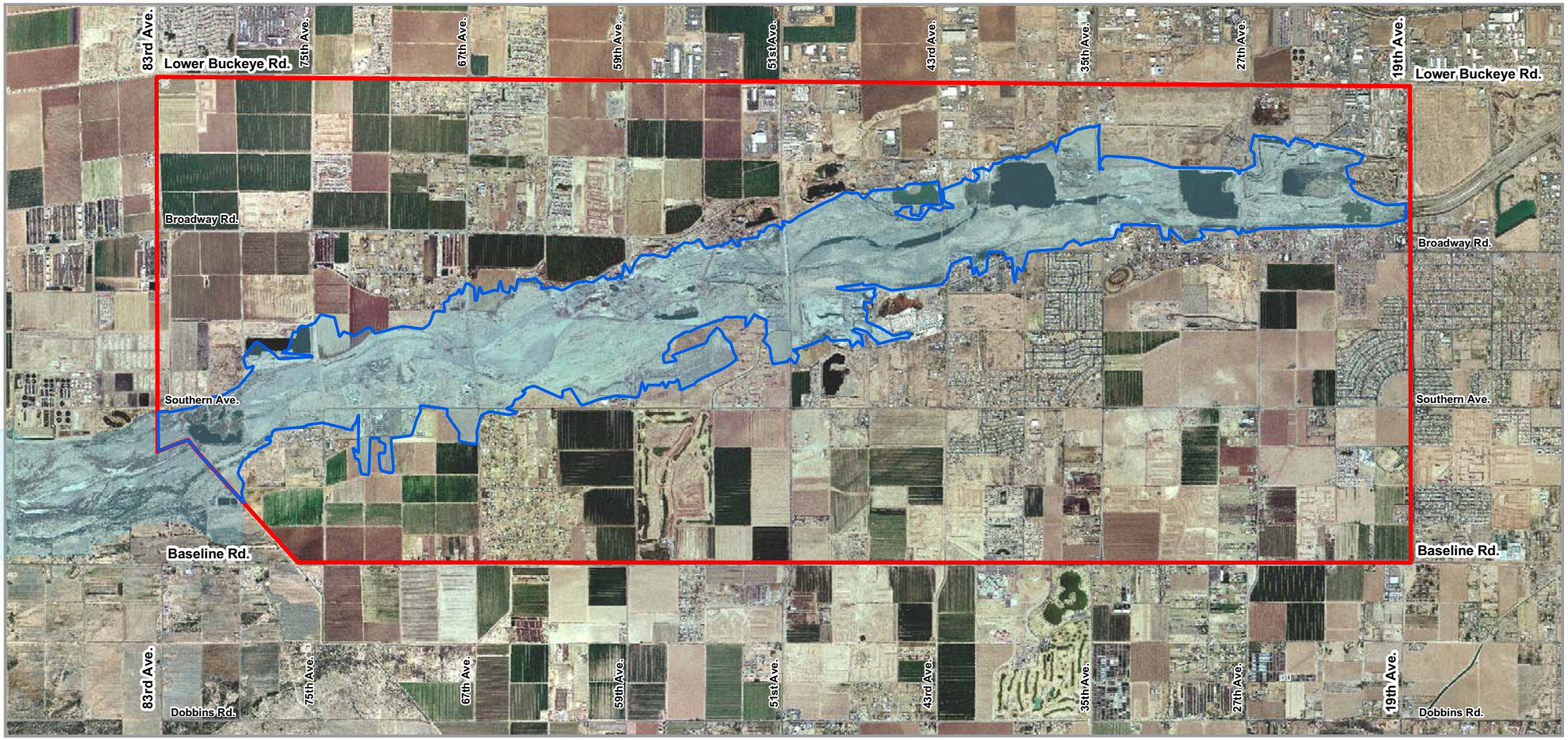
While not necessarily a preferred source for delivery of water and implementation of restoration measures, flood flows need to be considered in plan formulation. In a natural system, they provide the necessary dynamics to maintain the ecosystem and are an important factor in seed dispersal. Measures considered in the formulation of plans should account for the possible damages off loading as well as the potential advantages of flooding—flooding may provide benefits towards project sustainability.

**Table IV-6: Discharge-Frequency Values Used in the Existing Conditions Model**

| Location | Return Period | | | | | |
|---|---|---|---|---|---|---|
| | 5-yr | 10-yr | 20-yr | 50-yr | 100-yr | 500-yr |
| Peak Discharges ($ft^3/s$) in the Salt River at: | | | | | | |
| Central Avenue | 20,200 | 53,000 | 87,000 | 135,000 | 166,000 | 240,000 |
| 67th Avenue | 20,000 | 51,000 | 84,000 | 132,000 | 164,000 | 237,000 |

#### *4.2.4.4 **Groundwater***

The Salt River was once a perennial stream, and groundwater levels were shallow and provided for a significant amount of riparian and wetland habitat. Today, static water level ranges from 20 to 50 feet below ground surface within the Salt River channel to 60 to 80 feet below ground surface north and south of the river. Data indicate that over the past 25 years groundwater elevations in the study area have decreased approximately 15 to 20 feet.





**Legend**

- Project Study Area
- Project Implementation Area
- 100-Year Floodplain

March 2006

# 100-YEAR FLOODPLAIN

**Rio Salado Oeste**

N
W E
S

0 5,000 10,000
Feet

**Figure IV-3**

US Army Corps of Engineers

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Groundwater quality in the eastern half of the study area has been impacted by hydrocarbon releases and elevated concentrations of 1,1-DCE. Elevated concentrations of TDS and nitrates are of concern on the southwestern side of the project area.

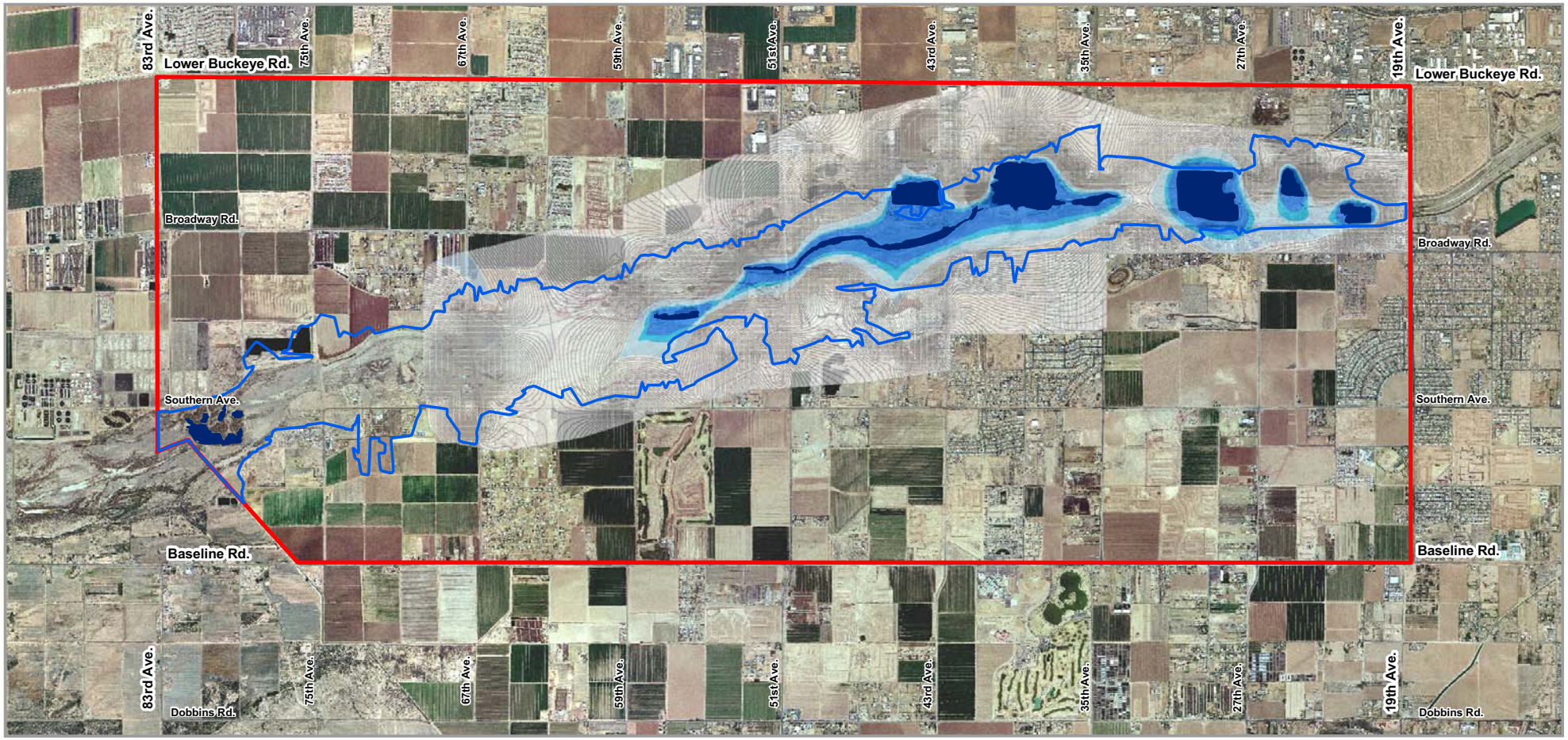
The subsurface geologic conditions in the study reach are within the Phoenix AMA and are regulated by the ADWR. The City has the rights to pumping of groundwater for their service area but would prefer to pursue other sources prior to considering groundwater as a project source. Figure IV-4 depicts an approximation of existing depth to groundwater within the study area, based upon extrapolation of 2002 ADWR well data and observed water levels in excavated gravel pits.

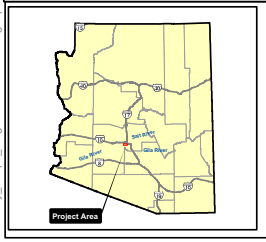
### 4.2.5 Land Use

The study area is located in a rapidly developing and changing area of metro Phoenix. Land uses range from industrial and commercial to residential and agriculture. Estrella Village and Laveen Village are the two primary planning areas that lie adjacent to the Salt River between 19th Avenue and 83rd Avenue. Estrella Village is characterized by an ample supply of undeveloped land, large parcels, natural and scenic amenities, and excellent transportation access. Approximately 62 percent of the Village is undeveloped, either vacant or with agricultural uses. However, there are at least 21 residential developments in various phases of approval and development.

The Laveen Village contains largely undeveloped and agricultural properties. Primary agricultural crops grown in the area include cotton, citrus, and corn. Farmers, equestrians, and those looking for solitude and mountain access have valued the area. However, development pressures have increased in this area due to its proximity (about 7 miles) to downtown.

Based upon the City of Phoenix General Plan (Revised February 2001), most of the land area on the north side of the river between 19th and 59th Avenues is zoned industrial, with some high-density residential between 43rd and 60th Avenues. From 60th to 83rd Avenues, the primary land use is low-density residential. To the south, some land between 19th and 35th Avenues is zoned as commercial otherwise, the prevailing land use is low- to medium-density residential.




**Legend**

- Project Study Area
- Project Implementation Area

**Depth to Groundwater**

- Surface Water
- 0 - 3 Feet
- 4 - 5 Feet
- 6 - 10 Feet
- 11 - 112 Feet

March 2005

# DEPTH TO GROUNDWATER

**Rio Salado Oeste**

**Figure IV-4**

N W E S

0 5,000 10,000

Feet

US Army Corps of Engineers.

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#### *4.2.5.1 Future Land Use*

As of July 2003 there were approximately 35,000 approved lots in the Laveen and Estrella Villages. At this rate of growth it is assumed that by 2009 the majority of the lands adjacent to the river will be developed and converted from agriculture to urban.

#### *4.2.5.2 Aggregate Mining*

As seen in Figure IV-5 below, since the construction of upstream dams began controlling the flows in the Salt River, sand and gravel mining operations moved into the riverbed and surrounding floodplain to mine the natural resource. The materials extracted from the river have been used extensively throughout the development of the Phoenix Metropolitan area and have contributed to geomorphic changes to the floodplain and adjacent over bank. Removal of sediments also removes materials that would normally be redeposited during flood events.

**Figure IV-5: Aggregate mining within the project area.**

There are an estimated 671 acres of sand and gravel mining operations within the 100-year floodplain of the project area. Between 19th and 35th Avenues, the river is lined with operations

and is nearly 100 percent modified. South of the river between 43rd Avenue and 51st Avenue there are mining operations that cross the river just downstream of 51st and extend on the north side to near 63rd Avenue. Two new operations are in the permitting process between 51st and 67th Avenues. It is assumed that the existing mining operations will continue operating until resources and demand dictate that they are no longer feasible in their existing locations. As can be seen to the west of 51st Avenue, new operations will begin in previously un-mined portions of the river, close to new development.

### 4.2.6 Vegetative Habitat

Historically, the study area supported significant biological resources including extensive riparian and wetland habitats within the floodplain. 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 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. 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 manmade artificial communities. Included in this reach of the Salt River are a large number of open water areas, mostly the results of gravel mining. Adjacent to several of these there is dense vegetation including some cottonwood and willows as well as the occasional cattail or bulrush.

#### *4.2.6.1 Cover Types*

A classification system of cover types was developed for this study and is mainly based upon vegetation cover. Cover types were mapped for the length of the study reach and 1 mile on either side of the thalweg, or center of the river channel. Scattered remnants of natural vegetation remain; those cover types include cotton-willow forest, mesquite, scrub-shrub lands, and emergent wetlands. Of those cover types, scrub-shrub lands are the most dominant in the study area, covering approximately 1,200 acres. The scarcest is cottonwood/willow forest, extant within merely 10.5 acres (not including an additional 120 acres in which salt cedar dominates Figure IV-6 below).

**Figure IV-6: Landscape dominated by Salt Cedar (83rd Avenue)**

*Cottonwood/Willow Forest*

Cottonwood/willow forest 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.

Because of the modification of the Salt River system, groundwater elevations have been lowered and have contributed to the decline in cottonwood and willow species. These same conditions have also favored the establishment and dominance of salt cedar. 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 salt

cedar. 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 salt cedar.

*Scrub-Shrub Lands*

Scrub-shrub lands are common and are present within the active channel of the river occupying 12 percent of the project study area (Figure IV-7). They are dominated by various combinations of burrobush, rabbitbush, quailbush, saltbush, and occasionally by creosotebush. 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. Throughout drainages in the Sonoran Desert there are dense areas of scrublands which are too dense to be considered desert scrub. They usually contain the same species found in the drier desert scrub but area usually more dense and also contain distinctive riparian species including Seepwillow, desert broom, or Desert willow. While river bottom, scrub shrub and riparian scrub are often referred to interchangeably by different disciplines this report will attempt to specify the difference.

**Figure IV-7: Scrub-Shrub Lands Dominated by Saltbush and Rabbitbush.**

*Wetlands (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 and mostly associated with effluent or storm water discharges (Figure IV-8). These features are characterized by either seasonal or perennial open water, and are generally unvegetated when present. Vegetation, when present, consists of scattered patches of Bermuda grass, salt heliotrope, and sedges.

**Figure IV-8: Low-Flow Channel with Wetland Vegetation (immediately upstream of 51st Avenue Bridge)**

*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 adjacent to the project study area on the Gila River Indian Community. Although scattered mesquite occurs throughout the study reach there are no large stands that could be considered mesquite woodlands.

#### *4.2.6.2* ***Habitat Evaluation***

*Hydrogeomorphic Modeling Process*

The Hydrogeomorphic Modeling (HGM) approach was chosen for habitat evaluation on the Rio Salado Oeste because of its ability to provide an analysis of the processes and conditions necessary for restoration and maintenance of riparian and wetland habitat. The HGM—developed by scientists and the Engineering Research and Development Center (ERDC)—allows existing community characteristics, composition, and function to be compared to fully functional systems. 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. The ability of a riverine system to have and sustain a majority of the identified functional components of a wetland ecosystem directly correlates to the quality, quantity, and type of riparian habitat that can establish and survive.

In arid regions, biological resources are typically concentrated along riparian systems. This feasibility study relies on the results of a Hydrogeomorphic Approach to Wetlands Assessment Methodology to yield quantitative descriptions of biological resources along and adjacent to the Salt River in the study area. HGM was chosen for its broad analysis of processes and conditions necessary for support of riparian habitat. Riparian components including size, substrate characteristics, and species composition will be considered in quantification of the biological resource function and value.

An HGM approach treats the biota of an area as the outcome of an ecological process. It also merges these biological events with hydrologic and geologic process 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, and 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 fully 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 the 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.

Using this methodology, the Salt River was classified as Riverine Over bank. The Salt River is also characterized regionally as arid and Southwestern. As such, the functions developed in an existing Riverine Over bank Subclass model were modified for Arizona low gradient rivers to be applied in the standard HGM approach for this study. The model for Arizona was further calibrated in a workshop with the Environmental Laboratory of ERDC, the Los Angeles District Corps, local sponsor representatives from the City of Phoenix, City of Tucson, Town of Marana, Pima County Flood Control District, Salt River Pima-Maricopa Community, AGFD, U.S. Fish and Wildlife Service (USFWS), and representatives from the scientific community. Field sampling results based on the calibration of the model during the workshop are used in the analysis of alternatives.

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

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

- Organic Soil Flats
- Riverine

The level of variability in the continental-scale wetland hydrogeomorphic classes presented above is too large 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 Rio Salado Oeste 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, five PWAAs were defined for the Rio Salado Oeste Project on the basis of species recognition and dependence, soil types, and topography. The dominant 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.

*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. Wetland functions 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, and 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 an FCI.

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 HGM FCI models used in this study are found in Table IV-7.

## Table IV-7: Wetland Functions Evaluated

| Wetland Function (symbol) | Description |
|---|---|
| Function 1: Maintenance of Characteristic Channel Dynamics (CHANNELDYN)<br><br>$(V_Q+V_{FPA}+V_{SED})/3$ | 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)<br><br>$(V_{FREQ}*(V_{FPA}+((V_{TOPO}+V_{TVV}+V_{CWD})/3)/2))^{1/2}$ | 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)<br><br>$(((V_{TOPO}*V_{FREQ})^{1/2})*(((1 - V_{PORE})+V_{SUBIN})/2))^{1/2}$ | 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)<br><br>$(V_{DEPSATSED})$ | Availability of water storage beneath the wetland surface. Storage capacity becomes available due to periodic drawdown of water table. |
| Function 5: Nutrient Cycling (NUTRIENT)<br><br>$((V_{TVV}+(3*V_{AGSA})/4)+((V_{DECAY}*((V_{LITTER}+V_{FWD}+V_{CWD})/3))^{1/2}))/2$ | Abiotic and biotic processes that convert elements from one form to another; primarily recycling processes. |
| Function 6: Detention of Imported Elements and Compounds (ELEMENTS)<br><br>$(((V_{FREQ}+V_{SURFIN}+V_{SUBIN})/3)+((V_{AGSA}+V_{LITTER}+(1-V_{PORE}))/3)+V_{TVV})/3$ | 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. |

| Wetland Function (symbol) | Description |
|---|---|
| $((2*V_{FPA})+V_{TOPO}+((V_{CWD}+V_{FWD}+V_{SED}+V_{TVV})/4))/4$ | |
| Function 8: Maintain Characteristic Plant Communities (PLANTS)<br><br>Cottonwood/willow and Mesquite Communities: $(((((V_{SPECRICH}+V_{WIS}+V_{INVASIVES})/3)*((V_{CANHERB} + V_{CANSHRUB} + V_{CANTREE})/3))^{1/2}) * V_{LANDBUFF})^{1/2}$<br><br>Scrub-Shrublands Communities: $(((((V_{SPECRICH}+V_{WIS}+V_{INVASIVES})/3)*((V_{CANHERB} + V_{CANSHRUB})/2))^{1/2}) * V_{LANDBUFF})^{1/2}$<br><br>River Bottom Communities: $(((((V_{SPECRICH}+V_{WIS}+V_{INVASIVES})/3)*(V_{CANHERB}))^{1/2}) * V_{LANDBUFF})^{1/2}$ | 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)<br><br>$(((V_{VEGSTRATA}+((V_{CWD}+V_{FWD}+V_{LITTER})/3))/2) * V_{LANDBUFF})^{1/2}$ | The capacity of the wetland to support animal populations and guilds by providing heterogeneous habitats. |
| Function 10: Maintain Interspersion and Connectivity (INTERSPERS)<br><br>$(((V_{FREQ}+V_{TOPO}+V_{CONTIG}+V_{TRIB})/4) * V_{LANDBUFF})^{1/2}$ | 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 pf the wetland to permit access for terrestrial or aerial organisms to contiguous areas of food and cover. |

*Selecting and Modifying the HGM Models*

In the HGM methodology, an 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 00.00 represents low functional capacity for the wetland and 1.0 represents high functional capacity for the wetland.

FCU is the unit of measure of the ability of a wetland to perform a certain function and is calculated by multiplying an FCI by the area of the wetland. FCI x acreage = FCU. When evaluating restoration alternatives, with-project FCU will be compared to without-project FCU. The change in FCU will be the unit of measurement of the outputs from restoration measures.

*Environmental Output*

Baseline (existing conditions) results for the Rio Salado Oeste Project area are shown below in Table IV-8. These results show that riparian and wetland habitats within the study area have low functional values and are therefore highly degraded. Figure IV-9 below depicts the FCI graphically.

**Table IV-8: Baseline Conditions Analysis Results**

| Function | Function Name | Baseline FCI | Baseline FCU |
|---|---|---|---|
| 01 | Maintenance of Characteristic Channel Dynamics | 0.23 | 41.4 |
| 02 | Dynamic Surface Water Storage/Energy Dis. | 0.42 | 74.9 |
| 03 | Long Term Surface Water Storage | 0.25 | 45.2 |
| 04 | Dynamic Subsurface Water Storage | 0.44 | 78.3 |
| 05 | Nutrient Cycling | 0.28 | 49.6 |
| 06 | Detention of Imported Elements and Compounds | 0.38 | 66.9 |
| 07 | Detention of Particulates | 0.33 | 58.9 |
| 08 | Maintain Characteristic Plant Communities | 0.42 | 74.8 |
| 09 | Maintain Spatial Structure of Habitat | 0.30 | 53.1 |
| 10 | Maintain Interspersion and Connectivity | 0.23 | 40.1 |
| | AVERAGE/TOTAL | 0.33 | 583 |

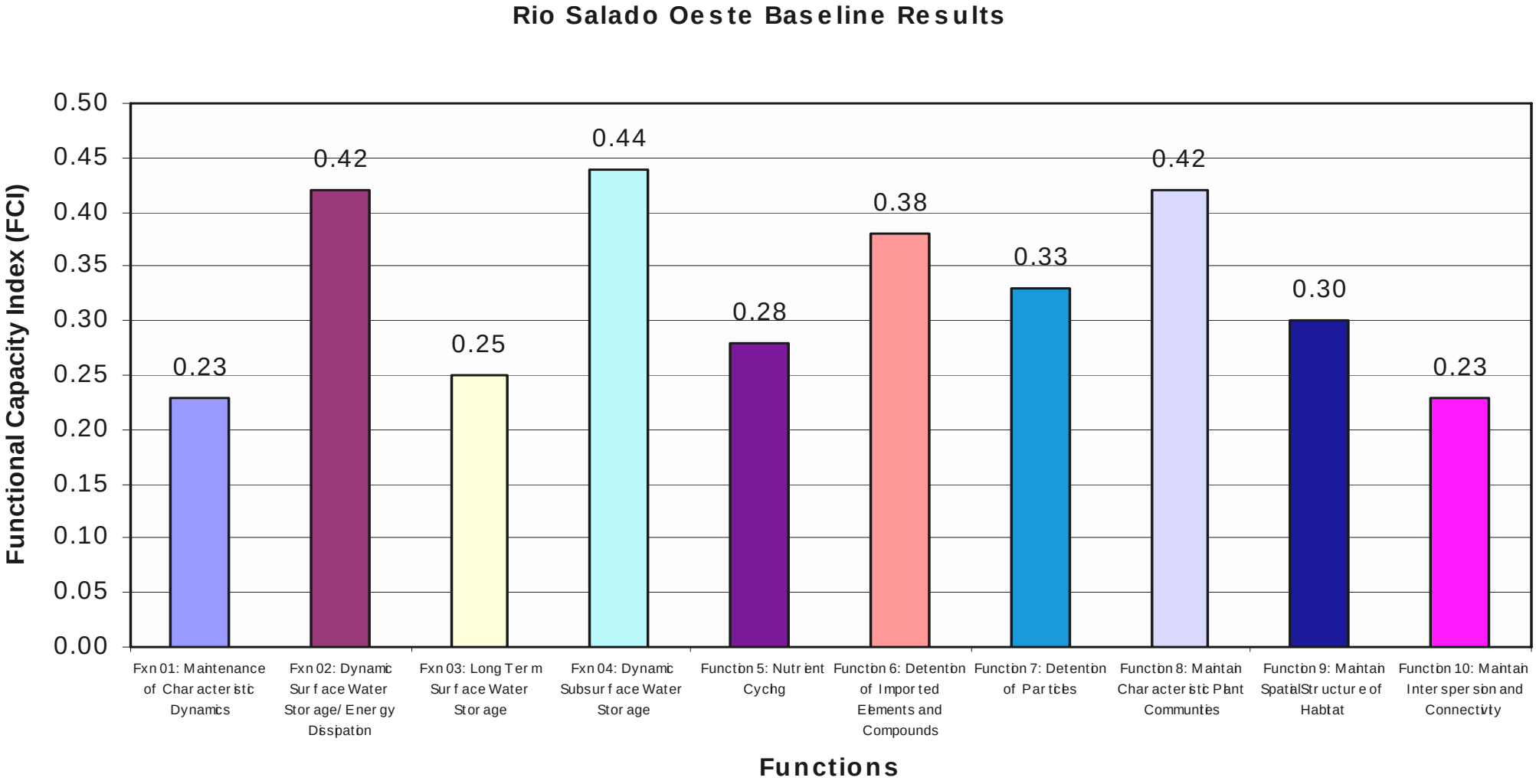



**Figure IV-9: FCI for the Rio Salado Oeste Study Area**

### 4.2.7 Hazardous, Toxic, or Radioactive Waste

The presence of Hazardous, Toxic, and Radioactive Wastes (HTRW) within the study area was evaluated for the study. Because of the size of the project study area, approximately 20 square miles total, a typical Phase I ESA was not possible. Consequently, a Modified Phase I ESA was decided to be most appropriate for the size of the project. The basic difference is that a site reconnaissance of every property within the project area would not be conducted, as infeasible. The Modified Phase I ESA was conducted to review past and current land use practices along the site corridor to identify areas of known or suspected contamination that may environmentally impact the subject property. URS completed the assessment under contract to the City of Phoenix. The entire report is found in Appendix F of this report.

The Modified Phase I ESA was accomplished by, and limited to, a visual reconnaissance of the site from existing rights-of-way and public areas, a drive-by survey of the site corridor (or vicinity), a review of publicly available records (including aerial photographs), and a review of pertinent documentation presently and readily available from the client and/or through URS' standard resources. The site corridor is defined as the neighboring properties and facilities along the Salt River within an approximate distance of 1 mile north and south of the river's centerline, the nature of which may adversely affect or have affected environmental conditions at the site due to the presence and/or release of hazardous substances or petroleum products to the environment. The following activities were conducted in accomplishing the Phase I ESA:

- Review of aerial photographs
- Review and interpretation of available archival topographic maps, historical land use maps of the site for information regarding historical site land use that could have involved the manufacture, generation, use, storage and/or disposal of hazardous substances
- Review of the following State and Federal agency lists of known or potential hazardous waste sites, and sites currently under investigation for potential environmental violations as prescribed by the American Society for Testing and Materials. All databases were

searched for areas approximately 1 mile from the Salt River centerline to include the project corridor study area (or buffer area):

Federal National Priorities List (NPL) site list

Federal Comprehensive Environmental Response, Compensation, and Information System (CERCLIS) list

Federal Resource Conservation and Recovery Act (RCRA) CORRACTS TSD facilities list

Federal RCRA non-Corrective Action Report (CORRACTS) Treatment, Storage, and Disposal (TSD) facilities list

Federal RCRA generators list

Federal Emergency Response Notification System (ERNS) list

State lists of hazardous waste sites identified for investigation or remediation:

State-equivalent NPL

State-equivalent CERCLIS

State landfill and/or solid waste disposal site lists

State LUST lists

State-registered UST lists

- Review of previous environmental reports conducted within or relating to the Oeste study area
- Performance of an onsite visual reconnaissance of the subject property and the area within 1-mile of the Salt River centerline in each direction to make visual observations of existing site conditions, activities, and types of land use and businesses within the project corridor area

Sites identified with possible HTRW concerns are for the most part outside the 100-year floodplain and location where project features would be located. Project features are located within the 100-year floodplain and avoid the known HTRW sites. In accordance with Engineer Regulation 1165-2-132, the Corps would not participate in clean up of materials regulated by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or by the RCRA.

#### *4.2.7.1 "Wildcat" Dumping*

"Wildcat" or uncontrolled, random dumping of materials has occurred and continues to occur along the river and study area. This dumping includes soils, concrete, asphalt, household and landscape waste, etc. The reach between 35th and 51st Avenues was at one time littered with such waste materials. However, the City of Phoenix has implemented changes that significantly reduced the amount of dumping in this through barricades and increased policing. It should be assumed that some waste is still present within the study area.

#### *4.2.7.2 Landfills*

There are three closed landfills within the study area. These include the 27th Avenue Landfill which was closed in 1995, and the SRP landfill (North of the river at 67$^{th}$ Avenue), closed in 2000. The 19th Avenue landfill, located east of 19th Avenue, has been closed and a remediation plan has been implemented. Groundwater monitoring is conducted at the landfills. Although these landfills are within the study area they are outside the possible location for project features and should not have any impact on the project.

#### *4.2.7.3 Leaking Underground Storage Tanks (LUSTs)*

Thirteen LUST sites with monitoring wells on record with ADWR were identified within the study area. Description of the sites can be found within Appendix D, Groundwater Quality and Hydrogeology Report. These sites may have impacts to local soil and water conditions but are not considered likely to affect the project to be implemented within the floodplain.

### 4.2.8 Cultural Resources

#### *4.2.8.1* ***Prehistory***

*Paleoindian and Archaic*

Thus far there are no known Paleoindian sites in the Phoenix Basin or surrounding environs. Little is known of the archaic occupation of the area, but newly acquired excavation data is becoming available. The current construction boom in Scottsdale has required new surveys,

which in turn has prompted excavation of previously unknown archaic sites. Presently, much of that information is locked up in unpublished, possibly proprietary reports.

*Hohokam*

The principal prehistoric cultural manifestation in the project area is the Hohokam culture. Hohokam is a Pima word that means "those who have gone" (Gladwin and Gladwin, 1933), or more poetically, "those who have vanished" (Wormington, 1973). The name Hohokam has endured and is still the preferred name in spite of the renaming of some other prehistoric cultures being renamed. The four southern O'odham tribes crafted a policy statement that stated, "We recognized Indian Tribes have mutually agreed to promote and protect the archaeological artifacts and remains of our ancestors, the Hohokam…" (SRPMICC, 1989).

### *4.2.8.2 History*

The potential value of the Salt River was realized when, in 1867, John W. "Jack" Swilling first ventured from Wickenburg to John Y. T. Smith's Hay Station, approximately 4 miles from present-day Phoenix (Granger, 1960). In 1867, as a farmer visiting Smith's Hay Station, he observed the long, low earthen ridges radiating out from the Salt River and concluded that these were the remnants of a long-forgotten irrigation system (SRP, 1979; Myers, 1961). This observation prompted him to envision the irrigation potential of the Salt River.

Other canals followed Swilling's Ditch, developing the agricultural potential of the Salt River Basin. The Maricopa Canal was completed in 1869, the Arizona Canal in 1887, and the Highlands Canal was constructed in 1888. The early canals were beset by their own problems stemming from Salt River floodwaters. Flooding washed out the diversion dams, leaving the headgates high and dry and rendering them useless (Walker and Bufkin, 1986). A number of the historic canals were reconstructed from the old Hohokam canals. The only functional difference between the Hohokam and modern canals is the lack of drop structures and drainage canals in the Hohokam systems, according to Nials and Gregory (1989).

By 1871, Phoenix was an official town. The number of townspeople had risen to 300, a far cry from the old Smith Hay Station: population 1. All the original lots had been sold and the town

was formally mapped. Phoenix was one-mile-long and one-half mile wide, and encompassed 96 blocks. Washington Street was the first main street running east-west. The Salt River Valley Post Office was moved to Phoenix, and the first County election was held. In 1872, the 320-acre town site of Phoenix was officially filed in Prescott.

#### *4.2.8.3 **Previous Work in the Study Area***

The earliest known archaeological work in the vicinity of the Rio Salado Oeste project area included Adolph Bandelier and Frank Cushing's studies in the 1880s of Pueblo Grande, approximately 15 miles to the east (Downum and Bostwick, 1993:17-21), and investigations of the prehistoric Hohokam canals (Hodge, 1893; Patrick, 1903).

The eastern portion of Cashion Ruin was recorded by Frank Midvale in 1923. Turney documented the western portion of Cashion Ruin in 1925 with updates in 1929 and 1935. Cashion Ruin was recorded again and trenched in 1939 by Audie R. Kelley as part of the Salt River Valley Stratigraphic Survey financed by the U.S. Works Progress Administration and headquartered at Pueblo Grande Museum under Director Odd Halseth (Downum and Bostwick 1993:212-220).

Glen Rice (personal communication 1999) said that Midvale's Canal Cashion may not have actually been a canal, and that Midvale's site map was of an area south of the site's actual location. During the Museum of Northern Arizona's (MNA's) excavation of the Cashion Site, Antieau (1981) noted that he was unable to locate the Canal Cashion and three Casa Grande-type ballcourts, probably due to this locational error. Midvale mapped all the ruins in the Palo Verde project area right-of-way in 1967 and in some cases corrected Turney's locations (cf. Legend on Midvale's map of the Cashion ruins in Antieau (1981:42). Antieau's excavations verified that Turney was correct and Midvale was incorrect (Antieau 1978).

Following Turney, Frank Midvale developed an interest in prehistoric irrigation and spent the 1920s, 30s, and 60s investigating every lead he could in an attempt to retrace the flow of irrigation water through the Salt-Gila Basin (Antieau 1981:8). He had also mapped the 5 sites that were excavated by the MNA for the Palo Verde Nuclear Generating Station Wastewater Conveyance System.

The Cashion site, NA 14690, was excavated by the MNA in 1977 and 1978 (Antieau 1981). Midvale originally mapped the Cashion site in 1927 when he called it Los Conejos (Antieau 1981:144). Estimated to cover approximately 640 acres, the Cashion site was listed on the National Register of Historic Places on December 19, 1978 (Reference No. 78000547). It is the largest site excavated near the confluence of the Salt and Gila Rivers, one of the largest and the most complex in the Salt-Gila River Valley (Stein, 1977), and it equals Snaketown in size (Antieau, 1981). Encompassing dates from A.D. 500 - 1150, the Cashion site was occupied from the Pioneer through the Classic Periods (Stein, 1977; Antieau, 1981). By the end of the Classic Period, Cashion was largely abandoned.

#### *4.2.8.4 Records and Literature Search*

For the purposes of the record and literature investigation, the following description was used. The study area is approximately 8 miles long extending from 19th Avenue on the east to 83rd Avenue on the west and from Lower Buckeye Road on the north to approximately Baseline Road on the south. The project implementation area extends from 19th Avenue on the east and 83rd Avenue on the west and is the area within the 100-year floodplain of the Salt River. The study area is approximately 4-miles wide and consists of approximately 20,480 acres. The project Area of Potential Effect (APE) is on average approximately 1-mile wide and consists of approximately 3,315 acres, and almost entirely of the outfalls and adjacent or nearest terrace.

A literature search of the proposed project APE was performed through the Arizona State Museum, Arizona State Office of Historic Preservation, the City of Phoenix, and Corps of Engineers files. This search indicated that archeologists had never surveyed the APE.

#### *4.2.8.5 Recommendations*

Geoarchaeological investigations were conducted for the Tres Rios project (Onken et al. 2004), which provide a very good reconstruction of the floodplain history just west (downstream) of the Rio Salado Oeste Project, at the junction of the Salt and Agua Fria Rivers with the Gila River. The results of the Tres Rios geomorphological investigation suggest that 94% of that project area has no or low sensitivity for buried prehistoric sites.

Given the Oeste project's location upstream of Tres Rios, it is reasonable to conclude that the alluvial stratigraphy of the lower Salt River might be comparable. The entire length of the Salt River within the Oeste project boundary appears to have been more disturbed than downstream, and has been modified through natural scouring action of periodic flooding, sand and gravel mining, and dumping.

Surveys of selected portions of the river, at all outfalls and adjacent or nearest terrace, were conducted by a Corps of Engineers staff archeologist. No cultural material was observed at any of these areas. The effects of the above mentioned impacts on the river are evident at the outfalls and surrounding areas. Based on the reconnaissance survey, level of disturbance, and data provided by the Tres Rios geological assessment, the Corps believes that the potential for buried archeological resources within the project area is low. A letter was sent to the Arizona State Historic Preservation Officer (SHPO) on July 6, 2005 with our determinations in accordance with 36 CFR 800.4(d). We received a letter of response dated August 10, 2005. This letter concurred with the APE as described in Section 4.4.5 above. The SHPO requested a written report of the survey conducted by Corps personnel. A Memorandum of Record (MFR) was completed describing the survey conducted in March 2004. Copies of all these documents can be found in the EIS.

All supporting documentation required under 36 CFR 800.11(d) has been provided to the SHPO, this includes the draft environmental impact statement (EIS). The archeologist representing the City of Phoenix has received copies of SHPO communications in addition to a copy of the draft EIS.

#### *4.2.8.6 Native American Concerns*

Section 106 of the National Historic Preservation Act, as amended 16 U.S.C. 470 et seq. and the American Indian Religious Freedom Act of 1978, Public Law 95-341, 42 U.S.C 1996 require consultation and Coordination with Indian Tribal Governments all require that government agencies consult with Native Americans to determine their interests in federal projects.

Letters including project descriptions and requests for comments were sent to the interested tribes noted below on July 6, 2005. The MFR was transmitted to the tribes on October 6, 2005. Ak-

Chin Indian Community, Gila River Indian Community, Hopi Tribe, Pascua Yaqui Tribe, Salt River Pima-Maricopa Indian Community, Tohono O'odham Nation, and Yavapai-Apache Nation. The draft EIS has been provided to the above groups for comment.

### 4.2.9 Socioeconomics

Benefits and costs for flood damage reduction analysis was computed at FY05 price levels, but was recomputed at 5 1/8%. Costs for the restoration and recreation alternatives are FY06 price levels, and we are using 5 1/8%. Since no flood damage reduction alternatives are being pursued, additional price level update of the structure inventory was not necessary. The period of analysis is 50 years. The Base Year for economic computations is 2010.

#### *4.2.9.1 Flood Damages*

SRP maintains four dams on the Salt River, as well as two on the Verde River, of which only one dam on the Salt River has flood-control capacity. Granite Reef Diversion Dam is located about 5 miles downstream of the confluence of the Salt and Verde Rivers. At this dam site, all water is taken from the Salt River and diverted into the Arizona and South Canals, which deliver drinking and irrigation water to the greater Phoenix area. During significant flood events, the SRP is forced to release water over Granite Reef Dam into the normally dry Salt River.

*Historical Flood Damages*

The highest release from Granite Reef Dam since the construction of the Salt and Verde River dams occurred in February 1980, when 178,000 cfs was released because of heavy rains and rapid snowmelt in the watersheds. All downstream bridges through Phoenix were forced to close during that flood except the Central Avenue Bridge. Subsequently, most of the remaining bridges crossing the Salt River have been rebuilt to withstand flow rates of 200,000 cfs and greater. (However, the Roosevelt Dam has been modified so it is unlikely that such a large release would occur.)

High releases were also experienced in 1993 (approximately 130,000 cfs). 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.

*Floodplain Boundaries*

An inventory of structures possibly susceptible to damage, and estimates of the value of these structures must first be developed in order to determine potential flooding damages. Floodplain boundaries depicted in Appendix A were used to determine properties susceptible to flooding up to the 500-year floodplain. The Rio Salado Oeste 500-year floodplain encompasses a large area, primarily to the south of the Salt River.

The floodplain has been further segmented into sub-areas, or Reaches, for analysis purposes. Those reaches are shown in Table IV-9 below. Critical factors used to determine reach boundaries include discharge/frequency characteristics, overflow spatial characteristics, and economic activity. Table IV-9 below provides a summary of reach characteristics, including approximate upstream and downstream boundaries.

**Table IV-9: Floodplain Reach Definitions**

| Reach Name | Upstream Limit | Downstream Limit | Notes |
|---|---|---|---|
| 1L | 75th Ave. | 91st Ave. | Only a few structures in this reach |
| 2L | 67th Ave. | 75th Ave. | Small number of large-lot industrial and agricultural properties/structures along Southern Ave.; some residential development along Baseline Road |
| 2R | 67th Ave. | 75th Ave. | Small number of structures at northwest corner of Roeser & 67th |
| 3L | 51st Ave. | 67th Ave. | Under existing conditions, reach includes residential development at downstream end – northwest of Baseline and 67th. Removed under Base Year conditions |
| 4L | 43rd Ave. | 51st Ave. | Small number of structures along 51st Ave. north of Southern |
| 4R | 43rd Ave. | 51st Ave. | Includes a few structures just west of 51st Ave. adjacent to floodway |
| 5L | 35th Ave. | 43rd Ave. | Large residential development in this reach on south side of Salt River; most of development removed from floodplain under Base Year conditions |
| 5R | 35th Ave. | 43rd Ave. | Mostly industrial structures, concentrated south of Lower Buckeye, between 35th and 39th Aves |
| 6L | 27th Ave. | 35th Ave. | Limited industrial/commercial development, primarily along Broadway Road |
| 6R | 27th Ave. | 35th Ave. | Mostly industrial structures, concentrated along east side of 35th Ave., Lower Buckeye to floodway |
| 7R | 19th Ave. | 27th Ave. | Small number of structures near 27th Ave. on north side of Salt River under existing conditions – removed under Base Year conditions |

* 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. Table IV-10 shows that there are approximately 386 structures in the Rio Salado Oeste 500-year floodplain. Of these, 59 percent are residential (single-family residential/multi-family housing [SFR/MH]). Roughly 139 structures are located within the 100-year floodplain boundaries (about 36 percent of the structures in the 500-year floodplain). Reach 5L contains the majority (51 percent) of floodplain structures. This area contains numerous structures, primarily residential (including both single-family residences and mobile homes). Structures in this area are generally of fair to low-cost construction. Most single-family residential structures are of

block construction. The other area with the greatest number of structures is within Reach 6L (19 percent), east of 35th Avenue on the south side of the Salt River.

**Table IV-10: Number Of Structures**

| Structure Type | 100-Year | 500-Year |
|---|---|---|
| SFR | 15 | 207 |
| MH | 19 | 22 |
| Industrial | 78 | 114 |
| Office/Commercial | 27 | 43 |
| Public | 0 | 0 |
| **Total** | **139** | **386** |

*Without-Project Damages*

Expected annual damages by reach and structure type are shown on Table IV-11. Damages to industrial and agricultural structures and contents, primarily located in Reaches 2L and 5R, comprise most of the expected annual damages. This is attributable to the fact that these two reaches contain structures in close proximity to the floodway, and therefore are susceptible to more frequent flood events. It should be noted that these results reflect planned bridge improvements at 35th Avenue. Preliminary analysis indicates that expected annual damages without these improvements would be substantially higher (approximately $670,000 vs. $235,000).

Without-project damages by event for Base Year conditions, as calculated by the HEC-FDA program (see Table IV-11). The non-damaging event is approximately the 10-year event. However, most reaches do not incur damages until less frequent events. Damages calculated for the 20-year event are approximately $1.14 million. A majority of these damages are attributable to one parcel within Reach 5R. There are approximately 11 industrial structures on this parcel (located adjacent to the floodway on the west side of 35th Avenue) owned by a metal scrap recycling business.

**Table IV-11: Without-Project Damages by Reach & Event (Base Year – 2010)**

**(in $1,000s)**

| Reach | 10-year | 20-year | 50-year | 100-year | 500-year |
|---|---|---|---|---|---|
| **1L** | $ - | $ - | $ - | $ 1 | $ 13 |
| **2L** | $ - | $ 88 | $ 754 | $ 1,183 | $ 1,561 |
| **2R** | $ - | $ - | $ - | $ 8 | $ 30 |
| **3L** | $ - | $ - | $ 10 | $ 87 | $ 254 |
| **4L** | $ - | $ 4 | $ 52 | $ 90 | $ 125 |
| **4R** | $ - | $ - | $ - | $ - | $ 10 |
| **5L** | $ - | $ - | $ 59 | $ 1,163 | $ 4,039 |
| **5R** | $ 38 | $ 1,050 | $ 2,615 | $ 3,929 | $ 5,633 |
| **6L** | $ - | $ - | $ 52 | $ 378 | $ 1,056 |
| **6R** | $ - | $ - | $ 2 | $ 78 | $ 659 |
| **7L/7R** | $ - | $ - | $ - | $ - | $ - |
| **Total** | $ 38 | $ 1,142 | $ 3,544 | $ 6,917 | $ 13,380 |

Damages increase significantly for the 50-year event, and approximately double subsequently for the 100-year and 500-year events. A majority of the damages for these flood events are expected to occur in Reaches 5R and 2L (primarily industrial properties) and 5L (which is the reach with the large residential development discussed previously).

#### *4.2.9.2 Demographics*

*Population*

The southern portion of the study area lies in the southwest portion of the City of Phoenix, which has a total population of 1,321,045 (U.S. Census Bureau, 2000). Table IV-12 shows the 2000 population and household characteristics for the county and study area. In 2000, the county population totaled 3,072,149 (U.S. Census Bureau, 2000). The MAG projects that the county's population will grow to approximately 3,709,566 by 2010, and to approximately 4,516,090 by 2020, increases of 637,417 and 1,443,941, respectively (MAG, 2002). The study area makes up only 0.1 percent of the total county population (U.S. Census Bureau, 2000).

**Table IV-12: Population and Household Characteristics in the Vicinity of the Study Area**

| Jurisdiction | Population | Number of Households | Persons per Household | Number of Families | Persons per Family |
|---|---|---|---|---|---|
| Maricopa County | 3,072,149 | 3,027,366 | 2.67 | 763,110 | 3.21 |
| Study Area | 48,854 | 11,504 | 3.93 | 9,362 | 4.20 |
| Source: U.S. Census Bureau, 2000 | | | | | |

*Population Projections*

Table IV-13 displays population estimates and growth projections for Maricopa County and the City of Phoenix, obtained from the MAG and U.S. Census Bureau Web sites. Strong growth for the county and city is expected through year 2050, although the rates of growth will be substantially lower than those experienced in the past decade.

**Table IV-13: Projected Population and Annual Growth Rate (AGR) for Maricopa County and the City of Phoenix**

| Year | Maricopa County | AGR | City of Phoenix | AGR |
|---|---|---|---|---|
| 1995 | 2,529,000 | | 1,154,000 | |
| 2000 | 3,072,000 | 4.0 | 1,321,000 | 2.7 |
| 2010 | 3,710,000 | 2.0 | 1,544,000 | 1.6 |
| 2020 | 4,516,000 | 2.0 | 1,796,000 | 1.5 |
| 2050 | 7,265,000 | 1.6 | 2,568,000 | 1.2 |

Source: U.S. Census Bureau and Arizona Department of Economic Security

The Arizona Department of Economic Security projects that population within the Phoenix metropolitan area will total over 7.26 million by the year 2050. Growth rates for the region are anticipated to be more than double the National average throughout the period of analysis.

*Ethnicity*

The approximate population breakdown of the county by ethnicity is 66.2 percent White, 24.8 percent Hispanic, 3.5 percent African American, 1.4 percent American Indian and Alaskan Native, 2.1 percent Asian, 0.05 percent Native Hawaiian or other Pacific Islander, 0.1 percent other races, and 1.5 percent two or more races (U.S. Census Bureau, 2000). The ethnic composition of the study area differs from that of the county as a whole, most notably in the proportions of White and Hispanic residents (refer to Table IV-14). The proportions of the other

races do differ as well, although not as much. The approximate population breakdown in the study area is: 24.3 percent White, 62.0 percent Hispanic, 5.9 percent African American, 6.2 percent American Indian and Alaskan Native, 0.3 percent Asian, 0.06 percent Native Hawaiian or other Pacific Islander, 0.09 percent other races, and 0.85 percent more than two races.

**Table IV-14: Ethnic Population Characteristics in the Vicinity of the Study Area**

| Jurisdiction | White | Black or African American | American Indian or Alaskan Native | Asian | Native Hawaiian or other Pacific Islander | Other | Hispanic or Latino | Two or more Races |
|---|---|---|---|---|---|---|---|---|
| Maricopa County | 2,034,530 | 108,521 | 45,703 | 64,562 | 3,725 | 4,086 | 763,341 | 47,681 |
| Percent of County Total | 66.2% | 3.5% | 1.5% | 2.1% | 0.1% | 0.1% | 24.8% | 1.6% |
| Rio Salado Oeste Study Area | 11,714 | 2,918 | 3,019 | 166 | 31 | 47 | 30,543 | 416 |
| Percent of Study Area Total | 24.0% | 6.0% | 6.2% | 0.3% | 0.1% | 0.1% | 62.5% | 0.9% |

Source: U.S. Census Bureau, 2000

*Income*

Table IV-15 shows median household income for residents within Maricopa County and the study area for the year 1999. In 1999, the median household income for the county was $45,358; the median household income for the study area was substantially less, at $27,847 (U.S. Census Bureau, 2000).

**Table IV-15: Median Household Income in the Vicinity of the Study Area**

| Jurisdiction | Median Income Amount |
|---|---|
| Maricopa County | $45,358 |
| Study Area | $27,847 |

Source: U.S. Census Bureau, 2000

Additional demographic information can be found in Appendix F, Modified Phase I Environmental Site Assessment, and Appendix G, Economic Evaluation.

### 4.2.10 Real Estate

The majority of the land within the project area is privately owned. Within the floodplain, or the area where restoration measures will be proposed, this ownership includes sand and gravel companies, the State of Arizona, Maricopa County, and the City of Phoenix (Figure IV-10). The City of Phoenix currently owns approximately 511 acres in the project area and has a Recreation and Public Purposes Lease on an additional 159 acres of Bureau of Land Management property. A general summary of ownership of land within the 100-year floodplain is presented in Table IV-16. See Appendix G, Economic Evaluation, for more details.

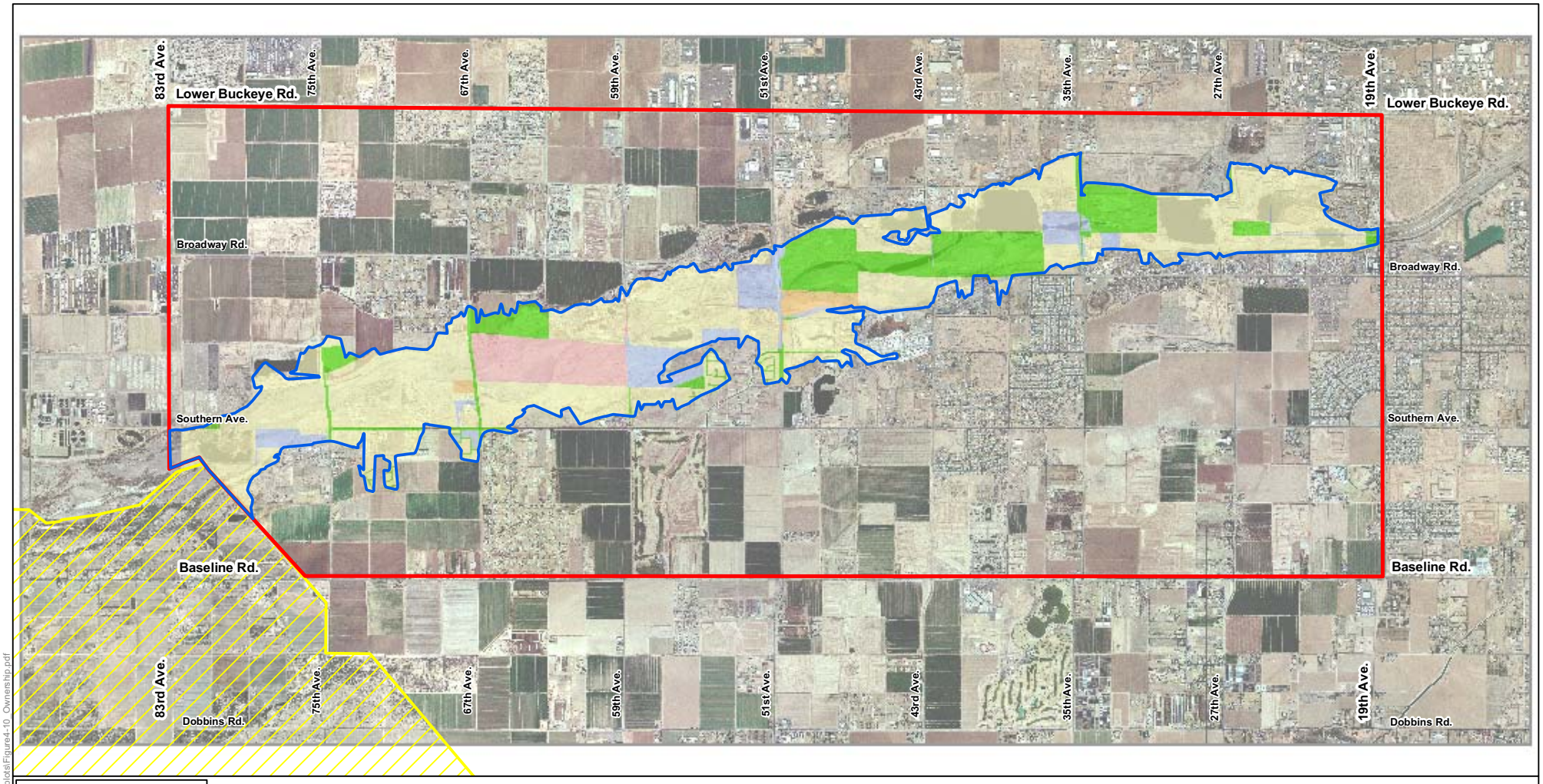
**Table IV-16: Property Ownership within the Study Area (100-Year Floodplain)**

| Owner Type | Acres |
|---|---|
| City of Phoenix | 511 |
| Maricopa County | 118 |
| State of Arizona | 261 |
| Federal | 190 |
| Private | 2094 |
| Total | 3174 |

### 4.2.11 Recreation

#### *4.2.11.1 Nearby Recreation Resources*

Arizonans place high importance on the State's outdoor recreation resources. In the 1994 Statewide Comprehensive Outdoor Recreation Plan survey, 94 percent of respondents stated that parks and recreation areas are important to their everyday lifestyles. The greater Phoenix area does not currently have any significant riparian habitat areas with supporting recreation facilities. The major existing parks in the area consist primarily of desert mountain preserves, which do not contain the types of habitat that could be supported in the study area. For purposes of this analysis, the market area will be defined as the greater Phoenix metropolitan area, which would include Maricopa and Pinal Counties, although it is likely that many visitors would be drawn from even greater distances.





# Property Ownership and Use Within Project Study Area

**Figure IV-10**

## Legend

- Project Study Area
- Project Implementation Area
- Private
- Federal Government
- State of Arizona
- Maricopa County
- City of Phoenix
- Gila River Indian Community

August 2005

**Rio Salado Oeste**

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US Army Corps of Engineers

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Estrella Mountain Regional Park, South Mountain Park, and Papago Park are three of the largest recreation areas nearby the study area. Estrella Mountain Regional Park is owned and managed by the Maricopa County Parks and Recreation Department. The rugged and scenic Sierra Estrella Mountains are the most dominant features of Estrella Mountain Regional Park. The terrain of these mountains is characterized by very steep slopes, numerous rock out-crops, shallow soils, and sparse desert vegetation.

South Mountain Park is located about 3 miles south of the Salt River. It extends from about 48th Street on the east to 43rd Avenue on the west—a distance of over 10 miles. The park encompasses about 17,000 acres of desert mountain landscape and is the largest municipal park in the United States. It is bounded on the north by Baseline Road and on the south by Chandler Boulevard, and is over 3 miles wide in some places. It contains an activity complex, hiking and riding trails (extending over 40 miles), an interpretive center, lookouts, ramadas, picnic areas, and restrooms. According to the *Sonoran Preserve Master Plan*, annual park visitation during the 1990s exceeded 3 million.

Papago Park is located just north of the Salt River in eastern Phoenix and western Tempe. It includes about 1,400 acres bounded on the north by Oak Street, on the south by State Highway 202, on the west by 52nd Street, and on the east by 68th Street. The park includes rock formations dating back 15 million years, ramadas, picnic facilities, three fish ponds stocked with rainbow trout and channel catfish, a baseball stadium, a softball complex, volleyball courts, the Phoenix Zoo, botanical gardens, a state historical museum, two golf courses, an archery shooting range, nature trails, and restrooms. Annual visitation exceeds 2 million.

In addition to South Mountain Park, the Phoenix Mountain Preserve is the other major mountain-preserve area in greater Phoenix. Located in the northeastern section of the city, the Phoenix Mountains comprise combination of regional parks and preserves. The regional parks represent the partially developed areas, while the preserves represent the areas which are completely undeveloped except for trails. There are about 1,800 acres of regional parks embedded within the preserves, including the North Mountain, Phoenix Mountain Park (formerly Squaw Peak), and Shaw Butte recreation areas. These parks include extensive trails systems, picnic areas, and

restrooms. North Mountain recreation area also features basketball and volleyball facilities and a playground. The combined visitation at North Mountain and Phoenix Mountain Park and Recreation Area has totaled approximately 1.5 million in recent years.

*Study Area Recreation Resources*

Recreation in the study area 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 portion of the Salt River that passes through the City of Phoenix has, until the recently authorized Rio Salado and Tres Rios Projects and the upstream Tempe Town Lake, consisted of dry river bottom. As a result, virtually no recreation activities took place.

The only improved recreation area adjacent to the Salt River was Rio Salado Park, which is located at 12th Street and Elwood. The park encompasses about 14 acres and contains picnic facilities and racquetball and basketball courts. Most of the users are employees who work at industrial businesses located in the area. According to the City of Phoenix Parks Department, fewer than 200 people visit the park on a weekly basis (or fewer than 10,400 annually). There are currently no plans for expansion of the park, and visitation is not expected to increase in the absence of a Corps project.

The following shows the names and annual visitation for other community parks in the Phoenix area.

**Table IV-17: Parks and Annual Visitors for Community Parks**

| Park | Visitation | Features |
|---|---|---|
| Hayden Park | 121,000 | 14 acres, with picnicking, softball, basketball, playground, restrooms |
| Estaban Park | 58,000 | 62 acres, with picnicking, softball, soccer, volleyball, tennis, playground, restrooms |
| El Prado | 61,000 | 40 acres, with swimming pool, softball, picnicking, playground, restrooms |
| Cesar Chavez | 310,000 | 353 acres, with 25-acre lake with fishing/sailing/canoeing, picnicking, restrooms |
| Encanto | 1,200,000 | 63 acres, with fishing lagoon, 18-hole golf course, clubhouse, swimming pool, racquetball, tennis, basketball, softball, children's play area |
| Echo Canyon | 350,000 | 387 acres with hiking trails. |

The Rio Salado Project stretches from an upstream limit of 28th Street to a downstream limit of 19th Avenue (which is the upstream limit for this study) and comprises environmental restoration and passive recreation components along the Salt River. Approximately 5 miles (and 580 acres) of the Salt River will be restored to create riparian and wetland habitat. Passive recreation facilities, including over 10 miles of trails and interpretive signage, are also included. Construction commenced on the project in 2000. Recreation project features include parking lots, information kiosks, a visitor center, overlooks, shade structures, bridges, trails, an equestrian staging area, signage, and landscaping. Recreation activities provided by the plan include walking, hiking, biking, horseback riding, rollerblading, picnicking, and bird watching. Scenic overlooks will be included for the enjoyment of the restored desert riparian habitat. Information kiosks and the visitor center will provide education on the resource, including restoration of the habitat, the hydro cycle, a historical perspective of the Salt River, and flora and fauna within the project area. As documented in the Rio Salado Feasibility Study, annual visitation is expected to exceed 500,000.

Immediately upstream of the Rio Salado Project is Tempe Town Lake. The lake was constructed within the existing Salt River flood control channel (about 850 feet in width), extending from the Salt River's confluence with Indian Bend Wash to approximately 2 miles downstream. The river's flood control conveyance capacity is retained through the use of a system of rubber dams that can be deflated during significant floods. The lake contains about 220 surface acres and 20,000 feet of shoreline supporting paddle boating, canoeing, sailing, and fishing. Tempe is hoping to establish the State's largest urban fishing program. Over 1,000 acres of adjacent land has been dedicated for recreational development and open space. Activities will include picnicking, hiking, bicycling, horseback riding, softball/baseball, volleyball, golfing, water slides and play areas. Other possible recreational uses include soccer and major sports events, such as marathons.

While water is a highly attractive feature for recreationists, park trails and facilities have presently been planned away from the Gila River. Once the county completes its Sun Circle Trail System through this reach of the Gila and Salt Rivers, recreation use patterns are expected to expand throughout the study area. The Sun Circle Trail, a component of the National Recreation

Trail system, is a 110-mile loop encompassing the Phoenix metro area. The trail offers a unique opportunity for hiking, horseback riding, and bicycling throughout the urban area. Approximately 70 percent of the Sun Circle trail system is in place. The county has an agreement with the FCDMC to establish the Sun Circle Trail within the flood control district corridor from Skunk Creek to the Gila River–Salt River confluence. The Rio Salado Oeste Project is an excellent opportunity to designate a segment of the Sun Circle Trail. This would benefit Tres Rios, Rio Salado, and Rio Salado Oeste with a major nonmotorized travel way connecting the three river-restoration projects to the other valley areas.

*Educational Opportunities*

There are no formal environmental-education opportunities associated with the existing Salt River corridor in the study area. As agricultural land near the river is converted to residential, the need for recreation will increase. The 27th Avenue Solid Waste Recycling Facility (just north of the river) has an existing environmental-education master plan. The facility provides tours for children and adults. The 23rd Avenue WWTP also does environmental-education programming and touring for water treatment. These existing facilities provide an opportunity to link environmental education that could be developed for a restored river corridor. Upstream of the study area, the Rio Salado Project will include over 10 miles of trails, an environmental-education facility, and passive recreation opportunities. Passive recreation facilities are also planned downstream for the Tres Rios Project. There are opportunities to link recreation facilities at the study area with those that will be constructed upstream and downstream.

### 4.2.12 Summary of historic and existing conditions

As can be seen by the existing conditions presented in this section, the problems associated with this reach of the Salt River are significant. Federal dams constructed in the early 1900s on the upper Salt and Verde Rivers have limited flows in the lower Salt River. In pre-settlement times, the Salt River was one of the few perennial streams supporting riparian areas of the Sonoran desert with highly productive cottonwood, willow, and mesquite habitats. These areas were rich in habitat diversity, supporting a wide variety of wildlife species. As the lower Salt River Valley became developed, riparian habitat was degraded significantly. The upstream Federal water

projects curtailed year-round water flows and converted the once perennial Salt River into a dry riverbed devoid of habitat. In addition, the area is experiencing rapid growth and most areas adjacent to the river have been or are being developed. Only sporadic vegetation exists in the study area today, and those few native vegetation communities are seriously degraded. However, many opportunities to address problems through environmental restoration measures do exist. Since recreation opportunities in the study are limited and since recreation is compatible and desired in conjunction with ecosystem restoration, they will be evaluated during plan formulation. Although not repeated in this chapter, detailed description of additional resources and areas of environmental compliance are included in the companion Environmental Impact Statement.

## 4.3 EXPECTED FUTURE WITHOUT-PROJECT CONDITION (2010-2060)

The future without-project condition is defined as that condition expected to exist in the absence of any action taken (by the Federal Government) to solve the stated problems. 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.

### 4.3.1 Hydrology

The hydrologic analysis for Rio Salado Oeste first considered baseline conditions. Baseline flow rates for the Salt River were available from a 1996 Corps analysis of the river, completed as part of a modification project for the Roosevelt Dam. This report contained flow rates for the 5-, 10-, 25-, 50-, 100-, and 500-year events along the river at Central Avenue and 67th Avenue. The flow rates at these two locations were similar to each other for each event, and overall the flow rates varied from 20,000 to 240,000 cfs with the 100-year event equating approximately 166,000 cfs. The values presented from this analysis were for baseline hydrologic conditions.

For future hydrologic conditions, the same flow rates as the baseline conditions were used. However, a continuous hydrograph of the Salt River was used to simulate the erosion and deposition for the study reach. This hydrograph had a period of record from 1889 to 1993, and

the worst 50-year period (1889 to 1938) effectively represented the period of record for use in the future-conditions models. The peak flow in this period was about 190,000 cfs, which placed it between the 100- and 500-year events in magnitude. After the sediment simulation, the n-year flood events described above were used to simulate the future without-project condition. For purposes of ecosystem restoration it was assumed that base flow is virtually non existent with the exception of storm water runoff and effluent which is discussed in Section 4.2.4 Water Supply.

### 4.3.2 Hydraulic Conditions

For the hydraulic analysis of current conditions, the effective HEC-RAS (RAS) model that was created as part of the FEMA Flood Insurance Study of this portion of the Salt River was used. The cross sections from this model that were located between 19th Avenue and 91st Avenue were extracted and supplemented with additional cross sections. Terrain data for all of these cross sections was mostly acquired from a TIN terrain data set created for the Salt/Gila River Master Plan completed in 1992. Additional terrain data were taken from available two-foot contours and 30-meter Digital Elevation Maps. Other changes made to the effective RAS model included slight modifications to the Manning's *n* values, the addition of new bridges at 27th and 51st Avenues, and the adjustment of the ineffective flow areas. The discharges used in this model were taken from the 1996 Corps report mentioned earlier. It is unclear how these flows compared to the flows found in the effective FEMA model.

The results of these updated baseline models were compared to the effective FEMA model. From the downstream end of the models to River Station 204.25, the profiles were essentially identical. At this location, the geometries began to differ between the two models, and this difference caused the updated model to have an elevation 0.45 foot higher than the FEMA model. Between Stations 204.34 and 205.15, the differences between the models increased, with the FEMA model calculating elevations 0.6 to 2.54 feet higher than the updated model. In this area, most of the differences were attributed to variations in the placement of ineffective flow areas. Between Stations 205.25 and 206.51, the two profiles approached each other to within 0.4 foot. However, between Stations 206.6 and 207.07, where there are mining pits within the channel that were handled differently by each model, the updated model produced elevations 0.53 to 2.07 feet higher than the FEMA model. At cross section 207.34, the updated model was 0.78 foot higher,

but the difference approached zero at sections 207.48 and 207.49. By Station 207.53, the updated model was 0.49 foot higher. Between Stations 207.62 and 208.75, the models once again produced nearly the same results, but between cross sections 208.85 and 209.24, the update model generated values 0.46 to 2.15 feet higher. Over the remainder of the models, which extended from Station 209.42 to 211.54, the models produced significantly different results based on the differing geometries used to represent the 35th Avenue Bridge.

For analysis of future without-project conditions, the changes to the bed profile were predicted over the next fifty years due to erosion. The geometry from the current conditions RAS model were used to create a sediment-transport model. The sedimentation model used was HEC-6T, and this model produced results within 10 percent or within 1 foot of the depths in the existing conditions RAS model, whichever was smaller, for the 5-, 10-, and 100-year events under fixed bed conditions.

The Corps program SAMAID was used to determine the most appropriate sediment transport relationship, and this investigation determined that Madden's 1985 modification of Laursen's equation and Yang's equation were the best and second best choices, respectively. Based on its use of Yang's equation in previous studies of the Salt River upstream and downstream of this project's extent, Yang's equation was chosen to model the future conditions sediment transport.

The sedimentation model was then run over a 50-year period using the Salt River hydrograph from 1889 to 1938, and bed profiles were output at the end of each ten-year interval. For ease of modeling computations, all of the relevant 105 years of historical discharge information were effectively represented by needing only to simulate the period of record from 1989 to 1939. In addition, the constructed continuous 50-year hydrograph also reflects Salt River flood flows that have been normalized by flow regulation at the upstream Roosevelt Dam. The results of this model were used to create the geometry for the future-conditions RAS model. Overall, areas along the Salt River with ongoing mining operations experienced the greatest changes. In areas where mining was not present, the bed changes reached a maximum of 5.8 feet after 50 years with an overall average change of 1.9 feet.

Five new RAS models representing future conditions in 10, 20, 30, 40, and 50 years were created from the bed profiles predicted by the HEC-6T model. Otherwise, the future RAS models used parameters identical to those found in the existing-conditions RAS model. Overall, the future-conditions RAS models had smoother water surface profiles based on a smoothing of the stream bed over time. The major differences in water surface elevation occurred upstream of the 35th Avenue Bridge, with the future RAS models predicting lower water surface elevations due to erosion at this bridge. There are some other small stretches of the Salt River where moderate decreases in water surface elevations occur over time, but overall the future conditions RAS models mostly predicted decreases in the water surface profile of less than 1 foot within the study reach.

### 4.3.3 Biological Resources

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. 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 manmade artificial communities. These include a number of open water areas that are essentially old or abandoned borrow pits resulting from sand and gravel mining. Dense vegetation dominated by tamarisk or salt cedar, with some cottonwood and willows as well as the occasional cattail or bulrush, lies adjacent to some of these abandoned pits. Without the project, the biological resources within the study area are expected to continue to degrade. Without modifications to improve the functional components and improve the efficiency and effectiveness of the water resources available the diversity of species that are currently supported are expected to decline, and most of the remnant high value habitat (cottonwood, willow, and mesquite bosque) would be replaced with undesirable invasive plant species would become or devoid of vegetation altogether.

*Habitat Evaluation*

Table IV-18 below displays cover types and projected acreages in the study area (100-year floodplain only) and how they are projected to change under future without-project conditions.

Figure IV-11 shows that the without-project AACFU output is forecast to remain essentially unchanged (the slight decline from 583 AAFCU to 579 AAFCU is due to rounding error).

Key assumptions in projecting the future conditions include:

- All remaining agricultural land (133 acres) will be developed within five years.
- Remaining cottonwood/willow forest will decrease from 112 acres to 25 acres over 50 years due to reduced water supply, increased urbanization, and expansion of non-native saltcedar.
- Emergent wetlands will decrease slightly from 30 to 25 acres but will remain in areas of surface discharge and stormwater outfalls. O&M activities at these outfall locations will disturb and result in periodic reductions in quantity and quality of the existing emergent wetland areas
- The amount of dry river bottom is expected to increase from 66 acres to 71 acres, as the wetlands are lost.
- The amount of open water will decrease from 240 to 80 acres as other uses for effluent and dewatering are established. Existing areas of open water will likely be converted to bare earth or support undesirable low-value and/or non-native and invasive species, eventually converting to scrub-shrub and desert-wash cover. The amount of scrub shrub will increase from 1,566 to 1,653 acres.
- It is not possible to project acreage changes in sand and gravel operations, but it is assumed that some operations will go out of operation while others start operating. In general, these activities would migrate downstream, to the west end of the study area following the urban development.
- The reduction in water supply and decrease in surface flows will result in the reduction and/or elimination of one of the key mechanisms that drive many biochemical and biogeochemical processes that are associated with movement and cycling of nutrients.

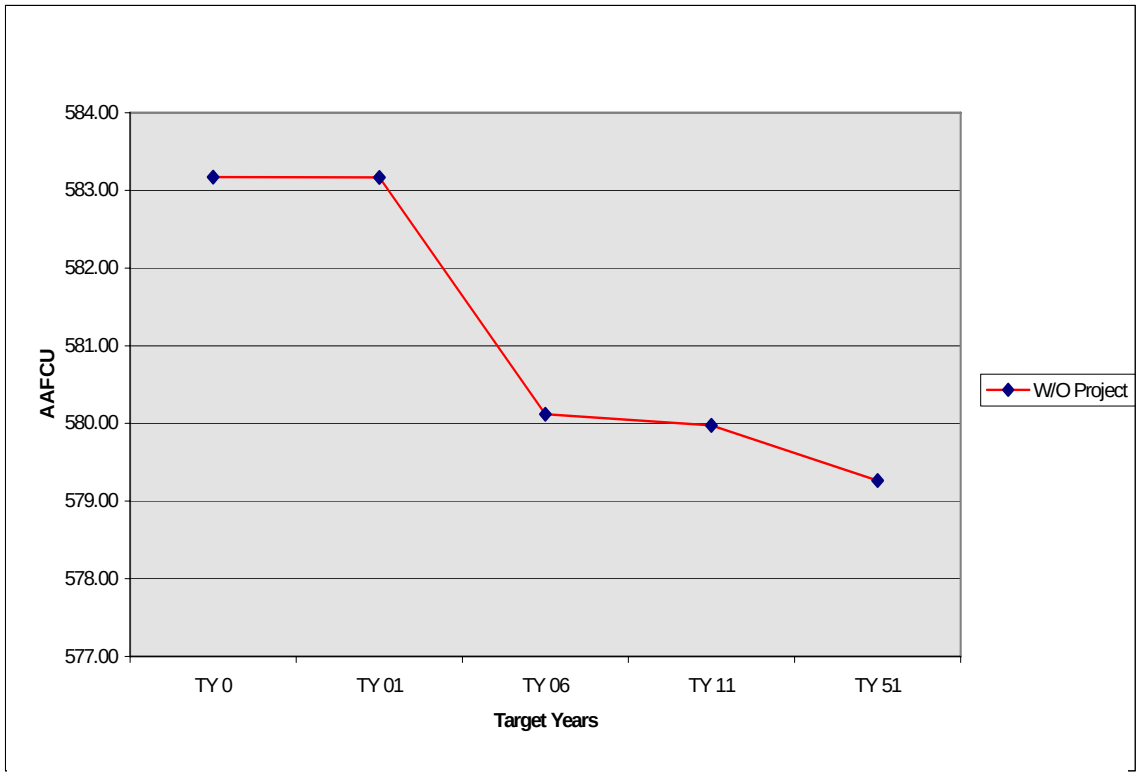



**Figure IV-11: Future Without Project**

- No establishment of new: cottonwood/willow forest, wet river bottom, emergent wetlands, open water, or mesquite woodlands or bouquets is expected.
- There will be a decrease in the connectivity and spatial structure of the remnant high-value cottonwood/willow strands and a disconnect between the authorized Rio Salado Restoration and Tres Rios Demonstration Projects.
- The biological diversity within the study area is expected to decrease with the reduction in high valley cottonwood/willow forest for cover, breeding, nesting, foraging, and fledging activities. The reduction of open water and emergent wetland areas reduces and/or eliminates a key habitat or life history/cycle component for many native wildlife species and neo-tropical migratory songbirds and over-wintering waterfowl and wading birds.
- The disturbance from unregulated recreation, OHV traffic, and "wildcat" dumping is expected to continue and potentially increase in some areas, further degrading the riparian system and the remaining higher value remnant habitat it currently supports.

## Table IV-18: Cover Types and Projected Acres Without Project

| COVER | DESCRIPTION | Target Year 0 | Target Year 01 | Target Year 06 | Target Year 26 | Target Year 51 |
|---|---|---|---|---|---|---|
| AGCROP | Farms and croplands in the uplands - dairy, cotton, and alfalfa | 133.00 | 133.00 | 0.00 | 0.00 | 0.00 |
| CWWFOREST | Existing cottonwood/willow forests in the active channel | 112.00 | 112.00 | 80.00 | 50.00 | 25.00 |
| DITCHES | Existing ditches in the uplands | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| WETRVRBOTTOM | Existing emergent wetlands in the uplands - cattails, cienegas and grasses | 30.00 | 30.00 | 25.00 | 25.00 | 25.00 |
| MESQUITE | Existing mesquite woodlands - on the terraces and in the active channel | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NEWWETRVRBOTTOM | Newly constructed river channel, includes emergent wetlands within the channel | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NEWCWWFOR | Newly planted cottonwood/willow forests in the active channel | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NEWDRYRVRBOTTOM | Newly developed dry river bottom areas in the active channel – largely unvegetated | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NEWMESQUIT | Newly planted mesquite woodlands - on the terraces and in the active channel | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NEWOPENWAT | Newly developed open water in the active channel | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| OPENWATER | Existing open water in the active channel - inactive sand and gravel operations | 240.00 | 240.00 | 168.00 | 118.00 | 80.00 |
| DRY RIVER BOTTOM | Existing river bottom in the active channel - largely unvegetated | 66.00 | 66.00 | 71.00 | 71.00 | 71.00 |
| SCRUBSHRUB | Existing scrub-shrub lands in the active channel - rabbitbush, quailbush, ironwood, and saltbush | 1566.00 | 1566.00 | 1598.00 | 1628.00 | 1653.00 |
| SANDGRAVEL | Existing sand and gravel operations/extractions in the active channel | 671.00 | 671.00 | 671.00 | 671.00 | 671.00 |
| DESERT | Desert or bare earth | 0.00 | 0.00 | 72.00 | 122.00 | 160.00 |
| URBAN | Existing residential, industrial and transportation avenues in the uplands | 327.00 | 327.00 | 460.00 | 460.00 | 460.00 |
| | TOTAL ACRES: | 3148.00 | 3148.00 | 3148.00 | 3148.00 | 3148.00 |

### 4.3.4 Land Use

Based upon the City of Phoenix General Plan (Revised February 2001), most of the land area on the north side of the Salt River between 19th Avenue and 59th Avenue is zoned as industrial, with some high-density residential between 43rd Avenue and 60th Avenue. From 60th Avenue to 83rd Avenue, the primary land use is low-density residential. South of the Salt River, there is some land between 19th Avenue and 35th Avenue zoned as commercial. Otherwise the prevailing land use designation is low- to medium-density residential. Estrella Village and Laveen Village are the two primary planning areas that lie adjacent to the Salt River between 19th Avenue and 83rd Avenue. Estrella Village is characterized by an ample supply of undeveloped land, large parcels, natural and scenic amenities, and excellent transportation access. As noted on the City of Phoenix Web site, the village also poses unique challenges given the isolation of its existing residential neighborhoods and the extensive industrial activities that have developed over the years. Approximately 62 percent of the Village is undeveloped, either vacant or with agricultural uses. However, there are 21 residential developments in various phases of approval and development (Figure IV-12). Over 8,000 new single-family housing units were

**Figure IV-12: New Subdivision along Southern Avenue South of the Project Area**

approved in this area in 1999 alone. Primary agricultural crops grown in the area include cotton, citrus, and corn. Farmers, equestrians, and those looking for solitude and mountain access have valued the area.

Land use is quickly changing within the study area as farmland is quickly converted to residential subdivisions, and associated commercial development follows. The study team assumed that within 5 years the lands adjacent to the floodplain would all be developed in some way, maybe sooner. Lands within the floodplain, however, are not expected to be developed unless by future aggregate operations or closure of existing operations.

### 4.3.5 Recreation

Based upon conversations with representatives from the City of Phoenix Parks and Recreation Department, the AGFD, and other agencies, the proposed habitat and recreation features would attract visitors throughout the Phoenix Valley region. The major existing parks in the area consist primarily of desert mountain preserves, which do not contain the types of habitat that could be supported in the study area. For purposes of this analysis, the market area will be defined as the greater Phoenix metropolitan area, which would include Maricopa and Pinal Counties, although it is likely that many visitors would be drawn from even greater distances. Currently, there are no recreation features that exist in this reach of the Salt River. The activities that do take place in the river corridor in general serve to accelerate the rate of degradation. As the area degrades over time, fewer people will select the study area for recreational activities.

The Tres Rios Project just downstream of the study area will provide recreation opportunities. The Tres Rios Project is located immediately downstream of the study area, beginning at the 91st Avenue WWTP. Components of this plan include new levee alignments for flood control, the establishment of wetland, marsh, and riparian habitat, and passive recreation/environmental education facilities. That project is currently in design and will be constructed within the next several years.

Over the period of analysis it is assumed that the City of Phoenix will develop smaller community parks in the neighborhoods surrounding the study areas.

Maricopa County has approved and begun implementation of the Maricopa Trail. The trail plan is a continuous nonmotorized trail system covering multiple jurisdictions around the county connecting regional parks. The entire loop is 242 miles and will be implemented over the next eight to ten years. The loop intersects the Salt River between 83rd and 91st Avenues and proceeds southward towards South Mountain. The Maricopa County Regional Trail System Plan identifies projects on the Salt River as potential and in the case of Rio Salado existing trail systems that would connect to the regional trail system.

### 4.3.6 Economics

#### *4.3.6.1 Results – Future Conditions (2059)*

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 re-compute expected annual damages under future conditions. The results are summarized in Table IV-19. A more detailed description of the estimates can be found in Appendix G, Economic Evaluation.

**Table IV-19: Without-Project Expected Annual Damages – Future Conditions (2059) ($1,000)**

| Reach | SFR/MH | Ind/Ag | Office/Com | Public | Total |
|---|---|---|---|---|---|
| 1L | $ - | $ - | $ - | $ - | $ - |
| 2L | $ 4 | $ 16 | $ 1 | $ - | $ 21 |
| 2R | $ - | $ - | $ - | $ - | $ - |
| 3L | $ 2 | $ - | $ - | $ - | $ 2 |
| 4L | $ 1 | $ - | $ - | $ - | $ 1 |
| 4R | $ - | $ - | $ - | $ - | $ - |
| 5L | $ 8 | $ 4 | $ 1 | $ - | $ 13 |
| 5R | $ - | $ 98 | $ 14 | $ - | $ 112 |
| 6L | $ 1 | $ 5 | $ 2 | $ - | $ 8 |
| 6R | $ - | $ 1 | $ 1 | $ - | $ 2 |
| 7L/7R | $ - | $ - | $ - | $ - | $ - |
| Total | $ 16 | $ 124 | $ 19 | $ - | $ 159 |

Without-project expected annual damages actually decrease from about $245,000 under Base Year conditions to about $159,000 under future conditions (a drop of about 35 percent). Water surface elevations are generally lower throughout the study area under future conditions due primarily to projected channel degradation and resulting in creases in channel capacity (refer to Appendix A, Hydrology and Hydraulics).

Equivalent annual damages were computed based upon forecast annual damages using a discount rate of 5 3/8 percent (see Table IV-20).

**Table IV-20: Without-Project Equivalent Annual Damages (50 Yrs, 5 1/8 Percent) ($1,000s)**

| Reach | SFR/MH | Ind/Ag | Office/Com | Public | Total |
|---|---|---|---|---|---|
| 1L | $ - | $ - | $ - | $ - | $ - |
| 2L | $ 7 | $ 24 | $ 2 | $ - | $ 32 |
| 2R | $ - | $ - | $ - | $ - | $ - |
| 3L | $ 2 | $ - | $ - | $ - | $ 2 |
| 4L | $ 2 | $ - | $ - | $ - | $ 2 |
| 4R | $ - | $ - | $ - | $ - | $ - |
| 5L | $ 24 | $ 4 | $ 1 | $ - | $ 29 |
| 5R | $ - | $ 126 | $ 16 | $ - | $ 142 |
| 6L | $ 1 | $ 6 | $ 3 | $ - | $ 10 |
| 6R | $ 1 | $ 2 | $ 2 | $ - | $ 5 |
| 7L/7R | $ - | $ - | $ - | $ - | $ - |
| Total | $ 37 | $ 161 | $ 24 | $ - | $ 222 |

As shown on Table IV-21, equivalent annual damages are concentrated in a few reaches. Reach 5R accounts for about 60 percent of total without-project damages. This reach contains a small concentration of industrial structures along 35th Avenue, primarily south of Lower Buckeye Road. There are several parcels with multiple structures that are within the 50-year floodplain, and just outside the 20-year floodplain. The risk and uncertainty analysis indicates that these structures may be flooded by events more frequent than the 20-year event.

**Table IV-21: Without-Project Equivalent Annual Damages (in $1,000s)**

| Reach | Structure and Content | Cleanup | Temp. Housing | Total |
|---|---|---|---|---|
| 2L | $ 32 | $ 10 | $ 0.4 | $ 42 |
| 3L | $ 2 | $ 1 | $ 0.1 | $ 3 |
| 4L | $ 2 | $ - | $ 0.1 | $ 2 |
| 5L | $ 29 | $ 4 | $ 0.9 | $ 34 |
| 6L | $ 10 | $ 3 | $ 0.1 | $ 13 |
| Total - S. of River | $ 75 | $ 18 | $ 1.6 | $ 95 |
| 5R | $ 142 | $ 5 | $ - | $ 147 |
| 6R | $ 5 | $ 0.5 | $ - | $ 6 |
| Total - N. of River | $ 147 | $ 6 | $ - | $ 153 |
| Total | $ 222 | $ 24 | $ 2 | $ 247 |

Note: Damages for Reaches Not Shown are Minimal

On the south side of the Salt River, Reach 2L has the highest amount of expected annual damages. Damages in this reach are attributable to the proximity of several structures to the floodway on the north side of Southern Avenue between 75th and 67th Avenues.

The highest concentration of residential damages is located in Reach 5L. Although there are nearly 200 structures in this reach, damages are limited due to the low per-unit structure values and because most are outside the 100-year floodplain. Most of the structures in this reach are located just southwest of Broadway Road and 35th Avenue.

The only other reach with significant damages is Reach 6L. This reach includes industrial and commercial structures located along Broadway Road between 35th and 27th Avenues.

*Impact of Assumed Rio Salado Marsh on Without-Project Damages*

Under existing conditions there is potential for flood damages in the study area. However, the planned improvements to the 35th Avenue Bridge and the Rio Salado Marsh that will take place from 37$^{th}$ to 51$^{st}$ Avenues virtually eliminate the potential for damage in the adjacent reaches. Additional floodplain delineations showing Base Year floodplain boundaries with both the bridge improvements and the channel excavation have not been prepared. However, water surface profiles have been developed, and an analysis of these water surface profiles shows that the potential for flooding in the 35$^{th}$ Avenue area is greatly reduced.

A detailed analysis of without-project flood damages reflecting the assumed Rio Salado Marsh between 37$^{th}$ and 51$^{st}$ Avenues has not been completed. However, water surface profiles have been developed for with-project alternatives that reflect the impacts of both the excavation and the features of the alternatives. It has been determined that the impacts of the excavation, particularly in Reach 5 area, are significant. In fact, it appears that the additional channel capacity created by this excavation will greatly reduce the potential for any flooding in this area. As this was the primary damage area under previous assumptions, the removal of the flood threat for this area essentially leaves only minor residual flooding, primarily in Reach 2, under without-project conditions.

# CHAPTER V
# PLAN FORMULATION AND EVALUATION

This chapter presents the results of the plan formulation process used in the development of alternatives to address the planning objectives for the Rio Salado Oeste 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. Each plan is evaluated for its ability and extent of meeting the specified planning objectives and constraints, as well as 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 to each other. A benefit-cost analysis is conducted to prioritize and rank flood damage reduction alternatives. 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 displaying Federal interest. A locally preferred plan may be recommended and approved if the non-Federal sponsor desires other acceptable project features than those in the National Economic Development (NED) or National Ecosystem Restoration (NER) Plans.

## 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. Although they are considered in plan formulation they should not be confused with planning objectives for which solutions will be formulated or plans recommended. 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 initial public meeting was held on September 13, 2001. Meetings and presentations were also held with the Rio Salado and Tres Rios Advisory Committees to seek stakeholder and agency input. Areas of concern included technical considerations based upon the specifics of the study, vector control, flood damage reduction, and opportunities for recreation. Additional public meetings are being scheduled to correspond with release of the Draft Feasibility Report.

The planning effort included extensive involvement by the various offices of the City of Phoenix, as well as agencies (e.g., USFWS, FCDMC, AGFD). Numerous plan formulation workshops and 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.

### 5.2.2 Problems

- Degraded river and adjacent overbank areas, due to upstream water resources development, has eliminated native riparian plant species and wildlife habitat. Perennial base flow conditions, critical to the needs of native plants, no longer exist in the river corridor through the study area.

- The 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.

- The construction of dams has reduced natural flooding. Records show that there were two to four floods per year prior to dam construction in 1941. These changes in the river system have adversely impacted the surface/groundwater interactions and sedimentation dynamics that are important for sustaining and regenerating riparian vegetation.

- The greater Phoenix area is lacking in significant riparian habitat areas with supporting recreation facilities. The major parks in the area consist primarily of desert mountain preserves, which do not contain the types of habitat that could be supported in the study area. There are no formal existing recreation or environmental-education opportunities associated with the existing river corridor. As agricultural land near the river is converted to residential, the need for recreation will increase. The 27th Avenue Solid Waste Recycling Facility (just north of the river) has an existing environmental-education master plan. The facility provides tours for children and adults. The 23rd Avenue WWTP also does environmental-education programming and touring for water treatment.

- Land use changes, including landfills and sand and gravel mining, bridges, pipes, stabilization measures, and outfalls, have degraded and are contributing towards continued degradation of the river corridor.

- Unsuitable bank conditions exist at many locations. Surface dumping and manmade bank changes have resulted in a degraded and unsafe bank in many locations.

- Previous reports identified the existence of contaminated sediments, including contamination by DDT, from approximately 51st Avenue continuing downstream. The contaminated sediments have been documented to extend continuously in the Salt-Gila River corridor all the way to the Corps-owned-and-operated Painted Rock Dam, near Gila Bend, Arizona. Although a previous report cited concern about the presence of DDT in the sediments from 51st Avenue downstream, there has not been a recent detection of it within the project area.

- Flooding and drainage problems exist in the Salt River. Contributing to these problems are flooding and drainage issues addressed by the Laveen and Durango Area Drainage Master Plans, which are being prepared by the MCFCD.

- Contributing interior drainages lack current hydrology information at all discharge points into the Salt River. Adequate points of disposal do not exist at many interior drainage discharge locations.

- There is a flooding problem on the south side of the river, within the 100-year floodplain, between 67th Avenue and 75th Avenue.

- Existing cultural resources need protection from erosion and vandalism.

- The extent and significance of existing cultural resources are unknown.

### 5.2.3 Opportunities

- There is an opportunity to restore degraded river and adjacent overbank area by restoring perennial base flow conditions. There is an opportunity to link other upstream and downstream projects to provide a continuous restoration and flood control corridor.

These would include the authorized Rio Salado Project and the authorized Tres Rios Project.

- There is an opportunity to utilize groundwater for restoration and other needs, as agricultural groundwater pumping phases out. This opportunity may be the greatest in the Laveen area.

- There is an opportunity to simulate the natural flood regime to sustain and regenerate riparian vegetation.

- There is an opportunity to increase recreation opportunities by taking advantage of existing open water bodies, locations in the river, and adjacent properties as potential recreation sites (i.e., public fishing areas). There is also an opportunity to incorporate trails and other passive recreational features. The existing WWTPs on 27th Avenue and 23rd Avenue provide an opportunity to link environmental education that could be developed for a restored river corridor.

- There is an opportunity to reduce and/or modify land use changes (i.e., landfills and sand and gravel mining, bridges, pipes, stabilization measures, and outfalls) that have degraded and are contributing towards continued degradation of the river corridor.

- There is an opportunity to restore degraded and unsafe banks in the river corridor.

- There is an opportunity to remove contaminated sediments from portions of the study area. This would be a local sponsor responsibility.

- There is an opportunity to reduce flooding and drainage problems in the Salt River floodplain including along the south side of the river between 67th Avenue and 75th Avenue.

- There is an opportunity to protect existing cultural resources from erosion and vandalism.

- There is an opportunity to document the extent and significance of existing cultural resources.

- There is an opportunity to use effluent water from the 23rd Avenue WWTP to supplement surface water and groundwater sources for restoration and other needs. The plant produces a high quality effluent, which meets the water quality standards for numerous uses including Partial Body Contact, Fish Consumption, Aquatic and Wildlife (effluent dependent), Agricultural Irrigation, and Agricultural Livestock.

## 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 the 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 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 indices (not monetary units).

One purpose of this feasibility study is to determine if ecosystem restoration with incidental flood damage reduction and recreation in this reach of the Salt River are consistent with the Federal objectives stated above.

### 5.3.2 Specific Planning Objectives

Clear statements of specific planning objectives and constraints act as basic building blocks for developing alternative management measures and plans to alleviate stated problems and achieve opportunities. Through coordination with local and regional agencies, the public involvement process, site assessments, interpretation of prior studies and reports, and review of existing water projects, specific planning objectives were identified for this feasibility effort. The water and

related land resource problems and opportunities identified in this study are stated as specific planning objectives to provide focus for the formulation of alternatives. The planning objectives listed below reflect the problems and opportunities and represent desired positive changes along the Rio Salado Oeste reach:

- Restore native riparian, wetland, and floodplain habitats and manage undesirable plant, fish, and wildlife species.
- Reduce flood damages to infrastructure and structures.
- Improve passive recreation and environmental-education opportunities.

### 5.3.3 Planning Constraints

The feasibility of restoring the river over this reach will be challenging. Surface water from storm drains and shallow aquifer groundwater is of poor quality and sporadically available. Land adjacent to the study reach causes additional challenges. Once the mining operations in the area are concluded, the final configuration of the abandoned operations will place additional land use burdens on the community.

These problems, however, may become integral components of the environmental restoration of the river. Abandoned gravel operations can be incorporated as water features into a restoration plan. Water quality improvement can be obtained through incorporation of wetlands into the restoration plan.

Unlike planning objectives that represent desired positive changes, planning constraints represent restrictions that should not be violated. The planning constraints identified in the reconnaissance study and considered in this feasibility study are as follow:

- In the 2000 reconnaissance report it was stated that, "51st Avenue to Painted Rock Dam may soon be designated as a state superfund site." This constraint was listed due to a study finding organochlorines in the Salt and Gila Rivers. Since then there has been no listing of the area as a "state superfund site" but the reach is on the EPA 303(d) list of impaired waters. The Arizona Department of Environmental Quality is planning to initiate monitoring and investigations in 2008 and complete TMDLs in 2010 to deal with

the legacy pollutants (DDT, toxaphene, and chlordane). There are no known site-specific areas of contamination that may affect a restoration project.

- Coordination is required with Federal Aviation Administration (FAA) to minimize bird strikes within a 5-mile radius of the Sky Harbor International and Goodyear airports. FAA's regulations oppose open water within 10,000 feet of the airport operational taxiway. In addition, safety must be kept as a priority within a 5-mile radius of the airport. However, the Rio Salado Oeste study area is well outside the zone of concern of local airports.
- Proposed restoration features must be coordinated with the proposed South Mountain Freeway, which will cross the river corridor.
- Existing Federal, State, county, tribal, and private land ownership, including sand and gravel ownership and leases, will impact real estate appraisals and acquisitions.
- Issues associated with existing landfills must be incorporated into plan formulation efforts. The plan must not alter the migration of contamination plumes from landfills nor increase leachate from existing landfills.
- AMA water conservation requirements associated with the State of Arizona Groundwater Management Act must be adhered to.
- The project must not impact the safety of existing bridges.
- Because the introduction of water bodies could provide increased opportunities for mosquito breeding, vector control should be incorporated into the design, operation, and maintenance aspects of the project.
- The existing level of flood protection must be maintained. The addition of vegetation must not compromise the level of flood protection in the channel. Project-induced bank erosion must be avoided.
- Potential damage to restored habitat areas from flood flows should be prevented. Restoration features should benefit from, or take advantage of, the infrequent flood flows, with a goal towards self-sustaining regeneration and recruitment from restored seed sources.

- Restoration features and implementation must be compatible with continued operation of sand and gravel mining in the river corridor.
- The proposed project must have strong public support.

## 5.4 DEVELOPMENT OF ALTERNATIVE PLANS

Alternative plans were developed during this feasibility study to meet the specified problems and opportunities and planning objectives and constraints. As such, the alternatives described in this feasibility report are not proposals for actual construction, nor are they of sufficient design detail to be constructed. Following the completion of the feasibility report, EIS, public feedback, and project authorization by Congress, if such action occurs, detailed design analysis and preparation of plans and specifications would take place.

Alternatives plans have been formulated in consideration of current Federal, State, and local planning and environmental guidance, laws, and policy concerning ecosystem restoration, flood damage reduction, recreation, water quality, and related purposes, to:

- Comply with the National Environmental Policy Act (NEPA) and other environmental laws and regulations.
- Restore a diversity of riparian and associated floodplain fringe habitats to a more natural state.
- Provide an acceptable means of capturing storm water or relocating other existing water sources and conveying it into restored habitat areas.
- Maintain or enhance existing conveyance of peak discharges and ensure that the system of stormwater collection would not increase flood flows or worsen flooding conditions downstream in existing developed areas.
- Address specific flooding problems within the floodplain.
- Produce NER benefits while positively contributing to the NED Account, Regional Economic Development (RED) Account, and the Other Social Effects (OSE) Account.
- Provide decision-makers with information that could be utilized to help determine the balance between construction costs, real estate costs, and social issues and concerns.

- Provide a framework for responding to future urban development in the floodplain consistent with Executive Order 11988.
- Match existing and proposed improvements, where possible, to take advantage of local improvements and to be consistent with the future master planning efforts of the local community.

## 5.5 ALTERNATIVE DEVELOPMENT AND EVALUATION PROCESS

The feasibility study process involves successive iterations of alternative solutions to the defined problems. These solutions are based upon the study objectives and constraints and address problems and opportunities that have been previously defined. As part of Federal guidelines for water resources projects, there are general feasibility criteria that must be met. According to USACE Engineering Regulation (ER) 1105-2-100 for planning, a project in a Feasibility Report or GRR must be analyzed with regard to the following four criteria:

***Completeness*** Does the plan include all necessary parts and actions to produce the desired results?

***Effectiveness*** Does the alternative substantially meet the objectives? How does it measure up against constraints?

***Efficiency*** Does the plan maximize net NER and/or NED benefits?

***Acceptability*** Is the plan acceptable and compatible with laws and policies?

In the initial phase of the study, measures were developed to satisfy the four feasibility criteria. This initial list of measures to be evaluated (Section 5.6) was based on public input and suggestions, experience with similar projects, and technical considerations based upon the characteristics of the area.

An assessment of the need for flood damage reduction measures is presented in Section 5.7.1. The combination of measures for ecosystem restoration that formed a preliminary array of 20 alternative plans is addressed in Section 5.7.3. After the initial analysis and screening of the preliminary alternative plans, a secondary array of twelve more refined alternative plans was developed (Section 5.7 4). Key features common to the alternatives are described in more detail in Section 5.7.5. Section 5.8 describes the final array of five action alternatives. Each alternative

plan was then independently evaluated and compared to the No Action Alternative. The final array of alternatives was analyzed and compared to use as the basis for selecting the recommended plan (Section 5.9).

## 5.6 PRELIMINARY MANAGEMENT MEASURES

A management measure is a feature or activity at a site that addressed one or more of the planning objectives. A wide variety of measures are being considered, some of which may be found to be infeasible due to technical, economic, or environmental constraints. Each measure will be assessed and a determination will be made regarding whether it should be retained in the formulation of alternative plans. Descriptions of the preliminary measures considered in the reconnaissance phase of the study are presented below.

- **Create Water Supply:** A water supply and distribution system will be formulated as part of the feasibility study. The system is required in order to return some form of surface (base flow) and groundwater hydrology to the river, as required to support the other objectives. Potential sources of water supply include discharges from the 23rd Avenue WWTP, groundwater, groundwater wells, storm-drains and other interior drainage tributaries. Therefore, human intervention and infrastructure measures would be required in order to reestablish base flow conditions.

- **Establish Mesquite Bosque:** Establish mesquite trees at higher elevations from the river bottom. These areas would include terraces and overbank areas. Low-water-use irrigation or site conditions would need to be implemented in order to establish and maintain the mesquite trees. Once established, mesquite trees are expected to not require continuous water supply or maintenance.

- **Create Cottonwood/Willow Gallery:** Plant and establish cottonwood and willow tree plant communities along the wetted perimeter (fringe area locations within the river). The adjacent fringe areas where the plants would be established include the areas around existing open water areas, created wetlands, and flowing water.

- **Establish Wetlands:** Establish wetlands at appropriate locations in order to create a diverse and high-value project habitat. Appropriate locations for wetlands would be

determined during the feasibility phase, but typically involve river backwater areas or ponded water locations.

- **Incorporate Existing Ponds:** Utilize existing open-water areas created by abandoned gravel mining operation to create habitat and recreation areas. The habitat and recreation would take advantage of the existing open-water value to further increase project outputs.

- **Create Base Flow:** Return the conditions of a perennial environment to the study area. This linear feature would also support appropriate plant communities, such as cottonwood/willow galleries and aquatic riparian vegetation.

- **Incorporate Vector Control:** Incorporate mosquito-control measures as an integral part of the selected plan design and maintenance.

- **Clean-Up Debris:** Clean-up debris and reshape the bank and channel where manmade changes have occurred, to create a suitable restoration substrate. This is expected to be site specific and details would be determined during the design phase.

- **Improve Levee/Channel:** Evaluate flood control levees and/or channel improvements to improve conveyance capacity at flood problem locations.

- **Create Recreational Corridor:** Incorporate trails and other passive recreational features in support of the other restoration management measures. In addition to trails, these features could include access locations, signage, and comfort stations to support eco-recreation activities.

- **Consider Cultural Resources Mitigation:** Incorporate cultural resources mitigation features, if feasibility analysis determines cultural mitigation is required as part of the recommended plan.

Locally implemented non structural measures for restoration such as allocation of water for restoration, zoning controls, elimination of aggregate mining, land set asides, re-operation of Salt River Project Dams, and BMP's were also recommended for consideration. However, most of these measures are both impractical and publicly infeasible. Allocation of water, zoning controls and land set asides by themselves would not provide a solution to the

degradation that has occurred and the existing zoning regulations and Best Management Practices contribute to reducing the decline of remaining habitat value to the extent possible. Re-operation of dams and elimination of aggregate mining are both infeasible and publicly unacceptable solutions as they would affect both the regional water supply and economy.

## 5.7 ALTERNATIVE DEVELOPMENT

The eleven preliminary measures described above were refined and incorporated into the development of alternatives discussed below. Those refinements and modifications to alternatives were completed in plan-formulation meetings with numerous study participants, and took into account study findings and public/agency input.

### 5.7.1 Flood Damage Reduction

Evaluation of flood damages and solutions to reduce those damages was a large part of this study. The flood damage reduction analysis was performed first to determine what measures could be implemented to reduce damages and if they were economically justified. Alternatives evaluated to reduce flood damages included levees, channelization, floodwalls, and relocation. Those alternatives focused on reducing damages from the 100- and 500-year events. While there are damages from the more frequent events (see Appendix G, Economic Evaluation) those damages are mainly to a single parcel and are less likely to be economically justified for flood damage reduction measures than the larger, less frequent events. After completing an initial evaluation of flood damage reduction measures, a proposed plan to modify the reach of river between 35th and 51st Avenues was proposed by the City of Phoenix. That plan, described in section 3.1.5 Rio Salado Marsh, is considered to be part of the future without-project and future with-project condition. Most damages previously considered as without-project conditions are reduced by that action. Results of the analysis below are left in this report for informational purposes.

#### *5.7.1.1 Structural Measures*

Structural measures include construction of structures to reduce damages and are most effective when damages are concentrated. In this case, damages are most concentrated in Reach 5. Although there are damages in Reach 2L, the structures are dispersed and the construction of

levees or channels in that reach does not appear to be feasible, either technically or economically.

**Levees**: Two levee scenarios were evaluated including extension of a levee for approximately 5,000 feet along the north bank and for approximately 6,000 feet along the south bank (Figure V-1). These levees encompass most of Reaches 5 and 6. Each levee would have a top width of 12 feet and a slope of 3:1. A 100-year level of protection for the two reaches would be approximately 3 feet high and a 500-year level would be 6 feet high. Construction of levees on both banks would be necessary to prevent flooding on

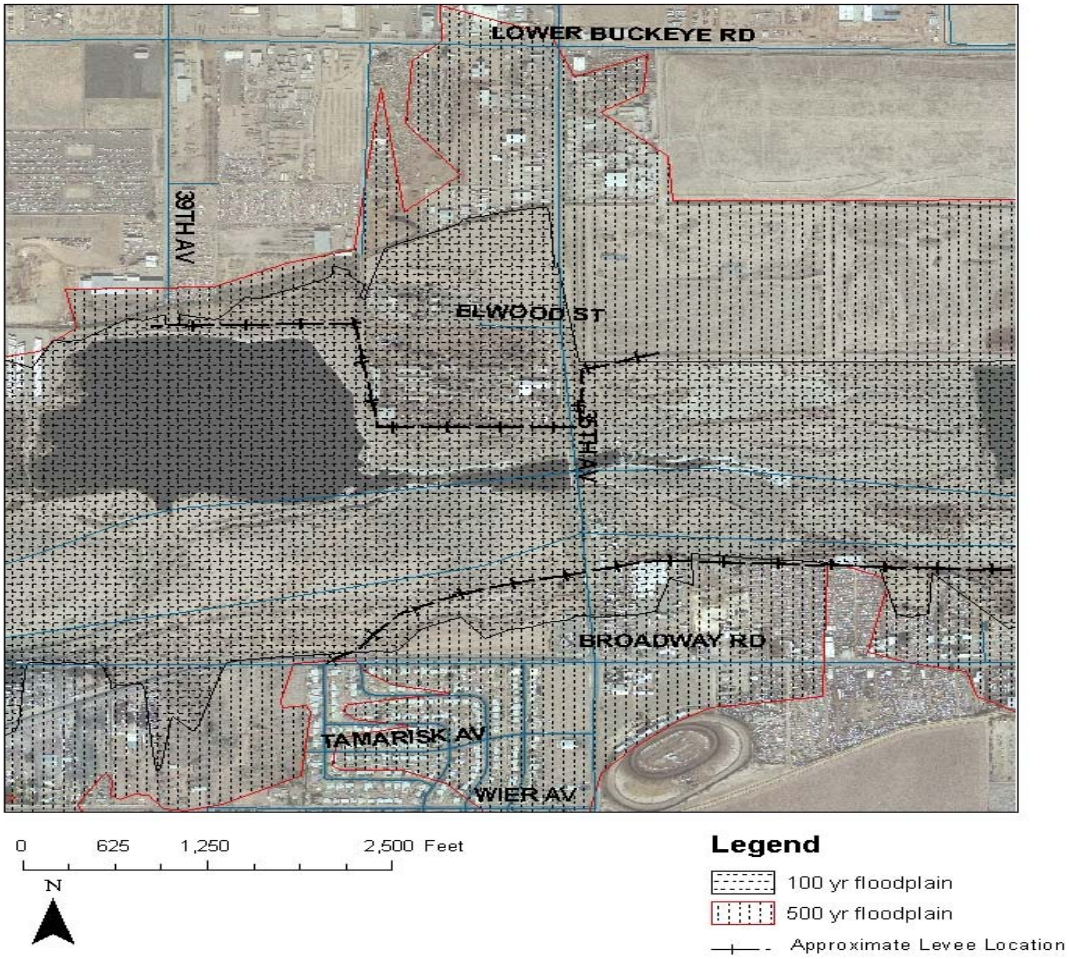



**Figure V-1: Approximate Levee Locations**

the opposite bank of the river. Since the damages within the two reaches appeared to be marginal for justifying levee construction, a preliminary construction estimate was calculated. This estimate used unit costs from the Tres Rios Project downstream to develop a preliminary estimate of $2,022,000.

**Channel**: Excavation and construction of a low-flow channel to pass flood flows for both the 100- and 500-year events were calculated. The excavation required for the Reaches 5 and 6 Channelization Alternative extends from Station 209.69 to 208.1, a distance of 1.59 miles, and includes excavation of approximately 1.4 million cubic yards (c.y.) of material. Modeling showed that for the 500-year level of protection this excavation would need to extend from Station 210.7 to 207.9, a distance of 2.27 miles, and would require the removal of approximately 2.4 million c.y. of material. Cost estimates for this alternative were estimated at $9.3 million for the 100-year and $16.6 million for the 500-year level of protection.

*Results*

For a flood control alternative to be feasible and economically justified, the benefits that it delivers (damages reduced) must exceed the costs to implement.

**Levee**: Table V-1 shows that the cost of implementation is more than the benefits produced from constructing levees. This analysis was preliminary to determine if further refinement of the structural alternatives and more detailed estimates were warranted. The results with benefit/cost ratios of less than 1:1 led the study team to consider other alternatives to reduce flood damages.

**Table V-1: Benefit/Cost Analysis - Levee Improvements**

| | Without Project | 100-Year | 500-Year |
|---|---|---|---|
| **EAD** | | | |
| Reach 5L | $ 32,400 | $ 29,800 | $ 10,300 |
| Reach 5R | $ 127,800 | $ 53,900 | $ 12,800 |
| Total | $ 160,200 | $ 83,700 | $ 23,100 |
| **Annual Benefits** | | | |
| Reach 5L | | $ 2,600 | $ 22,100 |
| Reach 5R | | $ 73,900 | $ 115,000 |
| **Total** | | **$ 76,500** | **$ 137,100** |
| **First Cost** | | $ 2,148,000 | $ 2,636,000 |
| IDC | | $ 60,000 | $ 73,000 |
| Investment Cost | | $ 2,208,000 | $ 2,709,000 |
| **Annual Cost** | | **$ 133,000** | **$ 163,000** |
| Net Benefits | | ($56,500) | ($25,900) |
| **Benefit/Cost Ratio** | | **0.58** | **0.84** |

Note - Does not include any Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) costs and does include the Lands, Easements, Rights-of-way, Relocations, and Disposal Areas (LERRD) estimate.
EAD = Equivalent Annual Damages
IDC = Interest During Construction

**Channel**: Table V-2 below summarizes the analysis of benefits for channelization of the reaches of the river where damages are greatest. The cost of implementation significantly exceeds the benefits that could be expected.

**Table V-2: Benefit/Cost Analysis – Channel Improvements**

| | Without Project | 100-Year | 500-Year |
|---|---|---|---|
| **EAD** | | | |
| Reach 5L | $ 32,400 | $ 6,100 | $ 800 |
| Reach 5R | $ 127,800 | $ 48,900 | $ 20,600 |
| Reach 6L | $ 14,300 | $ 2,900 | $ 1,900 |
| Reach 6R | $ 4,800 | $ 400 | $ 200 |
| Total | $ 179,300 | $ 58,300 | $ 23,500 |
| **Annual Benefits** | | | |
| Reach 5L | | $ 26,300 | $ 31,600 |
| Reach 5R | | $ 78,900 | $ 107,200 |
| Reach 6L | | $ 11,400 | $ 12,400 |
| Reach 6R | | $ 4,400 | $ 4,600 |
| **Total** | | **$ 121,000** | **$ 155,800** |
| **First Cost** | | $ 10,019,000 | $ 17,819,000 |
| IDC | | $ 278,000 | $ 494,000 |
| Investment Cost | | $ 10,297,000 | $ 18,313,000 |
| **Annual Cost** | | **$ 619,000** | **$ 1,101,000** |
| Net Benefits | | $ (498,000) | $ (945,200) |
| **Benefit/Cost Ratio** | | **0.20** | **0.14** |

Note - Does not include any Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) costs or Lands, Easements, Rights-of-way, Relocations, and Disposal Areas (LERRD) costs.
EAD = Equivalent Annual Damages
IDC = Interest During Construction

### *5.7.1.2 Non-Structural Measures*

Non-structural measures reduce flood damages without significantly altering the nature or extent of flooding by changing the use of the floodplain or accommodating existing structures within the floodplain. The non-structural measures evaluated here include floodwalls and relocation. Cost estimates for nonstructural measures were adapted from the National Flood Proofing Committee.

**Flood Walls:** Concrete floodwalls that are confined to specific parcels were evaluated. Elevations of either 2 or 4 feet high were the options considered. Parcels that could be protected with a floodwall were identified. Estimates were made of the length of floodwall around each structure necessary to prevent inundation. It was assumed that

floodwalls would be more suited to and more likely to be feasible for commercial/industrial rather than residential structures.

**Relocation:** Purchase and relocation of structures within the floodplain was evaluated also. This would include purchase of a property at fair market value, allowing the owner to relocate to a different location. Relocation was considered only for residential structures; relocation of commercial/industrial structures is highly unlikely to be feasible.

*Results*

Table V-3 below summarizes the results for those parcels that were evaluated either for floodwalls or for relocation. The results of the benefit/cost analysis were negative for all but one individual parcel. The Economic Evaluation (Appendix G) presents a more detailed analysis that was completed for that parcel. The parcel is a scrap-metal processing facility located at the northwest corner of the 35th Avenue Bridge. Because the property is occupied by a single owner/beneficiary, it is not eligible for Federal involvement in a cost-shared flood damage reduction project. However, the preliminary analysis shows that construction of floodwalls at that structure may be feasible. The single owner/beneficiary issue does not preclude local or private interests from implementing such measures to reduce damages.

*Summary*

Analysis of flood damages within the study reach showed that there are approximately $236,000 in expected annual damages to structures. The area with the most damages is the industrial area between 35th and 43rd Avenues on the north of the river. Damages also occur in Reach 5R, with additional damages across the river in Reach 5L in an area including residential, commercial, and industrial property. Reach 2L is made up of large-lot industrial and agricultural properties, but these are widely dispersed in the floodplain.

However, flood damage reduction alternatives do not meet the criteria for being economically justified at this time as the costs to implement the measures exceed the damages that they would prevent. One parcel did have a benefit/cost ratio greater than 1:1 and flood damage reduction measures may be economically justified, but Federal policy prohibits single-beneficiary

## Table V-3: Non-Structural Flood Damage Reduction Alternatives

**Rio Salado Oeste**

**Non-Structural Flood Damage Reduction Alternatives - Preliminary Benefit/Cost Analysis (in $1,000s)**

| | | Relocation Benefit/Cost Analysis | | | 2' Floodwall Analysis | | | | | 4' Floodwall Analysis | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Parcel | Approx EAD ($1,000s) | Estimated Reloc Costs | Reloc. Costs Annualized | Relocation B/C | Cost/Parcel | Annualized | Max Benefit | Approx Benefits | Approx BC | Cost/Parcel | Annualized | Approx Benefits | Approx BC |
| 10544007B | $ 4.9 | | | | $ 280 | $ 17.5 | $ 4.9 | NJ | | $ 411 | $ 25.6 | NJ | |
| 10546004B/4G | $ 83.4 | | | | $ 331 | $ 20.6 | $ 83.4 | $ 24.2 | 1.17 | $ 486 | $ 30.3 | $ 51,161 | 1.69 |
| 10471005 | $ 0.6 | | | | $ 284 | $ 17.7 | $ 0.6 | NJ | | $ 417 | $ 26.0 | NJ | |
| 10471007Y | $ 0.9 | $ 79 | $ 4.9 | 0.18 | | | | | | | | | |
| 10471007X | $ 1.9 | $ 88 | $ 5.5 | 0.34 | | | | | | | | | |
| 10471007F | $ 2.0 | $ 179 | $ 11.1 | 0.18 | | | | | | | | | |
| 10471015 | $ 7.8 | | | | $ 123 | $ 7.7 | $ 7.8 | $ 4.9 | 0.63 | $ 181 | $ 11.3 | $ 6.5 | 0.57 |
| 10471014 | $ 4.2 | | | | $ 72 | $ 4.5 | $ 4.2 | $ 3.1 | 0.70 | $ 105 | $ 6.5 | $ 4.2 | 0.64 |
| 10471007L | $ 2.5 | | | | $ 128 | $ 8.0 | $ 2.5 | NJ | | $ 188 | $ 11.7 | NJ | |
| 10471013A | $ 2.4 | | | | $ 129 | $ 8.0 | $ 2.4 | NJ | | $ 189 | $ 11.8 | NJ | |
| 10483003C | $ 5.3 | | | | $ 155 | $ 9.7 | $ 5.3 | NJ | | $ 227 | $ 14.2 | NJ | |
| 10483002N | $ 0.8 | $ 269 | $ 16.7 | 0.05 | | | | | | | | | |
| 10463004A | $ 1.0 | $ 44 | $ 2.8 | 0.37 | | | | | | | | | |
| 10569008D | $ 3.7 | | | | $ 294 | $ 18.3 | $ 3.7 | NJ | | $ 432 | $ 26.9 | NJ | |
| 10568002A | $ 1.1 | | | | $ 220 | $ 13.7 | $ 1.1 | NJ | | $ 324 | $ 20.2 | NJ | |
| 10550002A | $ 0.7 | | | | $ 82 | $ 5.1 | $ 0.7 | NJ | | $ 121 | $ 7.5 | NJ | |

Relocation scenario analyzed for parcels with residential structures
Floodwall scenarios analyzed for industrial/commercial parcels
NJ = Not Justified - based upon maximum potential benefits

involvement in a project. Therefore, there is no Federal interest in primary-purpose flood damage reduction alternatives.

River channel restoration is being considered as a measure within the ecosystem restoration component of this project and may have incidental benefits of reducing flood damages. That component will be discussed further later in this report.

### 5.7.2 Ecosystem Restoration

Project features were developed that will meet the primary project objective of ecosystem restoration while observing the constraints. The following list of restoration measures was derived from the initial list of management measures used in the reconnaissance phase and further developed based upon experience from similar restoration projects, technical considerations based upon the study area, input from the public and non-Federal sponsor, and coordination with other agencies.

**Channel Restoration**: A restored channel would provide a connection through the study reach, connecting upstream and downstream projects. Restoration would be accomplished by grading and terracing to restore an active channel through the entire reach.

**Stormwater Outfalls**: Existing outfalls would be modified to discharge to a concrete/stone channel that flows onto the river terrace, and the water would be directed toward the low-flow channel. Within that channel there would be a low weir to capture the low flows and allow floodwaters to pass. The weir would direct flows to a stormwater wetland constructed for the purpose of harvesting and improving the water qualtity of storm water and supporting adjacent habitat. Although the wetland would in some cases be ephemeral, it would provide habitat value.

**Cottonwood/Willow**: This measure would restore riparian cottonwood/willow stands adjacent to water sources and low terraces throughout the study area. Cottonwood/willow would be dominated by Fremont's cottonwood (*Populus fremontii*) and Gooding's willow (*Salix gooddingii*).

**Mesquite**: Mesquite habitat would be restored over a potentially large portion of the project area. Mesquite bosques would be dominated by velvet mesquite (*Prosopis velutina*), with scattered screwbean mesquite (*Proposis pubescens*) and some understory shrubs such as desert thorn (Lycium spp.) palo verde (*Cercidium floridum*) and brittlebush (*Encelia farinose*), and forbs.

**Wetlands**: Although rare in the Southwest wetland existed in the Salt River, and other Arizona rivers, in combination with the other riparian habitat types. In less degraded systems such as the Hassuyampa, Verde or San Pedro emergent wetlands can still be found. Cattail, willow, bulrush and other emergent wetland vegetation dominate emergent wetlands found in those natural systems. Due to the porous nature of soils now found in this project area, modificatoins will be required to assist in maintaining surface water. Excavation and layering of a silt/clay soil substrate approximately 12 inches thick is assumed to be sufficient to reduce permeability.

**Lakes:** There are existing features created from aggregate mining operations at 27th and 37th Avenues that would require modification to implement lake restoration. These modifications are recommended to restore the floodplain landscape and improve the functionality of these features. Although lakes are not necessarily consistent with historic, conditions they are existing features of the landscape for which restoration measures are being formulated to restore the area to a less degraded condition.

**Invasive Species Control**: Invasive species such as saltcedar (Tamarix spp.) and Arundo (*Arundo donax*) would require removal and management with project implementation. This would likely require physical removal and ongoing maintenance through the life of the project. Saltcedar is currently found in stands throughout the study area. Arundo, although not yet a significant problem in Arizona, is a problem in neighboring California. A stand of Arundo can be found on the south side of the river near a stormwater outfall at 43rd Avenue.

**Water Supply**: In addition to the stormwater runoff that would be harvested with the modificiatoin of stormwater outfalls, additional water supply would be required. Effluent from the 23rd Avenue WWTP is available for the restoration project. This

would also require construction of a pump and piping system to deliver water throughout the project area.

### 5.7.3 Preliminary Array of Alternatives

The preliminary measures described above were combined into alternatives with consideration of combinability and dependence. Table V-4 lists the preliminary alternatives considered for implementing ecosystem restoration. Development of those alternatives assumes that restoration of all specific habitat types is dependent on both water supply and control of invasive species. It was also assumed that restoration in the vicinity of the gravel pits (lakes) is dependent on both restoration of various riparian habitats and water supply.

Ctiteria were established to determine what alternaive plans to consider further. Those criteria are listed below. The criteria are meant to be a qualitative evaluatoin as to whether the plans meet minimum standards for being carried forward and evaluated in detail.

#### *5.7.3.1 Screening Criteria*

Principles and Guidelines describes the use of four evaluation criteria, two of which were applied at this phase of plan formulation. The other two criteria (efficiency and acceptability) not considered at this time will be evaluated and compared to the final set of alternatives in more detail, and described later in the report.

**Completeness**: "Completeness is the extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects".(P&G Section VI.1.6.2(c)(1)). This is the consideration as per whether the alternative includes all of the necessary actions to carry out the objective. The table below lists + or – depicting whether or not the team thought the individual alternative contained all necessary components to achieve the objective of restoration.

**Effectiveness**: "Effectiveness is the extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities." (P&G Section VI.1.6.2(c)(2)). In order to provide an initial measurement of how the effectiveness of the alternatives contribute to the planning objective (restoration) they were considered against the potential for restoring the most significant habitats. The significance of

riparian habitat has been discussed earlier in this report. Restoration goals pertaining to different riparian habitat cover types were developed with the recommendation of the USFWS and AGFD. Those include in priority order: cottonwood/willow, mesquite, wetland, and open water. To be minimally acceptable for further consideration it was decided that to be effective an alternative needs to include restoration of at least two significant habitat types.

**Flooding**: Since this is an urban environment with development adjacent to the river the consideration of induced flooding is an important one. Alternatives that install significant vegetation to the floodplain—but neither include channel restoration nor restrict the location of that vegetation—could raise water surface elevations and should be avoided. Therefore those alternatives were dropped from further consideration at this point in the study.

This preliminary screening of alternatives reduced the 20 alternatives to 12, including no action. It was meant to narrow the focus to those alternatives that are suitable for further detailed consideration.

**Table V-4: Preliminary Screening of Possible Alternatives**

| # | Description | Complete | Effective | Flooding |
|---|---|---|---|---|
| 1 | No Action | - | 0 | Y |
| 7 | Water Supply | - | 0 | Y |
| 8 | Water Supply, Invasive Control | - | 0 | Y |
| 2 | Invasive Control | - | 0 | N |
| 3 | Channel Restoration | - | 1 | N |
| 4 | Channel Restoration, Invasive Control | - | 1 | N |
| 9 | Water Supply, Channel Restoration | - | 1 | N |
| 10 | Water Supply, Channel Restoration, Invasive Control | - | 1 | N |
| 11 | Water Supply, Channel Restoration, Emergent, Invasive Control | - | 1 | N |
| 12 | Water Supply, Channel Restoration, Mesquite | + | 2 | N |
| 13 | Water Supply, Channel Restoration, Mesquite, Emergent, Invasive | + | 2 | N |
| 14 | Water Supply, Cottonwood, Channel Restoration, Invasive | + | 2 | N |
| 15 | Water Supply, Cottonwood, Channel Restoration, Emergent, Invasive | + | 2 | N |
| 5 | Storm Water | + | 3 | N |
| 6 | Storm Water, Channel Restoration | + | 3 | N |
| 16 | Water Supply, Cottonwood, Channel Restoration, Mesquite, Invasive | + | 3 | N |
| 17 | Water Supply, Cottonwood, Channel Restoration, Mesquite, Emergent, Invasive | + | 3 | N |
| 18 | Water Supply, Storm Water, Cottonwood, Channel Restoration, Mesquite, Emergent, Invasive | + | 3 | N |
| 19 | Water Supply, Lake, Cottonwood, Channel Restoration, Mesquite, Emergent, Invasive | + | 3 | N |
| 20 | Water Supply, Lake, Storm Water, Cottonwood, Channel Restoration, Mesquite, Emergent, Invasive | + | 3 | N |

Note: Effectiveness: Numbers designate number of habitat cover types that would be restored by that alternative. For example the number 2 indicates that 2 habitat types would be restored.
+ or – indicate if that alternative meets the subject criteria as described.

### *5.7.3.2 Alternative Formulation Rationale*

The above alternatives are combinatoins of measures that could be implemented at any location within the study area. The next step in formulating alternatives was to begin placing these features into suitable locations within the project area. For that purpose, measures have been broken into two categories: site-specific and systemic.

*Site-Specific Measures:*

Site-specific measures are dependent on the location of a specific feature already in place, such as a gravel pit, channel, or stormwater outfall. Site specific conditions at the various locations throughout the study area provide opportunities for restoration.

**Lake Restoration**: This feature would occur at existing gravel pit lakes within the study area. Specifically, the large lakes in the vicinity of 27th and 37th Avenues (Figure V-2) are focus sites. Lake restoration is dependent on both riparian and wetland restoration

and must be combined with those measures for success. Control of water levels is also necessary for success. This may be accomplished by modifying the substrate to make it impermeable and providing water supply.

**Figure V-2: Abandonned Gravel-Pit "Lake" (37th Avenue)**

**Stormwater Outfalls**: There are restoration opportunities at existing stormwater outfalls sited throughout the study area (Figure V-3 and Table V-5). Specific restoration would follow recommendations considering runoff amount, soil conditions, location in

**Figure V-3: Stormwater Outfall at 19th Avenue**

floodplain, and existing habitat. Further information on the individual stormwater outfalls is included in Appendix M, Wetland Restoration.

**Table V-5: Summary of Stormwater Outfalls with Recommended Restoration Potential**

| Location | Restoration |
|---|---|
| 19th Avenue NW | Mesquite Bosque/Palo Verde |
| 19th Avenue SW | Wetland and Riparian Corridor |
| 27th Avenue SE | Wetlands and Riparian |
| 35th Avenue NW | Cottonwood/willow |
| 43rd Avenue N | Wetland/Cottonwood-Willow |
| 43rd Avenue S | Wetland |
| 51st Avenue NW | Wetland/Mesquite |
| 67th Avenue | Wetland/Cottonwood-Willow |

Although stormwater runoff is seasonally inconsistent, observations in the study area indicate that there is sufficient runoff to support wetland vegetation. In many cases the existing vegetation is mostly exotic. Table V-6 below lists the locations of each stormwater outfall and the amount of habitat acreage that could be supported by the water available at each site. Potential runoff at each storm drain was calculated using the seven inches of annual rainfall and the drainage area size. Since there is not a consistent supply

of water, a conservative estimate was used to calculate water available to support habitat. The acreage of habitat that could be supported was based on utilizing one-half of the estimated water supply currently found at each site. It was assumed that when stormwater wetland is combined with cottonwood/willow riparian, the wetland would utilize one-third of the potential supply, with the cottonwood/willow utilizing the remainder.

**Table V-6: Restoration Potential at Each Stormwater Outfall**

| Location and Estimated Runoff (ac-ft) | | | Acreage of Habitat | | |
|---|---|---|---|---|---|
| | **Estimated** | **1/2** | **Cottonwood/ Willow** | **Mesquite** | **Wetland** |
| 19th Ave NW | 79 | 39.5 | | 13 | |
| 19th Ave SW | 231 | 115.5 | 10 | | 4 |
| 27th Ave SE | 196 | 98 | 8 | | 4 |
| 35th Ave NW | 224 | 112 | 14 | | |
| 43rd Ave N | 274 | 137 | 11 | | 5 |
| 43rd Ave S | Unknown | | | x | x |
| 51st Ave NW | 274 | 137 | | 30 | 5 |
| 67th Ave N | 558 | 279 | 23 | | 10 |

Note: Assumed water demand (ac-ft/acre): Cottonwood/willow = 8, Mesquite = 3 , Wetland = 9.

**Channel Restoration**: This measure is largely based upon historic conditions, hydraulics, and geomorphology. Therefore, implementation of this measure would be mainly within the 10-year area of inundation. Restoration would be accomplished through grading and excavation of materials to recreate a natural channel through the study reach. Channel restoration would serve several purposes: it would link upstream and downstream river reaches, transport low flows to adjacent habitats, convey flood flows, and reduce flood elevation on adjacent terraces and floodplains.

*Systemic Measures*

Systemic measures could be applied anywhere within the project area but would be based upon specific criteria for location. For example, all of the revegetation strategies, including establishment of cottonwood/willow, mesquite, and emergent wetland cover types, are systemic measures. In this case, existing data (soils, groundwater depth, flood elevation, etc.) was used to help determine optimum placement of individual habitat cover types. However, data was lacking in sufficient detail to do so across the entire area.

**Floodplain Location**: Elevation within the floodplain was a siting constraint adopted by the study team. Construction of permanent infrastructure and installation of woody vegetation would avoid the 10-year area of inundation and maintain an active channel to convey flood flows and minimize losses of project features during flood events.

**Water Availability**: Consideration was given to the availability of water (surface water, runoff, stormwater outfalls, or groundwater) at a given site or the liklihood of delivering water to that area cost effectively.

**Ecological**: Siting of restoration features took into account ecological conditions and strived to place restoration features in the most natural locations within the floodplain as possible. Doing so would produce a sustainable and successful restoration project and minimize operations and maintenance (O&M) costs. Cottonwood/willow cover type was placed either near the channel where the 10-year event would provide a wetted area, or where possible surface runoff would contribute the same effect. Mesquite bosques were located at the first floodplain terrace, and mesquite (xeric) higher in elevation in the floodplain.

### 5.7.4 Screening of Second Array of Alternatives

Although the second array of alternatives appeared to be complete and effective at meeting the restoration objective, the study team observed that further refinement would be necessary to aid the selection process. One final screening process was carried out by the study team using the following criteria:

1. Cottonwood-willow cover type is widely recognized as a significant and scarce cover type in the Desert Southwest. The Arizona Nature Conservancy (1987) rates the cottonwood-willow community as North America's rarest forest type. Its significance can also be seen in the literature, for example the highest population densities of non-colonial nesting birds in North America, are found in the cottonwood forests of central Arizona (Johnson 1971, Carothers et al. 1974). Cottonwood-willow is an important component of a functioning riparian ecosystem, it is present at all of the reference sites referred to in functional modeling, and meeting the objective of restoration requires that it be included. Therefore the study team determined that not

including cottonwood-willow would not be acceptable or effective and alternatives not including it should not be carried forward into detailed evaluation.

2. Existing storm water outfalls within the study area provide opportunities for restoration and for potential water harvesting. Outfalls include the inexpensive opportunity of providing additional water to the project area and associated restoration features. Since the watershed is developed tributaries to the river have been replaced by outfalls. The decision was made that the storm water measure is a necessary component to any alternative because of the restoration opportunities and potential water source. Therefore, alternatives not including that individual component should be eliminated from further consideration.

3. Channel restoration an important project component for various reasons. It provides a connection to other projects, is a potential means of water distribution, is important for the ecosystem, and contributes to reducing flooding potential. Therefore, alternatives not including that component were not considered.

Table V-7 shows the second array of alternatives along with the reasons for dropping individual alternatives from further consideration. As noted in the table at least 3 of the alternatives not only fail to meet criteria listed above but also are very similar to other alternatives.

**Table V-7: Second Array of 12 Alternatives**

| # | Preliminary Alternatives | Reason Dropped |
|---|---|---|
| 1 | No Action | |
| 2 | Storm Water | 3 |
| 3 | Storm Water, Channel | |
| 4 | Water Supply, Channel, Mesquite | 1 |
| 5 | Water Supply, Channel, Mesquite, Emergent, Invasive | 1 |
| 6 | Water Supply, Cottonwood, Channel, Invasive | 2 |
| 7 | Water Supply, Cottonwood, Channel, Emergent, Invasive | 2, similar to alternative 8 |
| 8 | Water Supply, Cottonwood, Channel, Mesquite, Invasive, added Storm Water | |
| 9 | Water Supply, Cottonwood, Channel, Mesquite, Emergent, Invasive | 2, similar to alternative 10 |
| 10 | Water Supply, Storm Water, Cottonwood, Channel, Mesquite, Emergent, Invasive | |
| 11 | Water Supply, Lake, Cottonwood, Channel, Mesquite, Emergent, Invasive | 2 water, with inclusion of it same as alternative 12. |
| 12 | Water Supply, Lake, Storm Water, Cottonwood, Channel, Mesquite, Emergent, Invasive | |

The study following set of five alternatives were carried further for development of designs and cost estimates. Those alternatives are:

1. No Action
2. Storm Water and Channel
3. Water Supply, Cottonwood, Channel, Mesquite, Invasive, Storm Water
4. Water Supply, Storm Water, Cottonwood, Channel, Mesquite, Emergent, Invasive
5. Water Supply, Lake, Storm Water, Cottonwood, Channel, Mesquite, Emergent, Invasive

## 5.7.5 Detailed Description of Project Measures

### *5.7.5.1 Provide Water Supply*

Project water is a constraint and a limiting factor across all alternatives. The project area can be split into two reaches based on water supply: (1) 19th to 51st Avenues where effluent and storm water are primary sources and (2) 51st to 83rd Avenues where groundwater is more likely to be

shallow enough to support vegetation after it is established. Water supply and distribution has been evaluated and planned by the City of Phoenix and is described in more detail within Appendix J, Design and Cost Estimate.

**Effluent**: Effluent from the 23rd Avenue WWTP is the primary source of water available for the restoration project. The City of Phoenix estimates that approximately 8 mgd (8,964 ac-ft) is available to the project. This would require construction of a means to deliver effluent to the project from the 23rd Avenue Plant.

**Storm Water**: Stormwater outfalls within the project area have been identified and possible discharges from them quantified. This includes 8 different outfalls from which an estimated average of 2,863 ac-ft was estimated to discharge based upon a 7-inch annual rainfall. Additional future outfalls may be implemented by the county at 51st Avenue (south) and 75th Avenue (north). While not a reliable constant source of project water, there are opportunities for future use of this water with proper design at the outfall locations. Currently, various forms of habitat are being supported by stormwater runoff, and design of a restoration plan would include site-specific measures maximizing use of that runoff.

**Groundwater**: Depth to groundwater through the project area varies from an average of 20 to 60 feet. In general, the depth to groundwater decreases to the west end of the study area where dewatering is required at 91st Avenue. In an analysis of ADWR well data and interpolation of surface water in gravel pits, there appears to be a zone of shallow (20-feet deep) groundwater between 51st and 19th Avenues in the river channel. This is likely due to excavation and is known to fluctuate as much as 20 feet annually (Rinker Materials Observation). Groundwater is being pumped in the vicinity of 23rd Avenue for sand and gravel mining where it contributes to the large lake near 27th Avenue. It was also assumed that the lake in the vicinity of 37th Avenue was excavated to groundwater depth, although observations in 2004 appear to indicate that the level has dropped significantly and that the elevations in the lake appear to be influenced more by effluent discharge.

**Supply Well**: A supplemental well providing up to 1.85 mgd from the Upper Alluvial Unit is part of the proposed system. This would provide redundancy in the event that there is a prolonged outage and effluent becomes unavailable for a period of time.

#### *5.7.5.2 Provide Water Distribution*

A water distribution system is needed to deliver water from the sources described above through the study area to locations of revegetation.

**Flood Irrigation**: Flood irrigation may be accomplished through a series of canals or channels delivering water to revegetation sites. Distribution within the revegetation sites may be through a braided network of channels. Effluent and pumped groundwater may be utilized for flood irrigation.

**Drip Irrigation**: This would be a temporary drip irrigation system consisting of small diameter pipes and drip emitters. Pumping would be required as a portion of this system. Drip irrigation works best with groundwater; effluent tends to clog the system and requires high maintenance.

**Stormwater Harvesting**: This measure is similar to creating a perched aquifer by providing water to a location with a below-grade low permeable layer. Although this could be accomplished with any water source and proper site-specific soil conditions, it appears that at several of the stormwater outfalls, similar conditions already exist. At constructed wetlands or ponds, a design option may include features that allow or encourage subsurface recharge to percolate down gradient and provide moist conditions, thereby irrigating adjacent vegetation.

#### *5.7.5.3 Revegetation*

*Cottonwood/Willow*

Due to groundwater depth, cottonwood/willow habitat could only be restored in proximity to existing or future surface water. This habitat would require a constant water source for the life of the project unless it can be verified that groundwater would be available within 6 to 7 feet of surface—in which case surface water would only be required for the first five years. Cottonwood/willow habitat would also require richer soils than some other habitat types.

Generally, cottonwoods occur at a greater distance from surface water than willows. Willows require more moisture at the surface for optimal growth. Besides cottonwoods and willows, plant species that would be included in the restoration of this habitat include Baccarus sp., arrowweed, and possibly ash. Cottonwood/willow would be dominated by Fremont's cottonwood (*Populus fremontii*) and Gooding's willow (*Salix gooddingii*). Other understory species would be planted, depending upon individual site conditions, but could include arrowweed (*Pluchea sericea*), elderberry (*Sambucus mexicana*) or burrobush (*Hymenoclea spp*.).

Two planting options are being considered for establishment of cottonwood willow. It is assumed that a combination of techniques would be utilized with specific planting techniques to be determined during project design.

**Plant Poles**: Plant poles are dormant pole cuttings harvested from living woody plants and planted vertically into the substrate. Poles need to be 3 to 4.5 inches in diameter and at least 6 to 8 feet long. Unless planted in saturated soils or near stable groundwater, temporary irrigation would be required. Pole plantings of cottonwood and willow have shown high rates of success with this technique. Plant materials should be available nearby, and may even be obtained from the other Salt River projects.

**Plant Containers**: Nursery grown potted containers would be planted on site. One gallon containers have shown the greatest success rates (80 percent +) at Lower Las Vegas Wash, Nevada. They are also the least expensive container plants available. Plantings would require a source of irrigation, at least temporarily.

*Mesquite*

This habitat would be restored over a potentially large portion of the project area. It would require periodic watering for the first five years after planting, although with less frequency than cottonwood/willow. Watering could possibly be discontinued after five years or when roots are expected to reach groundwater. Mesquite bosques would be dominated by velvet mesquite (*Prosopis velutina*), with scattered screwbean mesquite (*Proposis pubescens*), and some

understory shrubs, such as desert thorn (Lycium spp.) palo verde (*Cercidium floridum*), brittlebush (*Encelia farinose*), and forbs.

**Bosque**: Mesquite bosques are commonly found 5 to 20 feet above the river channel where water is adequate. They require a water table, or semi-saturated soil conditions 10 to 30 feet below the surface elevation and rely on occasional saturated conditions 1 to 3 feet below the surface. Soil requirements range from fine to gravelly, with some rocky areas. The mesquite bosques would be planted with a density of approximately 100 velvet mesquite, 10 screwbean mesquite, and 40 understory shrubs per acre. Understory forbs will also be planted using a seed mix.

**Xeric**: In locations throughout the study with less water supply, xeric stands of mesquite would be established. It is assumed that mesquite will survive under drier conditions and on higher terraces than mesquite bosque. Planting densities would be less, with approximately 25 velvet mesquite, 5 screwbean mesquite, and 10 understory shrubs per acre.

*Riparian scrub shrub*

As was discussed in Chapter IV the study area contains substantial acreage of scrub shrub habitat. Although portions of that cover type will be converted to the other riparian habitats others will be maintained, as they provide connection between other habitat types and contribute to the important mosaic of vegetative cover types that maximizes structural habitat complexity. It is assumed that some portions maintained will remain a more xeric desert scrub but others adjacent to the wetter riparian habitats will develop into more distinctive riparian cover containing species such as Seepwillow, desert broom, or Desert willow. Estimated acreages for both scrub shrub and riparian scrub are included in the listed acreages with each alternative below. It is estimated that if the active river channel is approximately 500 acres between 25 to 60% will be occupied by riparian scrub in the with project conditions depending on water supply.

### *5.7.5.4 Wetlands*

Wetlands can consist of open water, submerged vegetation, or mud flats, all requiring a high water table at or near the surface. Due to the porous soils found in this project area, lining the

site would be required to maintain surface water. Excavation and layering of a silt-clay soil substrate overlain by a mixed gravel, and finally, cobble layer, is 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.

**Stormwater Wetland**: Stormwater wetland restoration would take place at individual stormwater outfalls. Techniques would be site specific and would include grading or excavation, removal of exotics, and planting of suitable vegetation for the site conditions. Supplemental water would be required via an irrigation source, and structures would be installed to contain high-energy inputs and avoid erosion during storm events.

**Emergent Wetland**: Emergent wetlands contain primarily cattails (*Typha domingensis*), tule (*Scirpus acutus*), and sedges (Carex spp.). Because the river will not flow year round, the wetlands would need to be constructed specifically to retain water. In addition to grading and excavation, an impermeable layer would be added to retain water on site.

#### *5.7.5.5 Lake "Gravel Pit" Restoration*

There are existing features created from aggregate mining operations at 27th and 37th Avenues that would require modification to implement lake restoration. These modifications are recommended to better utilize the existing water and improve the functionality of these features. The existing banks would need to be reshaped for public safety and restoration. Potential substrate modification may be required to reduce the annual fluctuation in the lake levels. In addition, aeration would need to be considered to retain water quality.

**Grading**: Banks would be reshaped to create "irregular random terraces" (variable in length, width and depth below the water surface) that would become submerged to different depths to provide more diversity in the littoral zone. This is the nearshore area where sunlight penetrates all the way to the sediment and allows aquatic plants to grow. The irregularity and randomness of the terraces provides more opportunities for the establishment of submerged, floating, and emergent vegetation and a more diverse and natural shoreline habitat. The random terracing would provide different thermo strata for aquatic organisms, potentially improving mixing and maintaining a less stratified body of water, making it less susceptible to turnover (reducing oxygen levels). These terraces or

shelves may be exposed periodically, functioning as emergent wetlands or mud flats during seasonal fluctuations in the lake level. The terraces, when exposed, provide an opportunity for voluntary native vegetation to become established. When these areas are again submerged, some vegetation would persist and that which cannot would contribute to the organic content of the benthic zone. The productivity of the benthic zone is largely dependent on the organic content of the sediment and amount of physical structure.

**Substrate**: It would be necessary to modify the substrate of existing bodies of water within the study area to implement restoration at the lakes. This may include the addition of impermeable materials to both maintain water elevations and grow vegetation. There are some preferred alternatives for lake bottoms that improve the benthic zone productivity. There are tradeoffs in productivity, refuge, diversity, and food production associated with the various lake bottom characteristics. A sandy substrate contains relatively small amounts of organic matter for organisms and provides limited protection from predation. Higher plant growth is limited and sparse in sandy sediment; the sand is unstable and nutrient deficient. A rocky bottom has a high diversity of potential habitats offering protection (refuge) from predators, substrate for attached algae, and pockets of organic "ooze." A flat mucky bottom offers abundant food for benthos organisms; however, there is less protection and the diversity of structural habitats may be reduced unless higher plants colonize the lake bottom.

#### *5.7.5.6 Invasive Species Management*

**Invasive Species Removal/Control**: It would be necessary to remove and manage invasive species such as saltcedar and Arundo with project implementation. This would likely require physical removal and ongoing maintenance through the life of the project. Saltcedar is currently found in stands throughout the study area. Arundo, though not yet a significant problem in Arizona, is a problem in neighboring California. A stand of Arundo can be found on the south side of the river near a stormwater outfall at 43rd Avenue.

#### *5.7.5.7 River Channel Restoration*

Project implementation would restore the river channel to a more natural state based on hydraulics and geomorphology. This would be accomplished by grading and terracing to help restore an active channel through the entire reach. Average depth of grading is assumed to be 5 feet, with a width varying from 200 to 400 feet. The average width of the river channel ,including adjacent river terrace, thorughout the study area will be approximatley 500 feet. The channel design passes a 5-year event (~22,000 cfs) with occasional flooding on the terrace 2 to 4 feet depth at 1-7 cfs. Due to a drop in the channel downstream of the 35th Avenue Bridge, a grade control structure is recommended in that vicinity. At this time, erosion and scour do not appear to be a concern with project features or infrastructure. However, should it appear in future analysis that it is a concern, appropriate protection would be included. An estimated 660,000 c.y. would be removed from the channel to implement this measure. Material removed would be native riverbed material and would utilized on site for terracing and construction of other project components, such as lake restoration.

*River channel habitats*

As discussed earlier in this report the river channel itself can include different habitat cover types depending on site specific conditions. These may include dry river bottom, emergent wetland, riparian scrub or desert scrub. The team assumed that after construction a low flow channel similar to that in the Rio Salado Project area and the existing channel in the reach near 43rd Avenue would become established. The total acreage of this low flow channel through the project reach was assumed to be 170 acres. It was projected that between 10-20% of that would become vegetated with emergent wetlands. The remainder of the channel will vegetate with either riparian scrub or desert scrub depending on conditions within this active channel.

## 5.8 THIRD/FINAL ARRAY OF ALTERNATIVES

While evaluating the future conditions that would occur with each of the five remaining alternatives, the study team decided that different scales of restoratoin at the lakes should be evaluted. These included differeng levels of restoration based mainly on different water levels within the gravel pit lakes. These were developed by the study team and made the final array of project alternatives, which then became seven, including the No Action Alternative. Note that Alternatives 3 and 4 were nearly identical, apart from the emergent wetlands in Alterative 4. These two very similar alternatives were therefore combined as Alternative 4. The final set of project alternatives is shown in Table V-8 below, including short descriptions and the restored acreage associated with each alternative. Plates depicting each alternative and features therein are included at the end of the report.

1. **No Action**: No Federal Action to be conducted and no habitat restored. This is the future without-project condition.

2. **Storm Water and Channel:** This alternative includes the modification of existing stormwater outfall areas to improve retention and water spreading as well as increase the existing habitat currently supported by these outfalls. It also includes modification and/or restructuring of the primary conveyance channel to a more natural state by grading and terracing the river corridor from 19th Avenue to 83rd Avenue. No additional water source is included in this alternative other than temporary irrigation to establish vegetation.

3. **This alternative was merged with Alternative 4 below.**

4. **Storm Water, Channel, Water Supply, Cottonwood, Mesquite, Invasive, Emergent:** This alternative includes the features described in Alternative 2 and adds supplemental water supply in the form of effluent. It also includes restoration of emergent wetlands at the existing lake in the channel immediately downstream of 19th Avenue. At locations identified as suitable throughout the project area, cottonwood/willow and mesquite cover types would be restored. This alternative

would also address the management, control, and removal of invasive species within the study area.

5. **Storm Water, Channel, Water Supply, Cottonwood, Mesquite, Invasive, Emergent, Lake:** This alternative includes the features described in Alternative 4 and adds lake restoration at the existing gravel pits at 27th and 37th Avenues.

5A. **Wetland restoration in lieu of permanent open water and lakes:** In lieu of lake restoration, this alternative includes regrading the existing gravel pits to restore them to the floodplain, and restoring emergent wetland and riparian areas.

5B. **Hybrid of 5 and 5A:** This alternative includes restoration of one gravel pit to a wetland/riparian complex, and the other to include the lake.

## Table V-8: Final Array of Restoration Alternatives Evaluated

| Action Alternative | Cover Type | Acres |
|---|---|---|
| 2. Storm Water and Channel | Cottonwood/Willow | 66 |
| | Mesquite | 43 |
| | Open Water | 0 |
| | Scrub Shrub* | 305 |
| | Wetlands | 28 |
| | Channel ** | |
| | Low flow channel | 170 |
| | In-Channel Wetlands | 17 |
| | Riparian scrub | 125 |
| 4. Storm Water, Channel, Water Supply, Cottonwood, Mesquite, Invasive, Emergent | Cottonwood/Willow | 348 |
| | Mesquite | 409 |
| | Open Water | 0 |
| | Scrub Shrub* | 63 |
| | Wetlands | 33 |
| | Channel ** | |
| | Low flow channel | 170 |
| | In-Channel Wetlands | 34 |
| | Riparian scrub | 165 |
| 5. Storm Water, Channel, Water Supply, Cottonwood, Mesquite, Invasive, Emergent, Lake | Cottonwood/Willow | 375 |
| | Mesquite | 417 |
| | Open Water | 40 |
| | Scrub Shrub* | 92 |
| | Wetlands | 76 |
| | Channel ** | |
| | Low flow channel | 170 |
| | In-Channel Wetlands | 34 |
| | Riparian scrub | 296 |
| 5A. Wetland/riparian restoration in lieu of permanent open water and lakes | Cottonwood/Willow | 375 |
| | Mesquite | 417 |
| | Open Water | 0 |
| | Scrub Shrub* | 52 |
| | Wetlands | 156 |
| | Channel ** | |
| | Low flow channel | 170 |
| | In-Channel Wetlands | 34 |
| | Riparian scrub | 296 |
| 5B. Hybrid of 5 and 5A with one gravel pit restored to a lake and the other wetland//riparian complex | Cottonwood/Willow | 375 |
| | Mesquite | 417 |
| | Open Water | 20 |
| | Scrub Shrub* | 52 |
| | Wetlands | 136 |
| | Channel ** | |
| | Low flow channel | 170 |
| | In-Channel Wetlands | 34 |
| | Riparian scrub | 296 |

* Scrub shrub acres are dispersed among and between the other restored cover types within the floodplain.
** Note that the acres of river channel is made up of (low flow, wetland, or riparian scrub)

**Comparison and Evaluation of the Third Array of Alternatives**

*5.8.1.1 Water Supply and Water Budget*

Water sources within the project area available for the alternatives are evaluated within Appendix A, Hydrology and Hydraulics. Available sources for the project include effluent and harvested storm water. Approximately 8 mgd (8,961 ac-ft/yr) of effluent would be made available from the 23rd Avenue WWTP. Stormwater runoff within the project area was also calculated based upon average monthly rainfall in Phoenix, and approximately 2,900 ac-ft can be expected to runoff into the project area from the approximately 8 adjacent outfalls. Water demand for individual alternatives is summarized in Table V-9 below, with more detail included in Appendix B, Water Budget Report and Interior Drainage Report.

**Table V-9: Water Demand for Alternative Plans**

| Alternative | Water Demand (A/F) | Water Demand (mgd) |
|---|---|---|
| Alternative 2 | 1,583 | 1.41 |
| Alternative 4 | 4,701 | 4.20 |
| Alternative 5 | 7,752 | 6.92 |
| Alternative 5A | 9,293 | 8.30 |
| Alternative 5B | 9,234 | 8.24 |

*5.8.1.2 Hydraulics*

The hydraulic model of the study area was modified to reflect with-project conditions for a range of modifications including low, medium, and high amounts of vegetation restored in the floodplain. The high end of the range mimics Alternative 5. Results indicate that with-project conditions do not induce flood damages anywhere in the study area. Detailed results of the modeling can be found in Appendix A, Hydrology and Hydraulics.

*5.8.1.3 Cultural Resources*

While there are cultural resources at sites adjacent to the project area, surveys conducted by a Corps of Engineers staff archaeologist failed to locate any cultural material within selected portions of the project area. Based upon the reconnaissance survey, level of previous disturbance, and data provided from the geological assessment downstream in the Tres Rios Project area, the Corps believes that the potential for buried archaeological resources is low. If

project alternatives change or additional information is located, further surveys and coordination with the SHPO would be completed. More detailed description of cultural resources and reasons for this determination are provided in the Environmental Impact Statement.

#### *5.8.1.4 Hazardous, Toxic, or Radioactive Waste*

A groundwater quality analysis and a Modified Phase I ESA were completed during the study and may be seen in Appendix D and Appendix F, respectively. Landfills, LUSTs, and groundwater contamination are known to occur within the study area. This includes an area in the vicinity of 19th Avenue with elevated concentrations of 1,1 DCE. Although these sites mentioned above are known to exist adjacent to the river, they have been avoided throughout the plan formulation process, to the greatest extent possible, in accordance with Corps guidelines.

Experience during construction of the Rio Salado Project upstream has shown that due to the nature of the riverbed and dumping that has occurred over the years, it is likely that debris would be unearthed during excavation. This could include inert construction debris, tires, or miscellaneous household waste. The reach of the river between 35th and 51st Avenues has a high occurrence of illegal dumping of household and landscape waste, as well as occasional construction debris. Much of this area has been cleaned and monitoring has increased, though some waste is likely to remain.

A remediation and management plan would need to be developed for unknown HTRW and other deleterious material encountered during construction. Project features are for the most part located within the 100-year floodplain and avoid the known HTRW sites. In accordance with Engineer Regulation 1165-2-132, the Corps would not participate in clean-up of materials regulated by the CERCLA or by RCRA.

#### *5.8.1.5 Environmental Benefits*

Riparian ecosystems in the Southwest are invaluable. Although they represent less than 1 percent of the region's area (Knopf, F. L., 1989), a large proportion (75 to 80 percent ) (Gillis 1991) of vertebrate wildlife species depend on riparian areas for food, water, cover, and migration routes. Riparian zones also improve water quality because they filter sediments and nutrients. Accumulated sediments in riparian zones store large amounts of water, which helps sustain

stream flow during drier times. Estimation of environmental benefits was accomplished using the functional model described in Section IV and in Appendix I, Functional Assessment Methodology.

*Refined Alternatives*

Four additional alternatives were evaluated during policy review to assure that the Cost Effectiveness and Incremental Cost Analysis provided an evaluation of alternatives covering a full range of both output and cost . These alternatives include:

**Partial**: This alternative restores only the portion of Salt River from 19th to 35th Avenues without any restoration of existing gravel pit lake. It includes capture of storm water from only 4 outfalls. Approximately 270 acres are required for this alternative and restored areas include 15 acres of emergent wetlands, 30 acres of cottonwood-willow, 30 acres of mesquite, and 75 acres of riparian scrub. In addition the low flow channel would encompass approximately 48 acres.

**Refine 1**: This alternative includes restoration of the river channel from 19th to 83rd Avenues, modification of existing storm water outfalls and restoration of associated habitats and restoration of the two existing gravel pit lakes. Approximately 1024 acres are required to implement this alternative. Acres restored with this alternative include: cottonwood-willow 210, mesquite 56, wetlands 140, low flow channel 170, riparian scrub 125 and the remaining areas would be scrub shrub.

**Refine 2**: This refinement restores the river from 19th to 83rd Avenues and includes the same features as Alternative 5A but is scaled back to restore much less cottonwood-willow and mesquite habitats. Approximately 1300 acres are required to implement this alternative. Acres restored include: cottonwood-willow 204, mesquite 110, wetlands 140, low flow channel 170, riparian scrub 125 and the remaining areas would be scrub shrub.

**Refine 3**: This refinement also restores the river from 19th to 83rd Avenues without restoration of the gravel pit lakes and less acreage of cottonwood-willow and mesquite. Approximately 1130 acres are required to implement this alternative. Acres restored include: cottonwood-willow 169, mesquite 102, wetlands 92, low flow channel 170, riparian scrub 125 and the remaining areas would be scrub shrub.

*Functional Capacity Index*

The Functional Capacity Index (FCI) describes the quality of the functional capacity of the habitat. Of the 10 functions evaluated in the without-project conditions, all had low to moderate functional capacity. Implementation of project alternatives caused an increase in each FCI, with the average increasing by approximately 30 percent and into the ranges considered moderate to moderate-high functional capacity. The most improved functions included Function 1 (Maintenance of Characteristic Channel Dynamics), Function 7 (Detention of Particles), and Function 10 (Maintain Interspersion and Connectivity). Those functions showing the least improvement included Function 4 (Dynamic Subsurface Water Storage), Function 5 (Nutrient Cycling), and Function 6 (Detention of Imported Elements and Compounds). Table V-10 below displays the FCI for the baseline condition as well as for each alternative.

**Table V-10: With-Project Functional Capacity Indices (FCI)**

| Function Name | Existing | Alt 2 | Alt 4 | Alt 5 | Alt 5A | Alt 5B | Partial | Refine 1 | Refine 2 | Refine 3 |
|---|---|---|---|---|---|---|---|---|---|---|
| Fxn 01: Maintenance of Characteristic Dynamics | 0.23 | 0.27 | 0.4 | 0.39 | 0.4 | 0.39 | 0.25 | 0.27 | 0.28 | 0.27 |
| Fxn 02: Dynamic Surface Water Storage/Energy Dissipation | 0.42 | 0.45 | 0.57 | 0.57 | 0.57 | 0.57 | 0.45 | 0.49 | 0.50 | 0.49 |
| Fxn 03: Long Term Surface Water Storage | 0.25 | 0.27 | 0.34 | 0.33 | 0.34 | 0.34 | 0.27 | 0.29 | 0.30 | 0.29 |
| Fxn 04: Dynamic Subsurface Water Storage | 0.44 | 0.50 | 0.51 | 0.51 | 0.52 | 0.52 | 0.47 | 0.51 | 0.51 | 0.50 |
| Function 5: Nutrient Cycling | 0.28 | 0.28 | 0.33 | 0.33 | 0.34 | 0.33 | 0.27 | 0.29 | 0.28 | 0.27 |
| Function 6: Detention of Imported Elements and Compounds | 0.38 | 0.39 | 0.45 | 0.45 | 0.46 | 0.45 | 0.38 | 0.39 | 0.40 | 0.39 |
| Function 7: Detention of Particles | 0.33 | 0.36 | 0.48 | 0.47 | 0.48 | 0.48 | 0.34 | 0.38 | 0.39 | 0.38 |
| Function 8: Maintain Characteristic Plant Communities | 0.42 | 0.43 | 0.51 | 0.51 | 0.51 | 0.51 | 0.42 | 0.44 | 0.45 | 0.44 |
| Function 9: Maintain Spatial Structure of Habitat | 0.30 | 0.32 | 0.42 | 0.41 | 0.42 | 0.41 | 0.30 | 0.32 | 0.33 | 0.32 |
| Function 10: Maintain Interspersion and Connectivity | 0.23 | 0.29 | 0.33 | 0.34 | 0.34 | 0.34 | 0.25 | 0.28 | 0.28 | 0.28 |

*Acres Restored*

In the future without-project condition, existing cottonwood/willow cover type was projected to decrease from 112 acres to 25 acres, and existing wetland was projected to decrease from 30 to 25 acres as well. It is assumed that the quality of that habitat would be low with high concentrations of invasive species such as salt cedar. Although there are scattered mesquite trees within the study area, none are dense enough to consider a mesquite cover type.

Alternative 2 relies mainly on restoration at storm water outfalls and restoration of the river channel itself without large amounts of restoration elsewhere. Alternatives 3 through 5A all maintain and improve the highly degraded 112 acres of cottonwood/willow, and include restoration of mesquite and wetland habitats. Alternative 5A, which has the highest AAFCU outputs, includes restoration of 375 acres of cottonwood/willow, 417 acres of mesquite, and 190 acres of wetlands, including restoration of two large gravel pits within the floodplain. Also included in this alternative are 348 acres of scrub shrub and 170 acres of river channel. Acres restored of the Refined Alternatives are described on the preceding pages and are a smaller iteration of the previous alternatives ranging from 230 to 1300 acres.

*Average Annual Functional Capacity Units (AAFCUs)*

Based upon the functional assessment completed for this study, the number of acres and functional capacity indices were projected in order to derive with-project estimates AAFCUs. The same methodology that was employed for assessing without-project conditions was also employed to assess the habitat output of each alternative. Benefits are defined as the increase in AAFCUs for each alternative relative to without-project conditions. As a reminder, the Functional Capacity Unit (FCU) represents the factor of habitat quality multiplied by the quantity or FCI from above multiplied by acreage of habitat restored.

Table V-11 shows the results. The proposed alternatives result in increased AAFCUs (relative to without-project conditions) ranging from 51 for Alternative 2 to 267 for Alternative 5A.

**Table V-11: With-Project Average Annual Functional Capacity Units (AAFCUs)**

| Target Year | Without Project | Alt 2 | Alt 4 | Alt 5 | Alt 5A | Alt 5B | Partial | Refine 1 | Refine 2 | Refine 3 |
|---|---|---|---|---|---|---|---|---|---|---|
| T0 | 583 | 583 | 583 | 583 | 583 | 583 | 583 | 583 | 583 | 583 |
| T1 | 580 | 619 | 691 | 766 | 791 | 778 | 609 | 732 | 736 | 626 |
| T6 | 580 | 627 | 717 | 796 | 822 | 809 | 611 | 749 | 754 | 649 |
| T26 | 579 | 635 | 755 | 828 | 857 | 842 | 616 | 771 | 776 | 674 |
| T51 | 579 | 633 | 775 | 851 | 879 | 865 | 612 | 779 | 785 | 682 |
| Average (T0-T51) | 580 | 631 | 745 | 820 | 847 | 833 | 613 | 764 | 768 | 667 |
| Increase | | 51 | 165 | 240 | 267 | 253 | 33 | 184 | 187 | 87 |

As can be seen in the table above, the without-project conditions change only slightly over 50 years; the existing conditions within the project area are highly degraded and are not expected to

change without some action. Each column numbered with different alternatives displays the number of FCUs that are expected in that year, with the associated features of that alternative. The overall increase shown at the bottom of the table is the expected benefits to be accrued with that alternative between project year 1 and project year 50.

*Associated Planning and Future Conditions*

With any proposed project the associated local planning and zoning adjacent to the project area will affect each alternative similarly. The City of Phoenix has existing zoning regulations in place that in combination with a constructed restoration project will continue to ensure that any project implemented will not be adversely affected by development changes. Best Management Practices are in place as they relate to storm water outfalls entering the river and those will remain in tact in the future. The area adjacent to the Rio Salado Project upstream has an area plan and overlay district titled "Beyond the Banks" as described in Section 3.1.3. That connection between a restored river and adjacent community could expand downstream to the Rio Salado Oeste project area.

#### *5.8.1.6 Costs*

*Project Construction Costs*

Preliminary costs were developed for each project alternative. Estimates utilized a contingency of 25 percent of the First Cost and allowed 10 percent of the First Cost for engineering and design. One percent and 6 1/2 percent were utilized in estimating Engineering During Construction (EDC) and Construction Management. The Gross Investment for an alternative includes the first cost added to the other costs defined above plus Interest During Construction (IDC) calculated at the current 5.125 percent interest rate. Detailed cost estimates can be found in Appendix J, Design and Cost Estimate.

*Real Estate*

The proposed project features are located on areas of land that can be best described as the river corridor and floodplain mostly occurring within the 100-year 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 and recreation. The lands are all undeveloped with the principle economic or industrial use being sand and gravel extraction. For project planning, an average cost of $20,000 per acre was utilized.

*Operation and Maintenance (O&M) Consideration*

A priority during formulation of project alternatives was to minimize flood damages to project features. Therefore, the placement of plantings or infrastructure within the 10-year area of inundation was avoided to the extent possible. However, any river restoration project is inherently at risk of some damage by flood flows and inundation. O&M costs would include replacement of vegetation and structures damaged during flood events, wetland and channel maintenance, invasive species control, and inspections and surveys. Annual O&M costs for the alternatives range from $101,000 to nearly $2,200,000. The Monitoring and Adaptive Management estimates range from $697,000 to approximately $5,200,000.

*Associated Costs*

For the duration of project, authorization the Non-Federal sponsor must provide sufficient water supply for construction, operation, and maintenance of the project. The cost of providing this water is 100 percent non-Federal. Based on current and future water demand, a unit cost of $106 per ac-ft of CAP water was used.

Table V-12 below displays a summary of project costs for each alterative evaluated. Detailed cost estimates are provided in Appendix J, Design and Cost Estimate.

**Table V-12: With-Project Average Annual Costs by Alternative (in $1,000s)**

| | Alt 2 | Alt 4 | Alt 5 | Alt 5A | Alt 5B |
|---|---|---|---|---|---|
| Construction | $12,227 | $39,496 | $92,549 | $67,556 | $80,052 |
| Contingency (25% ) | $3,057 | $10,375 | $9,874 | $16,889 | $20,013 |
| PED/EDC (11%) | $1,345 | $4,345 | $10,180 | $7,431 | $8,806 |
| S&A (6.5%) | $795 | $2,567 | $6,016 | $4,391 | $5,203 |
| Real Estate | $21,994 | $36,313 | $49,485 | $49,485 | $49,485 |
| Subtotal | $39,417 | $92,594 | $181,367 | $145,752 | $163,560 |
| Monitoring & Adapt. Mgmt. | $697 | $2,251 | $5,275 | $3,851 | $4,563 |
| **Total First Cost** | **$40,114** | **$94,845** | **$186,642** | **$149,603** | **$168,123** |
| | | | | | |
| IDC | $2,020 | $8,463 | $19,066 | $15,322 | $17,195 |
| Gross Investment | $42,134 | $103,308 | $205,708 | $164,925 | $185,318 |
| | | | | | |
| Annualized Investment Cost | $2,353 | $5,769 | $11,486 | $9,209 | $10,348 |
| Associated Cost (Water Supply) | - | $331 | $654 | $817 | $811 |
| O&M | $101 | $1698 | $2,224 | $2,080 | $2,137 |
| **Total Annual Cost** | **$2,454** | **$7,797** | **$14,364** | **$12,106** | **$13,296** |

**Table V-12 Continued**

| | Partial | Refine 1 | Refine 2 | Refine 3 |
|---|---|---|---|---|
| Construction | $8,456 | $47,909 | $39,149 | $16,084 |
| Contingency (25% ) | $2,114 | $11,977 | $9,787 | $4,021 |
| PED/EDC (11%) | $930 | $5,270 | $4,306 | $1,769 |
| S&A (6.5%) | $550 | $3,114 | $2,545 | $1,045 |
| Real Estate | $8,438 | $31,319 | $39,625 | $32,375 |
| Subtotal | $20,488 | $99,589 | $95,413 | $55,295 |
| Monitoring & Adapt. Mgmt. | $482 | $2,731 | $2,232 | $917 |
| **Total First Cost** | **$20,971** | **$102,320** | **$97,644** | **$56,212** |
| IDC | $1,050 | $10,469 | $10,030 | $5,813 |
| Gross Investment | $22,021 | $112,789 | $107,674 | $62,025 |
| Annualized Investment Cost | $1,230 | $6,298 | $6,012 | $3,463 |
| Associated Cost (Water Supply) | $53 | $276 | $286 | $212 |
| O&M | $365 | $980 | $2,011 | $2,003 |
| **Total Annual Cost** | **$1,648** | **$7,553** | **$8,309** | **$5,678** |

*Cost-Effectiveness and Incremental Cost Analysis*

Cost-Effectiveness (CE) and Incremental Cost Analyses (ICAs) were performed on the above alternatives. CE 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 incremental cost per unit for maximum level of output is determined. The intent of the incremental analysis is to identify increases in cost relative to output.

Table V-13 summarizes average annual output and cost by alternative, as well as average annual cost per AAFCU. Figure V-4 below depicts graphically the comparison of annual costs versus annual benefits for the alternatives.

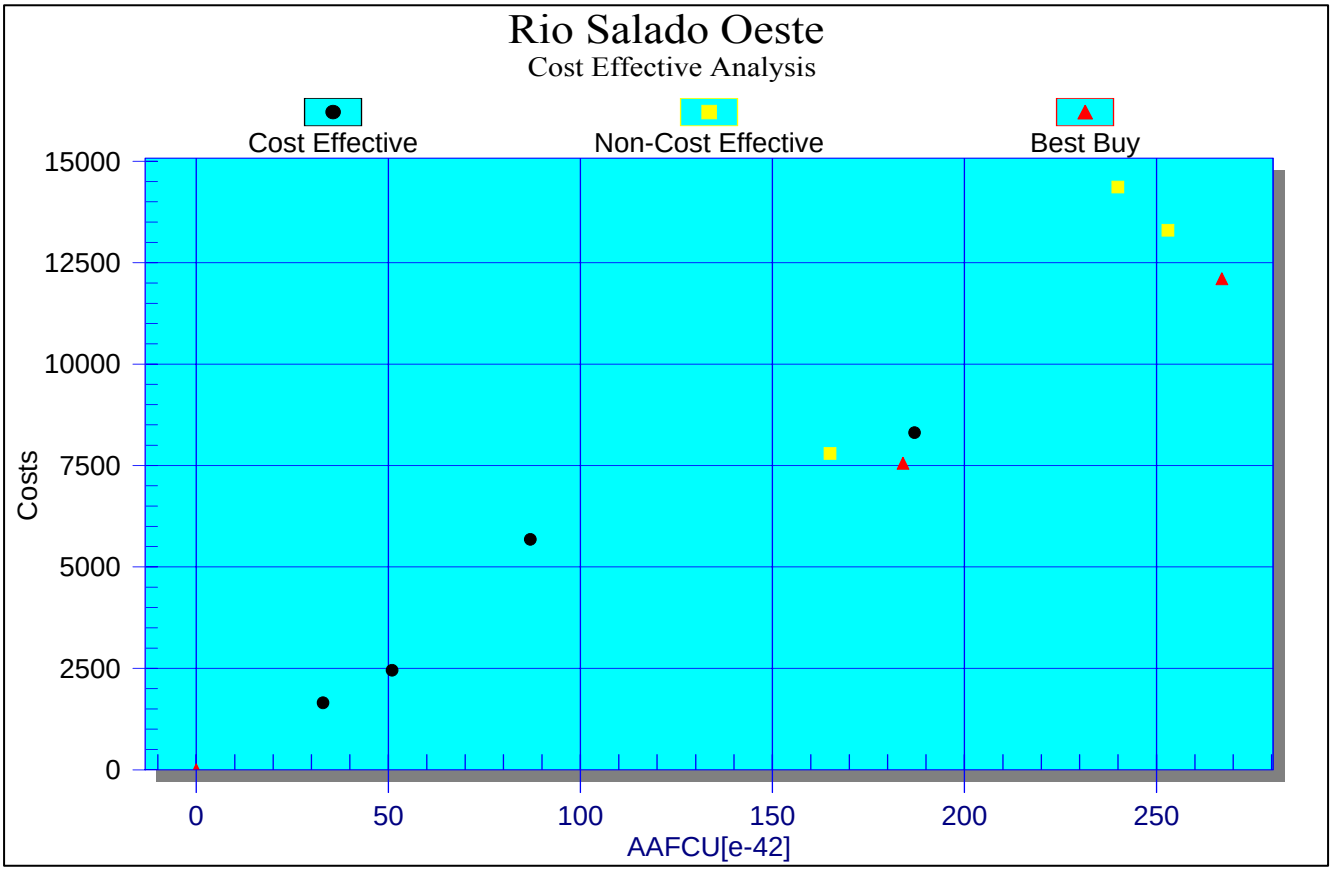
**Table V-13: Average Annual Costs Per Annual FCU by Alternative (in $1,000s)**

| Alternative | AAFCU | AA COST | AAC/AAFCU |
|---|---|---|---|
| Alt 2 | 51 | $2,454 | $47.94 |
| Alt 4 | 165 | $7,797 | $47.19 |
| Alt 5 | 240 | $14,364 | $59.76 |
| Alt 5A | 267 | $12,106 | $45.30 |
| Alt 5B | 253 | $13,296 | $52.59 |
| Partial | 33 | $1,684 | $49.34 |
| Refine 1 | 184 | $7,553 | $41.05 |
| Refine 2 | 187 | $8,309 | $44.52 |
| Refine 3 | 87 | $5,678 | $65,41 |

*Cost Effectiveness Analysis*

Alternatives are considered cost effective if there are no other alternatives that provide greater output for the same cost or provide the same output for a lesser cost. This step eliminates alternatives that are inefficient from further consideration. As can be seen in Figure V-4 there are six cost effective alternatives, Alternatives 4, 5, and 5B are not cost effective.

**Figure V-4: Cost Effective Analysis**




*Incremental Cost Analysis*

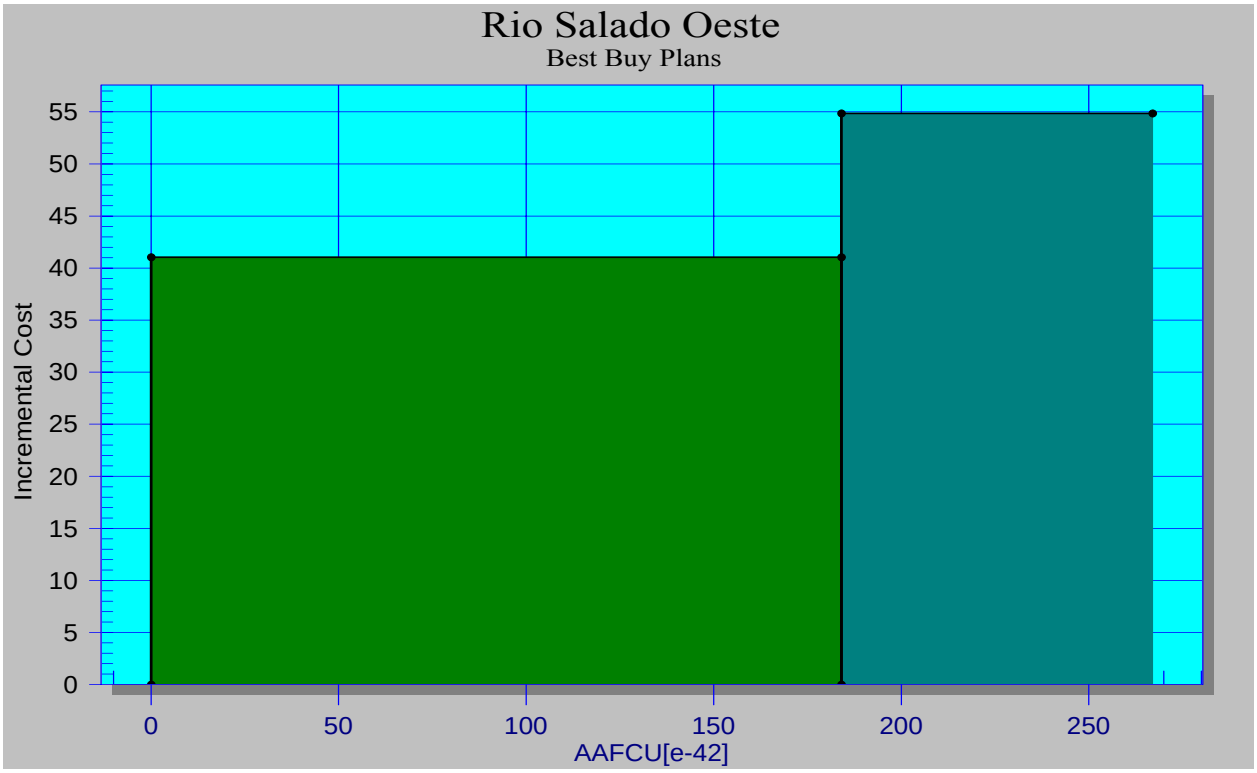
ICA goes beyond cost effectiveness analysis to consider the incremental change in cost and outputs from one alternative to the next. As you step through the successive levels of outputs in the AAFCU column in Table V-14 below you can see an increasing level of outputs (AAFCU's) from 184 to 267. Likewise the annual cost increases. The incremental increase in cost between alternatives displays the additional cost to implement one alternative over the next and likewise the benefits over the next. This information can be used to weigh the difference in levels of cost versus benefits and contributes to the plan selection process. Incremental cost analysis is also used to identify "best buy" plans. Best Buy plans are those that have the lowest incremental

average annual cost per incremental increase in output. The two best buy plans are shown in Table V-14 and Figure V-5 below.

**Table V-14: Incremental Cost Analysis**

| | AAFCU | Annual Cost | Cost/AAFCU | Incremental Cost/Incremental AAFCU |
|---|---|---|---|---|
| Refine 1 | 184 | $7,553 | $41.05 | $41.0 |
| Alt 5A | 267 | $12,106 | $45.34 | $54.7 |

**Figure V-5: Incremental Cost Analysis**




As can be seen above, Alternative Refine 1 provides 184 AAFCU and Alternative 5A provides 267. The AAC/AAFCU for Alternative 5A is about ten percent higher than Alternative Refine 1, and the incremental AAC per incremental AAFCU is about 33 percent higher than Alternative Refine 1. However, Alternative 5A provides 83 AAFCUs more than Alternative Refine 1, representing an increase in output of over 45 percent. .

*5.8.1.7 Recreation*

The Rio Salado Oeste Project provides a unique opportunity to enhance resource-based recreation and environmental education. The restoration of the dry Salt River channel would bring a riparian open space feature to the rapidly expanding Laveen and Estrella Planning Areas. Rio Salado Oeste would provide a habitat and recreational connection to the desert riparian habitat corridor created by the Rio Salado and Tres Rios Projects. By connecting the 7-mile gap between the two projects, Rio Salado Oeste would enhance the unique recreation and education opportunities for residents and out-of-town visitors. Drawing on a population base of over two million in the Valley, it is estimated that visitation to the Rio Salado Oeste Project would exceed 350,000 annually (see Table V-15). Primary use times for this unique resource would coincide with the "visitor season" between October and May when temperatures are moderate.

**Table V-15: Rio Salado Oeste Recreation Plan**
**Baseline Visitation Estimate**

| | Days | Turnover/Day | Visits* |
|---|---|---|---|
| Winter (Oct-May) | 243 | | |
| Prime Time | 78 | 1.50 | 160,875 |
| Non-Prime Time | 165 | .50 | 113,438 |
| Winter Total | | | 274,313 |
| Summer (Jun -Sep) | 122 | | |
| Prime Time | 36 | 1.00 | 49,500 |
| Non-Prime Time | 86 | 0.25 | 29,563 |
| Summer Total | | | 79,063 |
| **Grand Total (by vehicle)** | | | **353,376** |
| Add - Arrive by Alternative Mode (10%) | | | 35,338 |
| **Total Visitation** | | | **388,714** |
| Less Transfers (10%) | | | 38,871 |
| **Baseline Visitation for Benefit Analysis (rounded)** | | | **350,000** |

Note: Based upon parking capacity for 500 spaces.
Average of 2.75 Persons/Vehicle

The City of Phoenix developed the recreation plan for the project, which may be found in Appendix L, Recreation. The plan is consistent with Corps policy on development of recreation at ecosystem restoration projects as outlined in Policy Guidance Letter No. 59, USACE 1998. Major recreation features include multipurpose trails, shelters, signage, shelters, utilities, park furniture, and interpretive media. Access points are identified in the plan, with four drive-in points with parking facilities and 5 smaller access points for walk-in use. Additionally, 9 minor points for walk-in access from adjacent neighborhoods may be completed but are not part of this project. Table V-16 below includes the recreation features and associated cost estimates.

Although an environmental education center is planned and described in the Recreation Appendix L, it is not a cost-shareable portion of the project and would be a local sponsor cost.

**Table V-16: Rio Salado Oeste Recreation Plan with Costs**

| Component | Quantity | Unit Cost | Recreation Cost |
|---|---|---|---|
| **Site Preparation** | | | |
| Site Prep to include: clearing, grubbing, and grading | 9 | Lump Sum | $250,000.00 |
| Vegetative Restoration (Drive in Access) | 4 | Lump Sum | $600,000.00 |
| Vegetative Restoration (Walk in Access) | 5 | Lump Sum | $75,000.00 |
| **Access and Circulation** | | | |
| Entry Road w/Turnaround to include: curb, gutter, driveway, & road | 4 | Lump Sum | $600,000.00 |
| Parking lot | 500 | $1500/space | $750,000.00 |
| Sidewalks and Ramps | 40,000 sf. | $6.00 each | $240,000.00 |
| Multi-Use Trails (24mi * 5280 * 5ft) | 47000 | $6.00 / sy | $282,000.00 |
| Bridges and Culverts (small) @ Canals, and Localized Drainage Areas | 10 | $7,500 each | $75,000.00 |
| **Protection Access Control** | | | |
| Access Control Gates (vehicular) | 10 | $7,500 each | $75,000.00 |
| Access Control Gates (pedestrian) | 18 | $3,500 each | $63,000.00 |
| Handrails | 5,000 l.f. | $50.00 each | $250,000.00 |
| Guardrails | 3,000 l.f. | $50.00 each | $150,000.00 |
| Fencing | 5,000 l.f. | $30.00 each | $150,000.00 |
| Walls | 1,500 l.f. | $125.00 each | $187,500.00 |
| Security lights | 100 | $4,000 each | $400,000.00 |
| **Signage** | | | |
| Entrance identification signage | 8 | $15,000 each | $120,000.00 |
| Traffic Control (vehicular) | 20 | $500 each | $10,000.00 |
| Traffic Control (pedestrian) | 27 | $500 each | $13,500.00 |
| Instructional/Directional | 45 | $500 each | $22,500.00 |
| **Shelters** | | | |
| Picnic (large) | 5 | $60,000 each | $300,000.00 |
| Picnic (small) | 5 | $25,000 each | $125,000.00 |
| Restroom Facility/Comfort Station | 5 | $250,000 each | $1,250,000.00 |
| Shelter w/Bulletin Boards | 4 | $25,000 each | $100,000.00 |
| Trail Shelter w/Railing (large) | 9 | $40,000 each | $360,000.00 |
| Trail Shelter w/Railing (medium) | 4 | $30,000 each | $120,000.00 |
| Trail Shelter w/Railing (small) | 10 | $20,000 each | $200,000.00 |

| | | | |
|---|---|---|---|
| **Utilities** | | | |
| Municipal Water Supply and Wastewater Disposal | 5 | Lump Sum | $500,000.00 |
| Storm Drainage | 4 | Lump Sum | $80,000.00 |
| Drinking Fountain w/Chiller | 12 | $5,000 each | $60,000.00 |
| Electical | 4 | Lump Sum | $200,000.00 |
| **Park Furniture** | | | |
| Benches: | 14 | $1,500 each | $21,000.00 |
| Off-the-Shelf | 40 | $800 each | $32,000.00 |
| Recycled/Custom | 50 | $500 each | $25,000.00 |
| Picnic Tables | 40 | $1000 each | $40,000.00 |
| Trash Receptacles | 75 | $500 each | $37,500.00 |
| **Interpretive Guidance Media** | | | |
| Display Boards | 50 | $600 each | $30,000.00 |
| Interpretive Markers | 100 | $600 each | $60,000.00 |
| Bulletin Boards | 9 | $2,500 each | $22,500.00 |
| | | **Subtotal** | **$7,876,500.00** |
| | Contingency | 20% | $1,575,300 |
| | PED+EDC | 11% | $1,039,698 |
| | S&A | 7% | $681,947 |
| | | **Total** | **$11,173,445** |

## 5.9 EVALUATION OF FINAL ARRAY OF ALTERNATIVES

### 5.9.1 System of Accounts

The comparison and evaluation of alternatives involves the consideration of the effects that the plans would have on planning objectives and constraints. The following discussions address the differences and similarities between the future without project conditions and alternatives. The four national accounts are also considered in the comparison and evaluation of alternative plans, as are the associated evaluation criteria.

In the 1970 Flood Control Act, Congress identified four equal national accounts for use in water resources development planning. They are National Economic Development (NED), Regional Economic Development (RED), Environmental Quality (EQ), and Other Social Effects (OSE). Policy in the 1970s regarded making contributions to only two of these, NED and EQ, as national objectives. The Federal objective is taken from the "Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies" also known as Principles and Guidelines or P&G.

#### *5.9.1.1 National Economic Development (NED)*

The Federal objective of water and related land resources planning is to contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable Executive orders, and other Federal planning requirements.

"Contributions to national economic development (NED) are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the nation. Contributions to NED in clued increases in the net value of those goods and services that are marketed, and also those that may not be marketed" (P&G).

For this project, with the primary outputs being ecosystem restoration, the Environmental Quality (EQ) Account below includes those benefits. Benefits of recreation and flood damage reduction, if any, are accounted for within the NED Account.

*Recreation Benefit Analysis*

Visitation at the resource would be limited based upon the available parking in the area. Phoenix's design includes several parking lots with a total of 500 spaces. Visitation data maintained by the City for other recreation sites indicates an average number of visitors per vehicle of 2.75. In addition, it is estimated that ten percent of visitors arrive to the site by an alternative mode of transportation (e.g., bicycle, foot traffic and public transportation).

Annual visitation has been estimated for both the winter (October - May) and the summer (June - September) seasons. In addition, visitation has also been broken down by prime time (weekends and holidays) and non-prime time (weekdays). Transfers are expected to be minimal due to the unique recreation opportunities and setting offered at the restoration site. The City expects the primary transfers to be in the categories of education field trips, bird watchers, passive nature watchers, canal joggers, and recreational cyclists. Annual transfers were estimated at ten percent of total visitation. Excluding transfers, annual visitation is estimated at 350,000.

The above visitation projections were also compared to standards established by the National Recreation & Parks Association (NRPA), regarding trail usage and capacity. 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 proposed recreation plan includes approximately 16 miles of multipurpose trails. With baseline visitation projected at 350,000, this equates with a value of about 22,000 users per year per trail mile, which supports that the proposed facilities should be able to accommodate the projected visitation. Further, the proposed facilities should also be able to support likely increases in visitation over time, as the general population growth in the study area will inevitably increase demand and use of the facilities.

*Unit Day Point Value Estimates*

A panel of Phoenix Parks, Recreation and Library department personnel including Park Managers, Recreation Supervisors, Recreation Coordinators, and Landscape Architects reviewed the recreation plan in light of its location within the planned environmental restoration study area and derived the following point values for the Unit Day Value analysis:

| Criteria | Range of Point Values | Assigned Value |
|---|---|---|
| Recreation Experience | 0-30 | 24 |
| Availability of Opportunity | 0-18 | 8 |
| Carrying Capacity | 0-14 | 14 |
| Accessibility | 0-18 | 18 |
| Environmental | 0-20 | 12 |
| Total | 0-100 | 76 |

Recreation experience was rated very high, although most recreation activities could be described as general recreation. This is because of the context within which the recreation takes place. There are very few recreation sites in the market area located in a riparian and wetland environmental setting. This enhances the value of these activities. In addition, non-general recreation and education opportunities are provided, such as interpretive areas and scenic overlooks, birding, etc. The project would be designed to maximize recreational values in the other categories to the extent possible. Please refer to the Economic Appendix (Appendix G), and Recreation Appendix (Appendix L) for additional details.

EGM 06-03 provides ranges for point value to dollar value conversion. The dollar value corresponding with a point value of 76 is $8.254. This point value was applied to projected annual visitation to derive the annual value of the recreation resource. The resulting annual recreation value totals $2,889,000.

Recreation Costs & Benefit/Cost Analysis

Table V-17 details the cost estimates for the proposed recreation plan.

**Table V-17: Recreation Plan Expected Annual Costs**

| **First Cost** | |
|---|---|
| Site Preparation | $925,000 |
| Parking Lots (500 Spaces) | $750,000 |
| Entry Roads | $600,000 |
| Sidewalks & Ramps | $240,000 |
| Multi-Use Trails | $282,000 |
| Bridges & Culverts | $75,000 |
| Access Control | $875,000 |
| Security Lighting | $400,000 |
| Signage | $166,000 |
| Picnic/Trail Shelters | $1,205,000 |
| Restroom Facilities | $1,250,000 |
| Utilities | $840,000 |
| Park Furniture | $155,000 |
| Interpretive Guidance Media | $112,500 |
| **Subtotal – Construction** | **$7,876,500** |
| Contingency (20%) | $1,575,300 |
| PED/EDC (11%) | $1,039,698 |
| S&A (7%) | $681,947 |
| **Total First Cost** | **$11,173,445** |
| Interest During Construction | $573,000 |
| **Gross Investment** | **$11,746,445** |
| Annualized Investment Cost | $655,900 |
| OMRR&R | $800,000 |
| **Total Annual Cost** | **$1,455,900** |

Average annual benefits have been estimated at $2,889,000, and average annual costs are estimated at about $1,456,000. Therefore, the proposed recreation plan is economically justified, with net benefits of $1,433,000 and a benefit/cost ratio of 1.98.

### *5.9.1.2 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 V-18.

**Table V-18: Regional Economic Development Account**

| | No Action | Refine 1 | Alt 5A |
|---|---|---|---|
| Employment | No effect | Short-term increase in employment during project construction. | Short-term increase in employment during project construction. |
| Business and Industry | No effect | Increased recreation and tourist visitation to the area may increase revenues of local businesses. | Increased recreation and tourist visitation to the area may increase revenues of local businesses. |
| Local Government Finance | No effect | Financing required for construction, $42M. O&M. $980,000/yr $800,000 recreation | Financing required for construction, $60M. O&M. $2,083,000/yr $800,000 recreation. |
| Growth Inducing Impacts | No effect | No impact on growth. Potential benefit in contribution to neighborhood revitalization. | No impact on growth. Potential benefit in contribution to neighborhood revitalization. |

It can safely be assumed that river restoration would contribute significantly to local and regional economic development and revitalization of the neighborhoods adjacent to the river. Land being developed and redeveloped within several miles of the Salt River is taking the potential for a restored river into account. Model homes and developments advertise the restored Rio Salado and the City has a local plan for revitalization and future development upstream of the Rio Salado Oeste study area.

*Rio Salado Beyond the Banks*

The Rio Salado *Beyond the Banks* area plan is a local policy document for revitalization of the area, which includes approximately 7 square miles between the I-17/I-10 freeways, Broadway Road to the south, 19th Avenue to the west and 32nd Street to the east. City support of private sector investment will be provided through public improvements, financial incentives, technical assistance, and zoning enforcement. Improvements that will increase property values in the area are expected to occur incrementally over time in response to market forces, through private investment, and as a result of City revitalization efforts. As incompatible uses and blight are reduced and new developments, facilities, and amenities are added, the *Beyond the Banks* area will begin to realize its broad potential. Four major areas of emphasis for new development will

help spur area revitalization in general. Estimates of redevelopment that has occurred since the Rio Salado Interim Overlay zoning went into place in January, 2002 are between $325 and $400 million.

*Local Property Values*

Studies have documented higher property values associated with riparian areas and wetlands. One such study in Tucson, Arizona, documented a 6 percent difference in property value due to proximity to the riparian corridor (Colby and Wishart, 2002). It can be assumed that the change from a degraded floodplain to restored riparian and wetland habitat would have a similar effect on property values in the area.

#### *5.9.1.3 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 could have on significant environmental resources. Table V-19 shows the accounts for each alternative.

## Table V-19: Environmental Quality (EQ) Account

| | No Action | Refine 1 | Alt 5A |
|---|---|---|---|
| **AAFCU** | 580 | 764 | 847 |
| **Increase in AAFCU** | - | 184 | 267 |
| **Average Annual Cost ($1,000)** | - | $7,553 | $12,106 |
| **Average Annual Cost/AAFCU ($1,000)** | - | $41.05 | $45.30 |
| **Water Quality** | Water quality is expected to decline slightly as the watershed continues to urbanize. | Water quality could decrease temporarily during construction. Best Management Practices would be implemented for mitigation. However, positive impacts over current conditions would occur in the long-term. | Water quality could decrease temporarily during construction. Best Management Practices would be implemented for mitigation. However, positive impacts over current conditions would occur in the long-term. |
| **Air Quality** | Existing air quality levels created by business, traffic, and industry would continue. It can be assumed that dust levels would increase with additional dry river bottom disturbed by off road vehicles. | Temporary air quality decrease during construction but would be mitigated through implementation of Best Management Practices. This alternative would have positive long-term impacts when compared to the No Action Alternative. | Temporary air quality decrease during construction but would be mitigated through implementation of Best Management Practices. This alternative would have positive long-term impacts when compared to the No Action Alternative. |
| **Noise** | No impacts to noise would occur. | A temporary increase in construction noise would occur but long term conditions would be no more than existing levels. | A temporary increase in construction noise would occur but long term conditions would be no more than existing levels. |
| **Vegetation** | Existing native vegetation would decline within the study area. | Restoration of habitat throughout the study area would have a positive effect by restoring native vegetation. | Restoration of habitat throughout the study area would have a positive effect by restoring native vegetation. |
| **Fish and Wildlife** | Loss to habitat of fish and wildlife populations due to vegetation changes would occur. | Habitat would improve through the study area and connect upstream and downstream habitats for wildlife movement. | Habitat would improve through the study area and connect upstream and downstream habitats for wildlife movement. |

| | No Action | Refine 1 | Alt 5A |
|---|---|---|---|
| **Endangered Species** | No impacts to threatened or endangered plant species would occur. | Although no endangered species are known in the study area, habitat restoration could attract them and contribute to positive effects on their habitat. | Although no endangered species are known in the study area, habitat restoration could attract them and contribute to positive effects on their habitat. |
| **Cultural Resources** | No impacts on cultural resources. | Potential for impacts to cultural resources is believed to be low. If resources are located, consultation with SHPO would occur. | Potential for impacts to cultural resources is believed to be low. If resources are located, consultation with SHPO would occur. |
| **Aesthetics** | Existing aesthetic environment would remain relatively unaffected with continued illegal dumping throughout portions of the study area. | Could be affected during construction, however, many of these areas are not highly visible and affects are short term. Implementation would result in improved views of riparian vegetation. | Could be affected during construction, however, many of these areas are not highly visible and affects are short term. Implementation would result in improved views of riparian vegetation. |

#### *5.9.1.4 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 manmade and natural resources. A comparison of the effects that the proposed alternatives would have on OSE resources is shown in Table V-20.

**Table V-20: Other Social Effects Account**

| | No Action | Refine 1 | Alt 5A |
|---|---|---|---|
| Life, Health and Safety | No change | Improvement to river environment would improve safety and health in adjacent community. | Improvement to river environment would improve safety and health in adjacent community. |
| Recreation | Recreation conditions would stay substantially the same. Recreational experiences would also not be enhanced. | Implementation of recreation plan would increase availability and enjoyment of recreation opportunities. | Implementation of recreation plan would increase availability and enjoyment of recreation opportunities. |
| Community Cohesion | No change | River restoration is preferred over the No Action Alternative and contributes to community cohesion. | River restoration is preferred over the No Action Alternative and contributes to community cohesion. |

### 5.9.2 Associated Evaluation Criteria

The selection of a recommended plan from the alternative plans requires a combination of decision-making factors. As suggested by the U.S. Water Resources Council, 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.

#### *5.9.2.1 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 planning 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. In general, all of the final alternatives are fully formulated and complete. Completeness was a

factor considered in screening of the first set of alternatives. No further measures are needed to allow for the functioning of the final set of alternatives.

#### *5.9.2.2 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 Rio Salado Oeste portion of the Salt River. The No Action Alternative is ineffective in meeting any of the planning objectives. Action alternatives evaluated are all effective to some extent, although some are more effective than others to the extent to which they meet the objectives.

#### *5.9.2.3 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 identifies the plans that have the highest levels of output relative to costs. 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.

#### *5.9.2.4 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. It is assumed that the action alternatives are all acceptable, although this will be assessed further with public review of the draft report.

**Table V-21: Associated Evaluation Criteria**

| Criteria | No Action | Refine 1 | Alternative 5A |
|---|---|---|---|
| Completeness | Does not meet objective | Technically feasible, meets restoration objectives, requires less acreage than Alt 5A but also restores less habitat. | Technically feasible, meets restoration objectives, restores the most acreage of priority habitat types. |
| Effectiveness | Does not meet objective | Restores river channel and provided connectivity but restores less acreage of cottonwood/willow, mesquite and wetlands than Alt 5A. | Restores the river channel and provides connectivity and continuity along river with most acreage of priority habitats restored. Greatest acreage of significant habitat types restored. |
| Efficiency | Does not meet objective | Provides outputs of 184 AAFCU at a cost of $41,050/AAFCU. | Provides the most output (267 AAFCU) or 45% more than Alt Refine 1 with a 10% increase in cost per unit ($45,300/AAFCU) |
| Acceptability | Does not meet objective | Non Federal Sponsors have not indicated support for Alt Refine 1. | Supported by Non Federal sponsor, resource agencies, and initial public support was established after the public meeting and Draft Report review June 2006. |

## 5.10 SELECTION OF THE RECOMMENDED PLAN

Upon consideration of the National Objectives and other evaluation criteria Alternative 5A is selected as the NER 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.

That alternative includes restoration of approximately 1,500 acres of riverine habitat throughout the 8-mile study area Approximately 847 AAFCUs would be available with the project, an increase of nearly 47 percent over without-project conditions where there were projected to be 580 AAFCUs. Alternative 5A has an estimated restoration cost of $153,776,850 with an annual cost of $12,367.000 including $2,083,000 Annual O&M.

Restoration features of the alternative include restoration of the river channel to a more natural state by grading and terracing the channel from 19th Avenue to 83rd Avenue; modification of stormwater outfalls to improve water retention; restoration of cottonwood/willow, mesquite, and wetland cover types throught the project area; and the restoration of two old gravel pits to wetland and riparian complexes. The alternative also includes control of invasive species such as saltcedar and Arundo throughout the life of the project . Water supply and distribution for the alternative is to be provided through a combination of 8 mgd of reclaimed effluent from the 23rd Avenue WWTP, and harvesting of storm water.

**Table V-22: Acres of Habitat Restored with the Recommended Plan**

| Habitat | Acres |
|---|---|
| Cottonwood/Willow | 375 |
| Mesquite | 417 |
| Open Water | 0 |
| Scrub Shrub | 52 |
| Wetlands | 156 |
| Channel | |
| Low flow channel | 170 |
| In-Channel Wetlands* | 34 |
| Riparian scrub | 296 |
| *Note that the acreage of in channel wetlands are a part of the 170 acres of low flow channel | |

The recreation plan described above is also recommended for implementation. It is consistent with Corps policy on development of recreation at ecosystem restoration projects as outlined in Policy Guidance Letter No. 59, USACE 1998. Major recreation features include multipurpose trails, shelters, signage, shelters, utilities, park furniture, and interpretive media. Access points are identified in the plan, with four drive-in points with parking facilities and 5 smaller access points for walk-in use. Total cost of the recreation plan is $11,173,445. Average annual benefits have been estimated at $2,889,000, and average annual costs are estimated at about $1,456,000. Therefore, the proposed recreation plan is economically justified, with net benefits of $1,433,000 and a benefit/cost ratio of 1.98.

*Ecosystem Restoration Significance*

As discussed earlier in this report riparian habitat is significant in the Desert 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 recognized 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. The significance of riparian habitat in the Desert Southwest is recognized at various levels. Institutional, public and technical

significance of riparian habitat restoration and that of the Recommended Plan are summarized here.

Executive Order No. 91-6 Protection of Riparian Areas and issued by the Governor of Arizona in 1989 recognizes that "protection and restoration of riparian areas are of critical importance to the state". The order determines a policy statement of the State of Arizona in regards to the protection and restoration of riparian areas.

The Arizona Game and Fish Department Strategic Plan (2001) recognizes riparian habitat as the states richest wildlife habitat and includes focus of conservation on those riparian habitats. It also states that since lowland riparian forest and woodland declined so severely between the 1800 and 1900's that species occupying them comprise more than ½ of the non raptorial birds listed as Wildlife of Special Concern in Arizona.

The U.S. Fish and Wildlife Service describes Southwestern Riparian areas as contributing "significantly to the biological integrity, including biodiversity, of our Nation's waters." It goes on to describe the abundance of breeding birds, as well as its importance as habitat to threatened and endangered species (USFWS, 1993).

The Nature Conservancy in An Ecological Analysis of Conservation Priorities in the Sonoran Desert Ecoregion, lists desert riparian woodland as a very rare although significantly important cover type and describes restoration of riparian systems in the Sonoran Desert as critical. (Marshall et al 2000).

Arizona Partners in Flight Bird Conservation Plan (1999) recommends that maintenance and restoration of riparian deciduous forests should be a top conservation priority in the state. This is due to both the biological significance and the extent to which the habitat has been lost.

Audubon Arizona recognizes the significance of restoration on the Salt River and has entered an agreement with the City of Phoenix to construct the Rio Salado Audubon Center at Central Avenue. This will be an educational conservation center and be adjacent to the constructed Rio Salado project upstream from the Oeste study area.

The references discussed above describe the importance of riparian habitat in Arizona and the region. Restoration of 8 miles of the Salt River in Phoenix goes beyond the footprint of the recommended plan. It also provides a connection between the Rio Salado and Tres Rios projects, when all are combined nearly 18 river miles will be restored. Although significant themselves, once completed the entire reach will be even more so. Restoration will provide a large corridor of restored habitat of extreme importance to breeding and migratory birds and other wildlife that depend on it.

Riparian habitat is recognized in Arizona and the Desert Southwest as being biologically significant, scarce, and threatened due to the losses over the past 100 years. With the recognition of this importance it can be seen that the recommended plan contributes to restoration of a significant ecological resource.

## 5.11 RISK AND UNCERTAINTY

Uncertainty and variability are inherent in water resources planning and therefore the consideration of risk and uncertainty is important. Situations of risk are conventionally defined as those in which the potential outcomes can be described in reasonably well known probability distributions. In situations of uncertainty, potential outcomes cannot be described in objectively known probability distributions. Risk and uncertainty arise from measurement errors and from the underlying variability of complex natural, social, and economic situations. The degree of risk and uncertainty generally differs among various aspects of a project. It also differs over time, because benefits from a particular purpose or costs in a particular category may be relatively certain during one time period and uncertain during another.

### 5.11.1 Flood Damage Reduction

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 Corps ER 1105-2-101, *Risk-Based Analysis for Evaluation of Hydrology/Hydraulics, Geotechnical Stability and Economics in Flood Damage Reduction Studies (1 March 1996).*

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. Best estimates of key variables, factors, parameters and data components are developed, but are often based on short periods of record, small sample sizes, measurements subject to error, and innate residual variability in estimating methods. RBA explicitly analytically incorporates these uncertainties by defining key variables in terms of probability distributions, rather than single-point estimates. Uncertainties in flood damage analysis includes discharge/probability, stage/discharge, geotechnical features, structure elevation and values, and inundation depth/damage.

The Corps of Engineers Hydrologic Engineering Center has developed software specifically designed for conducting RBA, referred to as the HEC-FDA Program (Version 1.2 used for this analysis). This program applies a Monte Carlo simulation process, whereby the expected value of damages is determined explicitly through a numerical integration technique accounting for uncertainty in the basic parameters described above. Data requirements for the program include:

- Structure data, including structure I.D., category (sfr, mfr, etc.), stream location, ground and/or first floor elevation, structure value and content value. This data was developed in a Microsoft Excel spreadsheet and imported into the HEC-FDA program.

- Hydrologic and hydraulic data, including water surface profiles, frequency/discharge relationships, and stage/discharge relationships. For this study, water surface profiles were developed using the HEC-RAS program. These functions were imported into the HEC-FDA program.

- Depth/Damage functions. Functions for residential and non-residential structures were obtained from the Institute for Water Resources and FEMA's National Flood Insurance Program.

- Risk & Uncertainty Parameters, as described in detail previously, were also entered into the program.

More detailed discussion of risk and uncertainty in the flood damage analysis and hydrologic and hydraulic data can be found in Appendix A, Hydrology and Hydraulics, and Appendix G, Economic Evaluation.

### 5.11.2 Ecosystem Restoration

Some risk and uncertainty are assumed in nearly every aspect of a water resources project. The variability of outcome associated with the recommended plan does not fit the definition of risk. That variability is better characterized as uncertainty in that the potential outcomes cannot be described in known probability distributions. 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.

A higher than normal amount of uncertainty exists regarding landscape-scale ecosystem restoration in the arid southwest. This is because the few such projects that have been completed are of recent origin and detailed data is not yet available to assess the outcomes. Given the lack of precedent and scarcity of empirical data regarding restoration of Sonoran riparian systems, there is a degree of uncertainty regarding a number of aspects of the design, construction, and operation of the recommended alternative.
Within planning for the Rio Salado Oeste Project several areas of uncertainty were identified and addressed. Those areas of uncertainty include:

- **Storm Water availability**: In order to account for uncertainty in the volume of runoff at stormwater outfalls, the estimated annual volume of runoff was halved prior to planning the quantity of habitat that could be supported. While observations of existing vegetation at some of the existing outfalls suggest that there is sufficient water to support the proposed restoration, the reduced volume accounts for the uncertainties with rainfall in any given year. Additional water supply to each outfall was also planned for establishment period and as a back-up in severe drought conditions.

- **Trash/Debris unearthed during construction**: As observed in the Rio Salado Project under construction, more trash and debris than previously estimated were unearthed during construction. While a Modified Phase I ESA was performed for this project and

field observations have not identified known areas of extensive trash and debris, 2 percent of the construction cost was added to account for this unknown.

- **River discharges**: In order to reduce the unknown effects of river discharges on restoration features as well as the risk of damages, efforts were made during plan formulation to minimize placement of project features within the 10-year discharge area of inundation. Also, the channel restoration measure in addition to providing for restoration allows conveyance of flood flows and reduced the potential for damages to project features on the terraces.

- **Land use changes**: During project planning, efforts were made to account for any possible land use changes that may affect the project area. The largest area of uncertainty is the duration that existing aggregate operations will be in existence and the potential for new ones to be established prior to implementation. Should conditions change prior to project implementation, it can be assumed that the configuration of restoration features may change with them.

- **Revegetation success**: The success of revegetation measures is vulnerable to some uncertainty. While the proposed actions to restore vegetation have taken place and are in progress in the arid southwest, including immediately upstream of the study area, uncertainties remain. Mortality due to poor stock, disease, insect infestation, herbivore damage, and other unforeseen circumstances contribute to uncertainties. Revegetation techniques assumed with the proposed project features are very similar to those being implemented successfully elsewhere, including Rio Salado immediately upstream. It is assumed that by the time any authorized project is implemented, more will have been learned about the success of that project and any changes necessary would be incorporated at the time of construction. An O&M plan and costs include estimates for vegetation replacement. A Monitoring and Adaptive Management Plan will also be in place and would provide time to monitor success and make any changes to features that require it.

# CHAPTER VI
# DESCRIPTION OF THE RECOMMENDED PLAN

## 6.1 THE RECOMMENDED PLAN

Based on the results of the analyses conducted and described in Chapter V above, Alternative 5A has been identified as the recommended NER Plan. Alternative 5A is shown in plates at the end of the report.

## 6.2 PLAN FEATURES

The Recommended Plan (Alternative 5A) includes restoration of four significant habitat types throughout the project area. These are habitats that are scarce and ecologically significant in the desert southwest, including cottonwood/willow (375 acres), mesquite (417), wetlands including within the river channel (190 acres), and restoration of 8 miles of river channel made up of approximately 500 acres of active channel and riparian scrub. Multiple measures make up the restoration plan, including, water supply and distribution, channel restoration, revegetation, and invasive-species removal.

### 6.2.1 River Channel Restoration

Restoring the river channel to a more natural state would be accomplished by grading and terracing to help restore an active channel through the entire 8-mile reach. Average depth would be 5 feet, with a width varying from 200 to 400 feet. The channel design passes a 5-year event (~22,000 cfs) with occasional flooding on the terrace 2 to 4 feet depth at 1-7 cfs. An estimated 660,000 c.y. would be removed from the channel to implement this measure. Material removed would be native riverbed material and would be used on site for terracing and construction of other project components, such as reshaping of the two "lakes" within the project area.

**Grade Control Structure.** Due to a drop in grade downstream of the 35th Avenue Bridge, a grade-control structure is recommended within that vicinity. This structure would be similar to those installed in the upstream Rio Salado Project, and would consist of roller-compacted concrete and grouted stone.

would be less, with approximately 25 velvet mesquite, 5 screwbean mesquite, and 10 understory shrubs per acre.

**Riparian Scrub:** It is assumed that some portions maintained will remain a more xeric desert scrub but others adjacent to the wetter riparian habitats will develop into more distinctive riparian cover containing species such as Seepwillow, desert broom, or Desert willow. Approximately 296 acres of the active river channel will be riparian scrub.

### 6.2.4 Wetlands

A total of approximately 156 acres of wetlands would be restored with Alternative 5A. This would include the stormwater wetlands described above, in the vicinity of the "lakes," and within the restored channel. Wetlands could consist of open water, submerged vegetation, or mud flats, all requiring a high water table at or near the surface. Due to the porous soils found in this project area, lining the site would be required to maintain surface water. Excavation and layering of a silt-clay soil substrate overlain by a mixed gravel, and finally, cobble layer, is 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. Emergent wetlands contain primarily cattails (*Typha domingensis*), tule (*Scirpus acutus*), and sedges (Carex spp.). Because the river will not flow year round, the wetlands would need to be constructed specifically to retain water. In addition to grading and excavation, an impermeable layer would be added to retain water on site.

### 6.2.5 Lake Restoration

There are existing lake features created from aggregate mining operations at 27th and 37th Avenues that would require modification to implement lake restoration. Under Alternative 5A, the proposed measures include significant regrading to restore the lake features into a more natural state coinciding with the floodplain environment. This would include the movement of approximately 3 million c.y. of materials. With the reshaping of the two areas, additional measures described above would be incorporated, including the wetland and riparian habitat restoration that would be carried out within them.

**River Channel Habitats**: The habitats restored within the active channel will include a combination of dry river bottom, emergent wetland, riparian scrub or desert scrub, depending on the specific site. Total acreage of the active river channel is assumed to be nearly 500 acres comprised of a 170 acre low flow channel, 34 acres of emergent wetland and the remainder riparian scrub.

### 6.2.2 Stormwater Wetlands

Stormwater outfalls within the project area have been identified and average discharges from them quantified, with an estimated 2,863 ac-ft available for use in restoration. This measure includes the addition of grouted rock channels extending from the banks into the channel from existing pipe outfalls. The grouted rock would extend approximately 100 feet from the existing pipe outfall and would vary from 2 to 4 feet in height. The required grout is approximately thirty percent of the needed rock. Each outfall would require 221 c.y. of rock and 67 c.y. of grout. The outfall sites would require a total of 1989 c.y. of rock and 603 c.y. of grout. Large storm flows would be conveyed to the channel while smaller discharges would be directed into adjacent wetland and riparian habitat areas. Techniques would be site-specific and would include grading or excavation, removal of exotics, and planting of suitable vegetation for the site conditions. Supplemental water would be required via an irrigation source, and structures would be installed to contain high-energy inputs and avoid erosion during storm events. It was assumed that approximatley 28 acres of wetlands would be associated with the outfalls within the study area and that they will improve the water quality.

**New Stormwater Outfalls**: As the land to the west of 51st Avenue is developed, additional stormwater runoff to the river would be possible. At 75th Avenue, a future storm drain may provide additional source water for project features. However, current drainage regulations require onsite retention of runoff. Changes to local zoning regulations and implementation of stormwater drainage plans for lands nearby the river could provide the benefit of additional project water, increased habitat values, and management of stormwater quality and quantity as the area is devleoped.

### 6.2.3 Revegetation

Planting of riparian vegetation to restore the various cover types is included in the plan. General locations of the restored habitats are shown on Plates at the end of the report.

**Cottonwood/Willow**: Cottonwood/willow would be dominated by Fremont's cottonwood (*Populus fremontii*) and Gooding's willow (*Salix gooddingii*). Other understory species would be planted, depending upon individual site conditions, but may include arrowweed (*Pluchea sericea*), elderberry (*Sambucus mexicana*) or burrobush (*Hymenoclea spp*.). The feasibility design includes approximately 60 to 100 trees and 5 shrubs per acre, with a combination of pole and containerized plantings. Hydroseeding of ground cover and additional shrubs is also included in the design.

**Mesquite**: This habitat would be restored over a potentially large portion of the project area. It would require periodic watering for the first five years after planting, though with less frequency than cottonwood/willow. Watering could possibly be discontinued after five years or when roots are expected to reach groundwater. Mesquite bosques would be dominated by velvet mesquite (*Prosopis velutina*), with scattered screwbean mesquite, and some understory shrubs, such as desert thorn (Lycium spp.), palo verde (*Cercidium floridum*), brittlebush (*Encelia farinose*), and forbs.

**Bosque**: Mesquite bosques are commonly found 5 to 20 feet above the river channel where water is adequate. They require a water table or semi-saturated soil conditions 10 to 30 feet below the surface elevation, and rely on occasional saturated conditions 1 to 3 feet below the surface. Soil requirements range from fine to gravelly with some rocky areas. The mesquite bosques would be planted with a density of approximately 100 velvet mesquite, 10 screwbean mesquite, and 40 understory shrubs per acre. Understory forbs would also be planted using a seed mix.

**Xeric**: In locations throughout the study with less water supply, xeric stands of mesquite would be established. It is assumed that mesquite would survive under drier conditions and on higher terraces than mesquite bosques. Planting densities

### 6.2.6 Invasive Species Management

Invasive species such as saltcedar and Arundo would require removal and management with project implementation. This would likely require physical removal and ongoing maintenance through the life of the project. Saltcedar is currently found in stands throughout the study area. Arundo, although not yet a significant problem in Arizona, is a problem in neighboring California and some stands are found within the project area. It was assumed that an approximate 120 acres would require invasive-species control measures prior to restoration.

### 6.2.7 Water Supply and Distribution

The City of Phoenix developed the water supply and distribution plan for the project. The primary water supply for the Rio Salado Oeste project would be effluent obtained directly from the 23rd Avenue WWTP with supplemental water (if necessary) potentially from several sources. An estimated 8 mgd is available from the 23rd Avenue Plant.

The sustainable water supply and distribution system would consist of the following features:

- 20 mgd pump station
- Supply well
- Monitoring wells
- Electronic flow regulated valves
- Reservoirs
- Pump stations
- Open channel canals
- Irrigation system
- Pressurized distribution piping

A combination of irrigation approaches could be implemented in the project and would be determined in detail during design. These could include temporary drip systems for establishment of vegetation, subsurface liners to create an artificially perched aquifer, and canal or rill (ditch or flood) irrigation, as well as water-harvesting polymer, or polymer-type products, planted with vegetation. The estimated cost of the water supply and distribution for the recommended alternative is $22,037,500.

## 6.3 PROJECT OUTPUTS

The recommended plan provides a habitat value of 847 AAFCUs, or a net increase of 267 AAFCUs over without-project conditions. This is a 46 percent increase in AAFCUs with project implementation.

In addition, the restoration included in this project would provide an important and significant linkage between the other restoration projects on the river. Restoration of this 8-mile reach would tie together Rio Salado upstream and Tres Rios downstream, providing approximately 21 miles of contiguous Sonoran desert riparian habitat. This type of river-connected riparian and fringe habitat is of an extremely high value due to its rarity. Arid southwest riparian ecosystems are recognized 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.

**Table VI-1 Alternative 5A Cost Estimate**

| **Estimate** MCACES Cost Estimate ($1,000s FY 06 PL 5 1/8%) | |
|---|---|
| Construction | $66,343 |
| Contingency (20%) | $13,269 |
| Subtotal | $79,612 |
| PED/EDC (11%) | $8,757 |
| Subtotal | $88,369 |
| S&A (6.5%) | $5,744 |
| Total Construction Cost | $94,113 |
| Real Estate (including 25% contingency) | $55,900 |
| Subtotal | $150,013 |
| Monitoring and Adaptive Management | $3,765 |
| **Total First Cost** | **$153,776** |
| | |
| IDC | $15,770 |
| Gross Investment | $169,547 |
| | |
| Annualized Investment Cost | $9,467 |
| Associated Cost (water supply) | $817 |
| O&M | $2,083 |
| | |
| **Total Annual Cost** | **$12,367** |

Notes: *EDC= Engineering During construction*
*S&A= Supervision and Administration*

## 6.4 MAINTENANCE CONSIDERATIONS

O&M activities would occur after project construction in order for project features to function as designed. O&M activities are detailed within the cost estimate and would include the activities listed below.

**Replacement Costs**. Up to 25 percent of vegetation could require replacement following a flood event at some time during the project life.

**Invasive Species Control.** Annual removal of exotic species was assumed to be necessary. This would include removal of non-native species that threaten to overtake an area and become a monoculture. This wouldn't necessarily include removal of 100 percent of non-natives through the project area.

**Stormwater Wetlands.** Regrading and excavation was assumed to be necessary once every 10 years. It was assumed that 50 percent of the construction quantity would need to be regraded in this period.

**Irrigation System.** Maintenance of the irrigation infrastructure, including replacement of infrastructure, would occur annually. Costs were estimated on a per-acre basis for those acres planted to vegetation.

**Lakes/Wetlands.** The restored wetlands at existing lakes (gravel pits) would require regrading and excavation once every 20 years of up to 1 foot of material over the 40 acres of wetlands.

**Channel.** The active channel would require regrading up to once every 20 years for up to 50 percent of the estimated construction quantity or 330,000 c.y.

**Water Supply.** The water supply and distribution system would require periodic maintenance and inspection of pumps and pipelines. Inspection, repair, and replacement would be necessary for the irrigation system and infrastructure. More detailed description of maintenance is included in Appendix J, Design and Cost Estimate.

## 6.5 RECREATION PLAN

The City of Phoenix developed the recreation plan for the project, which may be found in Appendix L. The plan is consistent with Corps policy on development of recreation at ecosystem restoration projects, as outlined in Policy Guidance Letter No. 59, USACE 1998. Major recreation features include multipurpose trails, shelters, signage, utilities, park furniture, and interpretive media. Access points are identified in the plan, with four drive-in points with parking facilities and five smaller access points for walk-in use. Although an environmental-education center is included in the local plan, it is not a cost-shareable portion of the project and would be a local sponsor cost. Table VI-2 below summarizes the locations and features included in the recreation plan.

**Table VI-2 Recreation Plan**

| Component | Quantity | Unit Cost | Recreation Cost |
|---|---|---|---|
| **Site Preparation** | | | |
| Site Prep to include: clearing, grubbing, and grading | 9 | Lump Sum | $250,000.00 |
| Vegetative Restoration (Drive in Access) | 4 | Lump Sum | $600,000.00 |
| Vegetative Restoration (Walk in Access) | 5 | Lump Sum | $75,000.00 |
| **Access and Circulation** | | | |
| Entry Road w/Turnaround to include: curb, gutter, driveway, & road | 4 | Lump Sum | $600,000.00 |
| Parking lot | 500 | $1500/space | $750,000.00 |
| Sidewalks and Ramps | 40,000 sf. | $6.00 each | $240,000.00 |
| Multi-Use Trails (24mi * 5280 * 5ft) | 47000 | $6.00 / sy | $282,000.00 |
| Bridges and Culverts (small) @ Canals, and Localized Drainage Areas | 10 | $7,500 each | $75,000.00 |
| **Protection Access Control** | | | |
| Access Control Gates (vehicular) | 10 | $7,500 each | $75,000.00 |
| Access Control Gates (pedestrian) | 18 | $3,500 each | $63,000.00 |
| Handrails | 5,000 l.f. | $50.00 each | $250,000.00 |
| Guardrails | 3,000 l.f. | $50.00 each | $150,000.00 |
| Fencing | 5,000 l.f. | $30.00 each | $150,000.00 |
| Walls | 1,500 l.f. | $125.00 each | $187,500.00 |
| Security lights | 100 | $4,000 each | $400,000.00 |
| **Signage** | | | |
| Entrance identification signage | 8 | $15,000 each | $120,000.00 |
| Traffic Control (vehicular) | 20 | $500 each | $10,000.00 |
| Traffic Control (pedestrian) | 27 | $500 each | $13,500.00 |

| | | | |
|---|---|---|---|
| Instructional/Directional | 45 | $500 each | $22,500.00 |
| **Shelters** | | | |
| Picnic (large) | 5 | $60,000 each | $300,000.00 |
| Picnic (small) | 5 | $25,000 each | $125,000.00 |
| Restroom Facility/Comfort Station | 5 | $250,000 each | $1,250,000.00 |
| Shelter w/Bulletin Boards | 4 | $25,000 each | $100,000.00 |
| Trail Shelter w/Railing (large) | 9 | $40,000 each | $360,000.00 |
| Trail Shelter w/Railing (medium) | 4 | $30,000 each | $120,000.00 |
| Trail Shelter w/Railing (small) | 10 | $20,000 each | $200,000.00 |
| **Utilities** | | | |
| Municipal Water Supply and Wastewater Disposal | 5 | Lump Sum | $500,000.00 |
| Storm Drainage | 4 | Lump Sum | $80,000.00 |
| Drinking Fountain w/Chiller | 12 | $5,000 each | $60,000.00 |
| Electical | 4 | Lump Sum | $200,000.00 |
| **Park Furniture** | | | |
| Benches: | 14 | $1,500 each | $21,000.00 |
| Off-the-Shelf | 40 | $800 each | $32,000.00 |
| Recycled/Custom | 50 | $500 each | $25,000.00 |
| Picnic Tables | 40 | $1000 each | $40,000.00 |
| Trash Receptacles | 75 | $500 each | $37,500.00 |
| **Interpretive Guidance Media** | | | |
| Display Boards | 50 | $600 each | $30,000.00 |
| Interpretive Markers | 100 | $600 each | $60,000.00 |
| Bulletin Boards | 9 | $2,500 each | $22,500.00 |
| | | **Subtotal** | **$7,876,500.00** |
| | Contingency | 20% | $1,575,300 |
| | PED+EDC | 11% | $1,039,698 |
| | S&A | 7% | $681,947 |
| | | **Total** | **$11,173,445** |

The recreation plan is estimated at $11,173,445, with Annual O&M of $800,000.

## 6.6 ASSOCIATED NON-FEDERAL CONSIDERATIONS

The non-Federal sponsor (Sponsor) for the project would be required to purchase all lands, easements, rights-of way and disposal areas (LERRDs) needed for project implementation. Real estate is described in more detail in Appendix H. Approximately 1,500 acres are required for the project and currently estimated at $55,900,000. The estate to implement this project is recommended as fee simple. However, lands owned by Maricopa County are recommended to

be acquired by permanent easement. The estate will be requested in accordance with ER-405-1-12, Chapter 12 Paragraph 12-9 c.

The cost of lands for this project is in excess of 25% of the total project cost. Corps policy pertaining to ecosystem restoration states that "As a target, land value should not exceed 25 percent of total project costs. Projects with land costs exceeding this target level are not likely to be given a high priority for budgetary purposes." (ER 1105-2-100; Section E-30.f).

The Sponsor 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 Sponsor would also be responsible for Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) costs (estimated at $2,083.000 per year). The sponsor would also be responsible for 50 percent of the cost to implement the selected recreation plan. Annual OMRR&R costs of $800,000 associated with the selected recreation plan would also be the Sponsor's responsibility.

## 6.7 MONITORING AND ADAPTIVE MANAGEMENT PLAN

The Salt River, although highly modified and controlled, remains a natural river system where changes may occur. While planning for this project has accounted for the possible factors affecting the study area, it is inevitable that uncertainty would remain with the outcome of the recommended plan. Implementation of a monitoring and adaptive management plan would not alleviate all uncertainty, but would provide flexibility to account for changing environmental conditions and new information, as well as measure project success.

The Monitoring and Adaptive Management Plan is an essential element for the overall implementation of the proposed plan. It would provide a mechanism to evaluate the effectiveness of the restoration measures implemented in this project and to implement adaptive changes, if required, to realize project objectives. As described in ER 1105-2-100 Planning Guidance Notebook page 3-25 (8) Monitoring and adaptive management:

> "Monitoring may be necessary to determine if the predicted outputs are being achieved and to provide feed back for future projects … The cost of monitoring included in the total project cost and cost shared with the non-Federal sponsor shall not exceed one percent of the total first cost of ecosystem restoration features. For complex specifically

> authorized projects that have high levels of risk and uncertainty of obtaining the proposed outputs, adaptive management may be recommended. The cost of the adaptive management action, if needed, will be limited to 3 percent of the total project cost excluding monitoring costs."

It was assumed that the Monitoring and Adaptive Management Plan for the recommended plan would be 4 percent of total construction, or $3.75 million over five years. The plan includes cost-shared monitoring and adaptive management actions during the first five years after initial project implementation. After the first five years, monitoring and/or adaptive management would become the responsibility of the local sponsor (City of Phoenix). However, the local sponsor can use this plan to help guide the monitoring efforts and refine the project features such that project goals and objectives are achieved.

It is recommended that the plan, found in Appendix N (Monitoring and Adaptive Management) be reevaluated and updated during PED, taking into account lessons learned from the Rio Salado and Tres Rios Projects in the immediate vicinity, as well as other projects such as Va Shly'ay Akimel further upstream on the Salt River.

# CHAPTER VII
# PLAN IMPLEMENTATION

This chapter summarizes cost-sharing requirements and procedures necessary to implement the Recommended Plan.

## 7.1 STUDY RECOMMENDATION

The Recommended Plan would provide the maximum NER benefits relative to project costs while achieving the stated project objectives and while meeting the criteria established by the study team and Federal Principles and Guidelines. Because of its highly positive environmental contribution to restoration within the study area, the Recommended Plan is recommended for implementation.

## 7.2 DIVISION OF PLAN RESPONSIBILITIES

The Water Resources Development Act (WRDA) of 1986 (Public Law 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 related to ecosystem restoration and 50 percent related to recreation. (First costs are all costs to implement the project less O&M costs). The Federal Government's responsibilities are anticipated to be:

1. Design and prepare detailed plans and specifications.

2. Identify the real estate requirements for implementation of the project.

3. Administer contracts for construction and supervision of the project after authorization, funding, and receipt of non-Federal assurances. .

4. Conduct all necessary cultural resource investigations and coordinate and implement any necessary preservation or mitigation measures

5. Conduct periodic inspections with the non-Federal sponsor to determine adherence to the post-construction maintenance requirements

### 7.2.2 Non-Federal Responsibilities

Non-Federal or local responsibilities are anticipated to be:

1. Provide 35 percent of the total project costs allocated to ecosystem restoration and 50 percent of the total project costs allocated to recreation, as further specified below:

    a. Enter into an agreement that provides, prior to execution of a project cooperation agreement for the project, 25 percent of design costs.

    b. Provide, during construction, any additional funds needed to cover the non-Federal share of design costs.

    c. 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.

    d. 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.

e. Provide, during construction, any additional costs as necessary to make its total contribution equal to 35 percent of the total project costs allocated to ecosystem restoration and 50 percent of the total project costs allocated to recreation.

2. Assume responsibility for operating, maintaining, replacing, repairing, and rehabilitating (OMRR&R) the project or completed functional portions of the project, including mitigation features, without cost to the Government, in a manner compatible with the project's authorized purpose and in accordance with applicable Federal and State laws and specific directions prescribed by the Government in the OMRRR&R manual and any subsequent amendments thereto

3. 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.

4. Comply with Section 221 of the Flood Control Act of 1970, Public Law 91-611, as amended, 42 U.S.C 1962d-5b. and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, 33 U.S.C. 2213 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.

5. 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.

6. 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.

7. 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.

8. 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.

9. Agree that, as between the Government and the non-Federal sponsor, the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and, 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.

10. Prevent obstructions of, or encroachments on, the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) which might reduce the level of protection it affords, hinder its operation and maintenance, or interfere with its proper function, such as any new developments on project lands or addition of facilities which would degrade the benefits of the project.

11. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended 42 U.S.C 4601-4655, 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.

12. 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)).

13. 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.

14. 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.

15. Provide and maintain necessary access roads, parking areas, and other public use facilities, open and available to all on equal terms.

16. 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.

17. Provide the non-Federal cost share of that portion of the costs of archeological data recovery activities associated with historic preservation, that are in excess of one percent of the total amount authorized to be appropriated for the project, in accordance with the cost sharing provisions of the agreement.

## 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 or facilities; 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.

Table VII-1 provides a summary of project costs, apportioned between the Federal and non-Federal sponsors, for the recommended plan. The total project cost is currently estimated at $164,950,295.00 at a current Federal discount rate of 5 1/8 percent. Based on the requirements of WRDA 1986, as amended 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.

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 cost for this project is currently estimated at $11,173,000. The cost for all O&M would be the responsibility of the non-Federal sponsor. O&M of the ecosystem restoration is currently estimated at $2,083,000 annually and $800,000 annually for the recreation component. 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 $817,000 annually.

## Table VII-1: Cost Apportionment Recommended Plan

| Item | Federal | Non-Federal | Total |
|---|---|---|---|
| Construction of Ecosystem Restoration Features* | $ 61,173,031 | $ 32,939,324.60 | $ 94,112,356.00 |
| Monitoring and Adaptive Management | $ 2,446,921.10 | $ 1,317,572.90 | $ 3,764,494.00 |
| LERRDs** | - | $ 55,900,000.00 | $ 55,900,000.00 |
| **Total First Cost of Ecosystem Restoration** | **$ 63,619,952.50** | **$ 90,156,897.50** | **$ 153,776,850.00** |
| Cost Share Adjustment*** | $ 36,355,000.00 | $ (36,335,000.00) | |
| **Total Cost-Shared Costs** | $ 99,954,952.50 | $ 53,821,897.50 | $ 153,776,850.00 |
| *Percentage of Total Cost-Shared Amount – Ecosystem Restoration* | *65%* | *35%* | |
| **Total Cost-Shared Costs for Recreation** | **$ 5,586,722.50** | **$ 5,586,722.50** | **$ 11,173,445.00** |
| *Percentage of Total Cost-Shared Amount – Recreation* | *50%* | *50%* | |
| **TOTAL FIRST COSTS** | $ 105,541,675.00 | $ 59,408,620.00 | $ 164,950,295.00 |

**Construction, S&A, PED/EDC and Contingency, does not include IDC or OMRR&R*
*** Lands, easements, rights of way, relocations, and disposal areas.*
**** Non-Federal cost shared amount exceeds the 35% requirement for ecosystem restoration projects. Adjustment to the first cost amounts result to the 65-35 percent cost sharing requirement.*

## 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

The non-Federal sponsor will prepare the following preliminary financial analysis.

1 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.

2 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.

3 Investigate the means for raising additional non-Federal financial resources including, but not limited to, special assessment districts.

4 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

### 7.6.1 National Environmental Policy Act (NEPA)

NEPA ensures public involvement and notification of a proposed project. An initial public meeting was held on September 13, 2001, and a final public meeting was held on May 18, 2006. Multiple public workshops, information sessions, and meetings were also held as part of the scoping process. State and agency review of the Final EIS will be completed and a Record of Decision will be prepared.

### 7.6.2 Endangered Species Act

Endangered Species Act, Section 7 informal consultation was completed with concurrence letter dated August 7, 2006 received from the USFWS. The Biological Assessment (see EIS) found that the project may affect but not adversely affect bald eagle, Southwest willow flycatcher, and Yuma clapper rail.

### 7.6.3 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act Report provided by the USFWS supports the proposed restoration project and listed four recommendations to pursue in project implementation. These include the following:

1. Focus significant attention on securing a permanent and sufficient source of water, perhaps through a combination of effluent, groundwater, and storm water.

2. Maximize opportunities to restore a mosaic of heterogeneous vegetative cover types that maximizes structural habitat complexity.

3. Ensure that site-specific microhabitat conditions would be conducive to establishment and growth of native riparian plants, especially cottonwood, willow, and mesquite.

4. Encourage the non-Federal sponsor to evaluate Safe Harbor Agreements, Candidate Conservation Agreements, or Habitat Conservation Plans.

The first two recommendations have been implemented during formulation and evaluation of restoration alternatives. During project design site specific microhabitat conditions will be revisited and evaluated to ensure conditions are conducive to native riparian plants. The Corps will encourage and participate in evaluation of Safe Harbor Agreements, Candidate Conservation Agreements, or Habitat Conservation Plans as necessary during PED and Construction.

### 7.6.4 Clean Water Act, Section 404(b)(1)

Pursuant to sect 404 of the Clean Water Act, 33 U.S.C. 1251 et seq, the Corps regulates the discharge of fill materials into waters of the United States. Where, as here, the discharge is

part of a Federal construction project that Congress authorizes the Corps to perform, the Corps does not issue itself a permit, but rather evaluates the impacts of the discharge utilizing the section 404(b)(1) guidelines and includes the evaluation in the environmental impact statement (EIS) for the project. The EIS for this project contains a 404(b)(1) analysis as Appendix A to the EIS. Although no section 404 permit is required for Corps construction activities, the non-Federal sponsor may be required to obtain a Section 404 permit for discharges of material associated with post construction operation and maintenance activities, unless granted a 404(r) exemption.

The recommended plan would result in discharge of fill material into waters of the United States during the period of construction. Pursuant to section 404 of the Clean Water Act, 33 U.S.C. 1251 et seq, the Corps regulates the discharge of fill materials into waters of the United States. Where, as here, the discharge is part of a Federal construction project that Congress authorizes the Corps to perform, the Corps does not issue itself a permit, but rather evaluates the impacts of the discharge utilizing the Section 404(b)(1) guidelines and includes the evaluation in the environmental impact statement (EIS) for the project.

The recommended plan may result in discharges associated with O&M activities. A Section 404(b)(1) evaluation has been prepared to address practicable alternatives, and can be found in the accompanying EIS. Based on this analysis, the feasibility report recommends that the project receive a 404(r) exemption for the construction period when Congress authorizes the project. Discharges into waters of the U.S. for future OMRR&R activities by the non-federal sponsor would require separate authorization pursuant to the Clean Water Act.

### 7.6.5 National Historic Preservation Act

Archeological investigations have been conducted as described in Sections 4.2.8.4 and 4.2.8.5 of this report. A letter was sent to the Arizona State Historic Preservation Officer (SHPO) on July 6, 2005 with our determinations in accordance with 36 CFR 800.4(d). We received a letter of response dated August 10, 2005. This letter concurred with the APE as described in Section 4.4.5 above. The SHPO requested a written report of the survey conducted by Corps personnel. A Memorandum of Record (MFR) was completed describing the survey conducted in March

2004. Correspondence may all be found within the attached EIS. The Rio Salado Oeste project is in compliance with Section 106 of the National Historic Preservation Act, Public Law 89-665, as amended, 16 U.S.C. 470a, and its implementing regulations found at 36 C.F.R. Part 800.

**Unanticipated Discovery:** Pursuant to Section 106 of the National Historic Preservation Act, Public Law 89-665, as amended, 16 U.S.C. 470a, and its implementing regulations found at 36 C.F.R 800.12(2), any discoveries of either human remains or archeological deposits during construction activities shall result in the following process:

- Corps of Engineers Archeology Staff shall be notified of discovery.
- Corps Archeology Staff shall determine if discovered cultural matter is an isolated find, or consists of a deposit of some extent. If needed, hand excavations shall be conducted to determine if the deposit is of sufficient content and integrity to be eligibly for listing on the National Register of Historic Places.
- The Corps shall determine eligibility, and effect in consultation with the State Historic Preservation Officer pursuant to 36 CFR 800.

## 7.7 SPONSORSHIP AGREEMENTS

Prior to the start of construction, the non-Federal sponsor would be required to enter into an agreement with the Federal Government that it would comply with Section 221 of the Flood Control Act of 1970, Public Law 91-611, as amended U.S.C. 1962d-5b, and the Water Resources Development Act of 1986 , Public Law 99-662, as amended 33 U.S. 2201 et seq.

## 7.8 PROCEDURES FOR IMPLEMENTATION

Future actions necessary for authorization and construction of the Recommended Plan are summarized as follow:

1. The Draft and Final Feasibility Report/Environmental Impact Statement will be reviewed by the Headquarters of USACE, Washington, D.C, City of Phoenix, EPA, and the public.
2. The Chief of Engineers will seek formal review and comments by the Governor of the State of Arizona and interested Federal agencies.

3. Following State and Agency review, the report will be sent to the Assistant Secretary of the Army for Civil Works.

4. Upon approval of the Assistant Secretary, the report will be forwarded to the Office of Management and Budget to obtain the relationship of the project to programs of the President.

5. The final report of the Chief of Engineers will then be forwarded by the Assistant Secretary of the Army for Civil Works to Congress.

6. Congressional review of the feasibility report and possible authorization of the project would follow.

7. 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.

8. Following receipt of funds, preconstruction engineering and design would be initiated and surveys and detailed engineering designs would be accomplished.

9. Following Congressional authorization of the project, plans and specifications would be accomplished by the District Engineer.

10. Subsequent to appropriation of construction funds by Congress, but prior to construction, formal assurances of local cooperation would be required from non-Federal interests.

11. Bids for construction would be initiated and contracts awarded.

# CHAPTER VIII

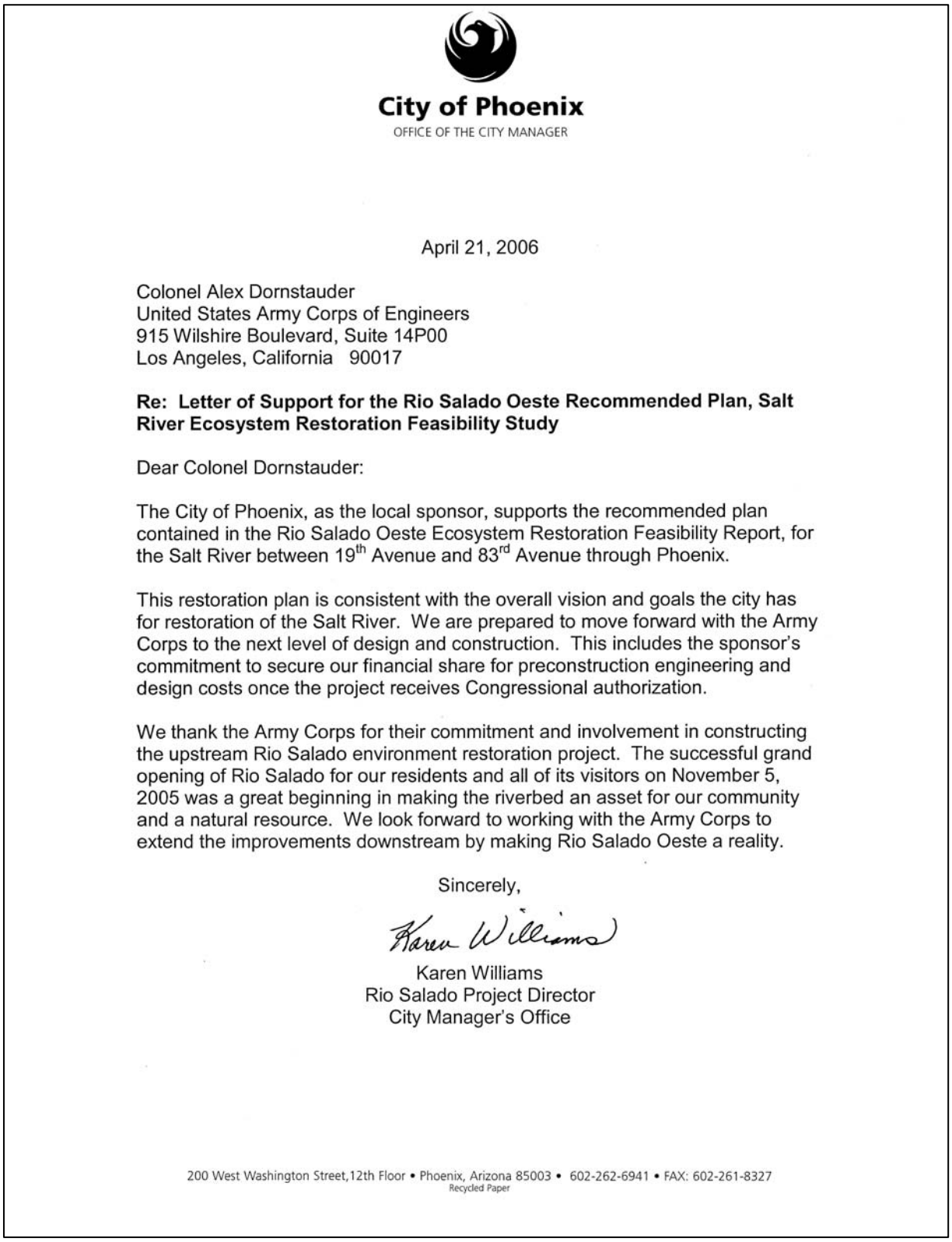
# SUMMARY OF COORDINATION AND PUBLIC VIEWS

## 8.1 NON-FEDERAL VIEWS AND PREFERENCES

The non-Federal views and preferences regarding ecosystem restoration measures, and problems they addressed, in general were obtained through coordination with the local sponsor and with other various local and regional public agencies, community groups, resource conservation groups and the public. These coordination efforts consisted of public meetings held during the reconnaissance and feasibility phases, through the maintenance of points of contact that any interested party could discuss matters, and a distribution list where notices of public meetings was distributed. Announcement of public meetings was made in local media providing the date, time, place and subject matter.

## 8.2 DIVISION OF PLAN RESPONSIBILITIES

The City of Phoenix has expressed willingness in continuing to be a non-Federal sponsor for project implementation. They 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 project is presented as Figure VIII-1. There is currently a significant interest in providing ecosystem restoration solutions with recreation opportunities on the Rio Salado Oeste reach of the Salt River.



City of Phoenix
OFFICE OF THE CITY MANAGER

April 21, 2006

Colonel Alex Dornstauder
United States Army Corps of Engineers
915 Wilshire Boulevard, Suite 14P00
Los Angeles, California 90017

**Re: Letter of Support for the Rio Salado Oeste Recommended Plan, Salt River Ecosystem Restoration Feasibility Study**

Dear Colonel Dornstauder:

The City of Phoenix, as the local sponsor, supports the recommended plan contained in the Rio Salado Oeste Ecosystem Restoration Feasibility Report, for the Salt River between 19th Avenue and 83rd Avenue through Phoenix.

This restoration plan is consistent with the overall vision and goals the city has for restoration of the Salt River. We are prepared to move forward with the Army Corps to the next level of design and construction. This includes the sponsor's commitment to secure our financial share for preconstruction engineering and design costs once the project receives Congressional authorization.

We thank the Army Corps for their commitment and involvement in constructing the upstream Rio Salado environment restoration project. The successful grand opening of Rio Salado for our residents and all of its visitors on November 5, 2005 was a great beginning in making the riverbed an asset for our community and a natural resource. We look forward to working with the Army Corps to extend the improvements downstream by making Rio Salado Oeste a reality.

Sincerely,

Karen Williams

Karen Williams
Rio Salado Project Director
City Manager's Office

200 West Washington Street, 12th Floor • Phoenix, Arizona 85003 • 602-262-6941 • FAX: 602-261-8327
Recycled Paper

**Figure 0-1 City of Phoenix Support Letter**

## 8.3 SUMMARY OF STUDY MANAGEMENT, COORDINATION, PUBLIC VIEWS AND COMMENTS

The study team was made up of a multi-disciplinary group that consisted of several functional elements of the Corps and the non-Federal sponsor. The study team included study and project managers, engineers, hydrologic and hydraulic engineers, groundwater specialists, environmental specialists, cost estimators, designers, appraisers, economists, materials, geotechnical specialists, real estate specialists, and landscape architects.

Formal and informal coordination occurred with a variety of Federal, State, and local agencies in addition to the public involvement described above. The Draft Environmental Impact Statement was distributed to local, State, and Federal Agencies and Tribal Governments for review and comment. Representatives from USFWS and AGFD participated in development of the functional assessment model and its application. The USFWS, AGFD, and FCDMC also participated in development of alternatives and their design. USFWS has provided a Coordination Act Report for this study, which can be found in the attached Final EIS. Further information pertaining to public meetings as well as public comments is also found in the EIS.

Letters from the US EPA, US Department of the Interior, Yavapai Prescott Indian Tribe, and Arizona Game and Fish Department were all supportive of the restoration project. Additional letters of support were received from Audubon Arizona, Phoenix Community Alliance, Valley Forward, Phoenix Planning Commission, Phoenix Parks and Recreation Board, members of the Phoenix City Council and former members of the Rio Salado Advisory Committee. All correspondence and comments on the report are found in the attached Environmental Impact Statement.

# CHAPTER VIII

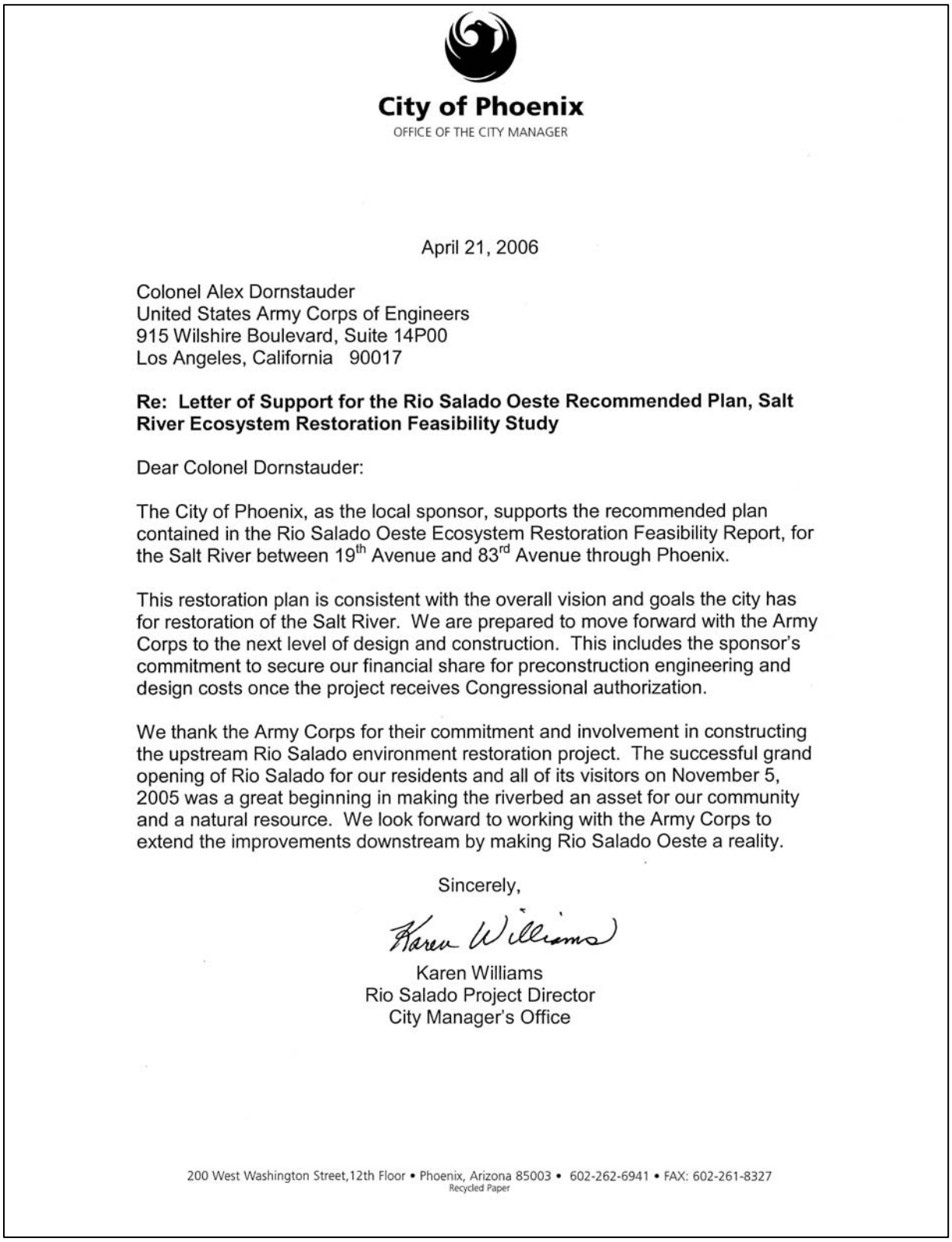
# SUMMARY OF COORDINATION AND PUBLIC VIEWS

## 8.1 NON-FEDERAL VIEWS AND PREFERENCES

The non-Federal views and preferences regarding ecosystem restoration measures, and problems they addressed, in general were obtained through coordination with the local sponsor and with other various local and regional public agencies, community groups, resource conservation groups and the public. These coordination efforts consisted of public meetings held during the reconnaissance and feasibility phases, through the maintenance of points of contact that any interested party could discuss matters, and a distribution list where notices of public meetings was distributed. Announcement of public meetings was made in local media providing the date, time, place and subject matter.

## 8.2 DIVISION OF PLAN RESPONSIBILITIES

The City of Phoenix has expressed willingness in continuing to be a non-Federal sponsor for project implementation. They 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 project is presented as Figure VIII-1. There is currently a significant interest in providing ecosystem restoration solutions with recreation opportunities on the Rio Salado Oeste reach of the Salt River.



City of Phoenix
OFFICE OF THE CITY MANAGER

April 21, 2006

Colonel Alex Dornstauder
United States Army Corps of Engineers
915 Wilshire Boulevard, Suite 14P00
Los Angeles, California 90017

**Re: Letter of Support for the Rio Salado Oeste Recommended Plan, Salt River Ecosystem Restoration Feasibility Study**

Dear Colonel Dornstauder:

The City of Phoenix, as the local sponsor, supports the recommended plan contained in the Rio Salado Oeste Ecosystem Restoration Feasibility Report, for the Salt River between 19th Avenue and 83rd Avenue through Phoenix.

This restoration plan is consistent with the overall vision and goals the city has for restoration of the Salt River. We are prepared to move forward with the Army Corps to the next level of design and construction. This includes the sponsor's commitment to secure our financial share for preconstruction engineering and design costs once the project receives Congressional authorization.

We thank the Army Corps for their commitment and involvement in constructing the upstream Rio Salado environment restoration project. The successful grand opening of Rio Salado for our residents and all of its visitors on November 5, 2005 was a great beginning in making the riverbed an asset for our community and a natural resource. We look forward to working with the Army Corps to extend the improvements downstream by making Rio Salado Oeste a reality.

Sincerely,

Karen Williams

Karen Williams
Rio Salado Project Director
City Manager's Office

200 West Washington Street, 12th Floor • Phoenix, Arizona 85003 • 602-262-6941 • FAX: 602-261-8327
Recycled Paper

**Figure 0-1 City of Phoenix Support Letter**

## 8.3 SUMMARY OF STUDY MANAGEMENT, COORDINATION, PUBLIC VIEWS AND COMMENTS

The study team was made up of a multi-disciplinary group that consisted of several functional elements of the Corps and the non-Federal sponsor. The study team included study and project managers, engineers, hydrologic and hydraulic engineers, groundwater specialists, environmental specialists, cost estimators, designers, appraisers, economists, materials, geotechnical specialists, real estate specialists, and landscape architects.

Formal and informal coordination occurred with a variety of Federal, State, and local agencies in addition to the public involvement described above. The Draft Environmental Impact Statement was distributed to local, State, and Federal Agencies and Tribal Governments for review and comment. Representatives from USFWS and AGFD participated in development of the functional assessment model and its application. The USFWS, AGFD, and FCDMC also participated in development of alternatives and their design. USFWS has provided a Coordination Act Report for this study, which can be found in the attached Final EIS. Further information pertaining to public meetings as well as public comments is also found in the EIS.

Letters from the US EPA, US Department of the Interior, Yavapai Prescott Indian Tribe, and Arizona Game and Fish Department were all supportive of the restoration project. Additional letters of support were received from Audubon Arizona, Phoenix Community Alliance, Valley Forward, Phoenix Planning Commission, Phoenix Parks and Recreation Board, members of the Phoenix City Council and former members of the Rio Salado Advisory Committee. All correspondence and comments on the report are found in the attached Environmental Impact Statement.

# CHAPTER IX

# RECOMMENDATIONS

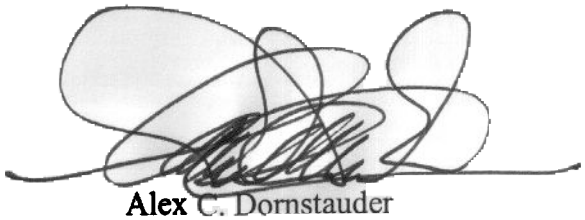
I recommend that the plan described herein for ecosystem restoration and recreation, be authorized for implementation as a Federal project. The total first cost of the project is currently estimated at $164,950,295 under October 2006 prices. The Federal share is currently estimated at $105,541,675.

I recommend that the Corps of Engineers participate in cost-shared monitoring and minor modifications, as may be required to ensure success of the project, as identified and described within the Monitoring and Adaptive Management Plan.

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 required items of local cooperation identified in Chapter VII which the non-Federal sponsor must agree to prior to project implementation.

The plans presented herein are recommended with such modifications 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 before they are transmitted to the Congress as proposals for authorization and implementation funding. However, prior to transmittal to the Congress, the non-Federal sponsor, the State, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.



Alex C. Dornstauder
Colonel, US Army
District Engineer

# CHAPTER X
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