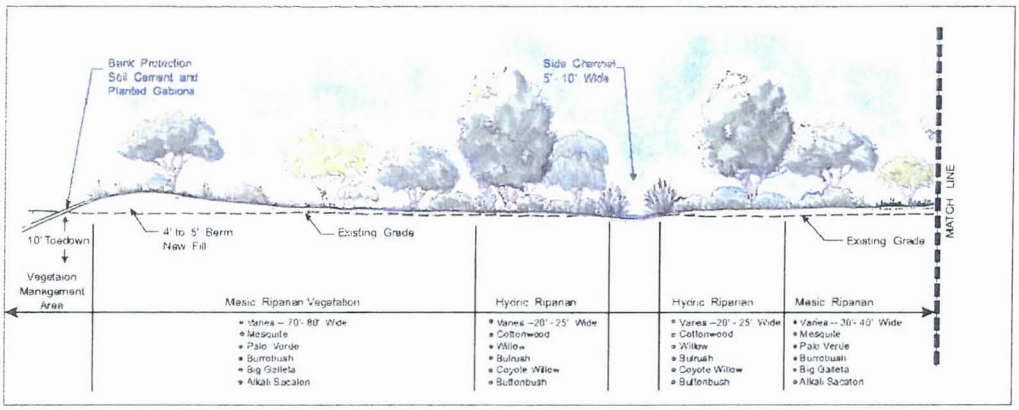
US Army Corps
of Engineers®

Final
DETAILED PROJECT REPORT
and
Environmental Assessment
Section 1135
Continuing Authorities Program
Los Angeles District

AGUA FRIA RIPARIAN RESTORATION PROJECT

Maricopa County, Arizona



Cross Section

Prepared by:
Department of the Army
Los Angeles District
Corps of Engineers,
the City of Avondale and
the Flood Control District of Maricopa County
August 2007

US Army Corps of Engineers®

FINAL
DETAILED PROJECT REPORT
SECTION 1135
Continuing Authorities Program

Los Angeles District

AGUA FRIA RIPARIAN RESTORATION

Maricopa County, Arizona

Prepared by:

Department of the Army
Los Angeles District Corps of Engineers

August 2007

Final

DETAILED PROJECT REPORT

FOR THE
AGUA FRIA RIPARIAN RESTORATION PROJECT

Prepared by:

U.S. Army Corps of Engineers
Los Angeles District

With Assistance from:

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Department of the Army
Los Angeles District, Corps of Engineers

FINDING OF NO SIGNIFICANT IMPACT

Agua Fria River
Section 1135 Ecosystem Restoration Study

Agua Fria River, City of Avondale

Maricopa County, Arizona

I have reviewed the attached Detailed Project Report (combined Feasibility Report and Environmental Assessment) that documents several proposed project modification /restoration alternatives for the Agua Fria River Section 1135 Ecosystem Restoration Study, Maricopa County, Arizona. This study is a joint undertaking of the U.S. Army Corps of Engineers (COE) and the City of Avondale and Flood Control District of Maricopa County.

The project modification boundaries are located on the Agua Fria River in the southwestern region of the Phoenix metropolitan area, within Maricopa County, Arizona, in the City of Avondale. Within the city limits of Avondale, the project reach is bounded to the north (upstream) by McDowell Road and to the south by the river's confluence with the Gila River. Within this reach of the river's width varies from approximately 1,200 feet in the narrowest portions at the northern end of the project site, to roughly 2,500 feet at the widest portions in the south. Flowage easements however extend beyond this width. The average elevation in the project area ranges from approximately 894 to 1,019 feet above sea level.

The project modification recommended for implementation is Alternative 8. Alternative 8 would occupy approximately: 25.7 acres of riparian strips; 81 acres managed to facilitate growth of native vegetation (i.e., vegetation management areas); and 8 acres of native cover established in areas affected by construction that are sparsely vegetated and dominated by invasive exotic species. Alternative 8 requires a relatively low water use (1.9 mGPD), and focuses restoration at two locations: (1) the I-10 site near the Papago Diversion Channel; and (2) the Avondale Waste Water Treatment Project (AWWTP) site. Restoration options near the Durango Regional Outfall Channel (Buckeye Road) site were not considered under Alternative 8 because of the 10,000-foot Goodyear Airport exclusion zone that prohibits land uses that may attract birds and wildlife that present a risk to air traffic. The airport exclusion zone also influenced delineation of the southern limit of the I-10 site and of the northern limit of the AWWTP site.

Restoration at the two principle sites for Alternative 8 would primarily involve eight measures:

1. Removal and control of exotic, invasive species throughout each restoration site
2. Construction of riparian strips along the eastern and western levees, with terrace bank armor protection
3. Establishment of Vegetation Management Areas between the riparian strips and at the AWWTP site
4. Introduction of water from an external source at the I-10 site

5. Retention of 1 mGPD of effluent from the AWWTP as a source of water at the AWWTP restoration site
6. Installation of filtration galleries and a system of pumps to recirculate shallow groundwater and infiltrated effluent at the AWWTP site from the downstream to the upstream end, to help support vegetation cover
7. Non-structural measures to enhance habitat resources (e.g., microtopographic variation, creation of plant regeneration areas, etc.)
8. Measures to eliminate or reduce impacts from adjacent park and trail users.

This Environmental Assessment is a National Environmental Policy Act (NEPA) document. It has been prepared in accordance with the requirements set forth in Section 102 of NEPA, the Council on Environmental Quality (CEQ) Regulations on Implementing National Environmental Policy Act Procedures (40 CFR 1500 *et.seq.*), and the Corps of Engineers, Department of the Army, Environmental Quality Procedures for Implementing the National Environmental Policy Act (NEPA) (33 CFR Parts 230 and 325). Reasonable alternatives to the proposed action were considered during the planning process. Potential environmental effects have been included in the evaluation of the proposed project modifications and all procedural review requirements have been met.

I have considered possible impacts to environmental resources and other information contained in this Environmental Assessment and it is my determination that there are no significant impacts associated with implementation of the proposed project modifications at the Agua Fria River project area. Therefore, an Environmental Impact Statement (EIS) need not be prepared for this project action.

_____
Date

_____
Alex C. Dornstauder
Colonel, US Army
District Engineer

FINAL DETAILED PROJECT REPORT
FOR THE
AGUA FRIA RIPARIAN RESTORATION PROJECT

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MAIN

REPORT

EXECUTIVE SUMMARY

This Detailed Project Report (DPR) analyzes the feasibility of restoring riparian habitat in portions of the Agua Fria River, within the City of Avondale, Arizona. This DPR integrates the U.S. Army Corps of Engineers (USACE) traditional feasibility report with the required National Environmental Policy Act (NEPA) documentation, in this case, an Environmental Assessment (EA). The intent of the DPR is to reduce paperwork and redundancy, consolidate planning documentation into a consistent report, and provide more complete information to the public. The integration is also encouraged by NEPA regulations (40 CFR 1500.2 and 1506.4).

This DPR has been prepared in accordance with the following requirements and guidelines:

- Section 102 of NEPA
- Council on Environmental Quality (CEQ) Regulations on Implementing National Environmental Policy Act Procedures (40 CFR 1500 et seq.)
- U.S. Army Corps of Engineers Environmental Quality Procedures for Implementing the National Environmental Policy Act (33 CFR Parts 230 and 325).

A reasonable array of restoration alternatives was identified and evaluated during the planning process. Potential environmental impacts were analyzed and documented for each of the alternatives. All other required procedural and review requirements have or will be met.

Study Authority

This DPR is submitted under the authority of Section 1135(b) of the Water Resources Development Act (WRDA) of 1986, as amended (P.L. 99-662). Section 1135(b) authorizes the Secretary of the Army to review the operation of water resources projects to determine the need for structural or operational modifications for the purpose of improving the quality of the environment in the public interest. The Federal costs to carry out such modifications shall not exceed $5,000,000 for each project without specific authorization by Congress.

As required of all Corps of Engineers Civil Works projects, a non-Federal co-sponsor must cost-share the project. Projects authorized under Section 1135 have a non-Federal cost-share of 25 percent of the total project costs or a maximum of $1,666,666 under this program. The Flood Control District of Maricopa County (FCDMC) and the City of Avondale (COA) are the non-Federal co-sponsors of the Agua Fria River riparian restoration project (restoration project).

In response to the study authority, the reconnaissance phase of the study was initiated in July 2001. Based on the findings of the reconnaissance phase, the FCDMC, COA and USACE initiated the feasibility phase of the study in November 2001. A baseline conditions report and preliminary alternatives array was produced in February 2002. The development of this Detailed Project Report (DPR) was initiated in March 2002.

Project Location and Characteristics

The project modification boundaries are located in the Agua Fria River in the southwestern region of the Phoenix metropolitan area, within Maricopa County, Arizona, in the City of Avondale (Figures 1 and 2). Within the city limits of Avondale, the project reach is bounded to the north (upstream) by McDowell Road and to the south by the confluence with the Gila River.[1] Within this reach of the river, the width varies from approximately 1,200 feet in the narrowest portions at the northern end of the project site, to roughly 2,500 feet at the widest portions at the confluence. The elevation in the project area ranges from approximately 894 to 1,019 feet above sea level (fasl).

Soil cement levees provide flood control protection along the east and west banks of the Agua Fria River, from approximately Indian School Road (north of McDowell Road) to Buckeye Road. The western levee extends 1/4-mile south of Lower Buckeye Road for a total length of approximately 3-1/2 miles within the project area, while the eastern levee is approximately 2 miles within the project area. Residential development has replaced or is replacing much of the historical agricultural lands surrounding the project area, although agriculture and sand and gravel mining still occur south of Lower Buckeye Road.

The Agua Fria River watershed covers approximately 2,250 mi^2, but 83 percent of it is controlled upstream by several manmade structures, including the New Waddell Dam, the Arizona Diversion Canal, and dams along the New River and Skunk Creek. The Agua Fria River flood control project was constructed for the pre-New Waddell Dam Standard Project Flood of 92,000 to 102,000 cubic feet (cfs) through the project reach. This discharge is approximately three percent to nine percent higher than the post-New Waddell Dam 100-year discharge. The New Waddell Dam, constructed in 1991, reduced the Standard Project Flood to approximately 83,000 to 94,000 cfs through the project reach. The 100-year discharge was reduced to approximately half the Standard Project Flood (SPF).

Average streamflow on the Agua Fria River is close to zero. There is generally no flow at all for the months of April, May, June, October, and November. Sporadic flows occur in the remaining months depending upon rainfall. Within the project reach there are several discharges or drainages, including the I-10 channel outflow (north of I-10), the Durango Regional Outfall Channel outflow (north of Buckeye Road), the Avondale Wastewater Treatment Plant (AWWTP), and several smaller irrigation and stormwater runoff drains (Figures 4 to 8, located in Appendix A).

The regional climate is semi-arid, with mean monthly temperatures ranging from approximately 50°F in December-January to approximately 85-90°F between July and August. Scarce rainfall occurs in a bimodal pattern during the months of December-February and July-August.

The project is located within the Sonoran floristic province of the Lower Colorado River Valley subdivision, (Shreve in 1951; Brown in 1994). Vegetation within and adjacent to the restoration project area consists of disturbed/ruderal, early successional, riparian, upland and agricultural. The Agua Fria

[1] The following boundaries have been used for the purpose of data research: (1) Latitude 33° 30' 00" and 33° 23' 30"; Longitude 112° 21 30 and 112° 18' 30"; and (2) T1N: R1W: Sections 02, 03, 10, 11, 14, 15, 16, 21, 22, 23, 26, 27, 28, 33, 34, and 35.

River, at its confluence with the Gila River, is within the Pacific Flyway and provides resting, foraging and nesting habitat for a variety of migratory and non-migratory birds.

Arizona is continuing to experience a significant loss of riparian habitat (Briggs, 1996). The Agua Fria River is one of three primary river corridors in the Phoenix area that have been subjected to significant development pressures. Within the channel of the Agua Fria River, existing riparian habitat is limited to a few isolated areas, which are determined by surface water discharges and shallow ground water. Overall, the habitats are of low value and declining because of chronic disturbance and alteration of basic ecosystem processes. Future without-project conditions will likely continue to follow this trend of declination.

Plan Formulation

The initial plan formulation process involved the identification of preliminary management considerations and opportunities/constraints. As additional information about the site was researched, and local sponsor input was received, the preliminary management measures and opportunities/ constraints were formulated into a set of preliminary alternatives. The preliminary management measures and alternatives were presented at a May 6, 2002 project charette attended by representatives of the USACE, COA, FCDMC, Arizona Department of Game and Fish, and other local stakeholders and experts. Based on consensus developed at the charette, four management considerations were emphasized that became the basis for modifying the preliminary alternatives into a final set of alternatives. The four management considerations are summarized in Table ES-1.

Table ES-1 Summary of Revised Management Considerations*

Management Considerations	Discussion
Flood Capacity – Maintain existing flood control capacity.	Portions of the study area have excess flood control capacity available relative to the channel's engineered design capacity, as modeled for the Standard Project Flood (SPF). This extra capacity would allow modifications to be made within the channel without affecting the design capacity of the channel itself, thereby not lowering the intended flood protection the channel provides. However, although some areas have this excess flood control capacity, the amount of excess capacity is finite. Therefore, the design flow capacity also restricts the amount of alterations that may occur.
Water Availability – Maximize habitat value by increasing water availability and input.	Urbanization has led to the installation of dams and levees along portions of the river for flood control purposes, which has altered the natural flow patterns of the system. Regional groundwater use has also lowered groundwater levels beyond the reach of many native plants. As such, irrigation would be required, at least temporarily, to gain a significant benefit from the restoration process. COA groundwater (from existing or new wells operated) was considered the most viable option for obtaining irrigation. It was considered economically infeasible to (1) move effluent from the AWWTP to the upper part of the project reach, or (2) divert water from nearby irrigation canals.
Restoration Model – Create a model for future restoration on the river.	While biological considerations should be considered the first priority of the restoration project, the configuration of the restoration areas should, where possible, be located adjacent to areas that maximize appreciation of the project by the public and other agencies.
Flood Damage – Protect restoration areas from flooding.	The alternatives should be designed to include riparian strips located along the sides of the channel that would be protected by armored bank terrace berms that could withstand frequent flood events. This would increase the likelihood that the restoration areas would survive for a number of years.

* See Section 4.2 for a complete description of management measures.

Alternatives Design and Evaluation. Eight final alternatives were developed to meet the project goals and objectives based on the management considerations. The alternatives (other than the No Action Alternative) would involve the placement of riparian strips along the levees within portions of the project area. The riparian strips would be protected from frequent flood events (i.e., less than or equal to 10 year events) by terrace bank armor. Required irrigation for the alternatives would come from an existing COA groundwater well and the existing flows into and within the river that includes 1 mGPD from the AWWTP, although other water sources may be phased into the project in the future as long as they satisfy the projected water needs for the project. Management measures were incorporated into the design of the alternatives. The alternatives include the following:

- **No Action Alternative** – Describes baseline conditions that would continue in the future without the project.
- **Alternatives 2** – Low Water Use
- **Alternative 3** – Moderate Water Use
- **Alternative 4** – High Water Use with Vegetation Management Areas
- **Alternative 5** – Lower Water Use without Western Levee (counterpart to Alternative 2 without western levee)
- **Alternative 6** – Moderate Water Use without Western Levee (counterpart to Alternative 3 without western levee)
- **Alternative 7** – Moderate Water Use with Vegetation Management Areas but without Western Levee (counterpart to Alternative 4 without western levee)
- **Alternative 8** – Moderate Water Use with Reduced Vegetation Management Areas and Reduced Riparian Strips (adaptation of Alternatives 2, 4 and 5).

The comparison and evaluation of the alternatives focused on the salient environmental, engineering, and cost features of each alternative, including the following analysis:

- Design and cost features
- Real estate and utilities
- Habitat output
- Water requirements
- Overall effects on environmental quality
- Conveyance capacity
- Cost effectiveness
- Formulation criteria (general project goals)
- Environmental impacts
- Environmental and cost trade offs.

Habitat Value

The alternatives were compared with regard to their relative potential habitat value, based on the number of habitat units (HUs) generated as measured by the Habitat Evaluation Procedure (HEP) analysis. Table ES-2 presents a summary of the HEP analysis detailed in Appendix K. Each alternative was assessed at time equals 0, 1, 15, and 50 years. The acreage for alternatives was normalized to Alternative 4, which restores the greatest amount of acreage (303.9). The HEP generally showed that the action alternatives would provide a greater number of HUs than existing conditions, with Alternatives 4, 7, and 8 providing the most HUs.

Table ES-2 Summary of Habitat Outputs

ALTERNATIVE	Habitat Units				
	T=0	T=1	T=15	T=50	Average Annual Habitat Unit
Alternative 1 - No Action	77.72	77.72	63.21	63.21	65.63
Alternative 2 - Low Water Use	79.93	87.55	84.97	88.91	86.60
Alternative 3 - Moderate Water Use	77.78	89.76	90.31	95.41	91.78
Alternative 4 -High Water Use and Vegetation Management Areas	77.72	154.90	189.84	209.96	189.60
Alternative 5 - Low Water Use without Western Riparian Strip	76.93	82.16	75.69	78.55	77.69
Alternative 6 - Moderate Water Use without Western Riparian Strip	77.85	84.43	81.09	85.11	82.94
Alternative 7 - High Water Use and Vegetation Management Areas without Western Riparian Strip	77.72	147.35	179.05	197.01	178.74
Alternative 8 – Low Water Use, With Reduced Vegetation Management Areas and Western Riparian Strip	77.98	101.68	104.84	113.40	106.87

Habitat outputs for each alternative were also converted and measured as average annual habitat units (AAHU), relative to the 50-year life of the project (Table ES-2).

Costs and Economic Analysis

Table ES-3 presents a summary of construction and related costs, annual operation and maintenance (O&M) costs, and annual O&M costs per acre for each alternative.

Table ES-3 Comparison of Alternative Total Costs and Annual O&M Costs

	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8 Recommended Plan
LERRDs	$868,000	$1,302,000	$3,328,000	$528,000	$962,000	$2,173,000	$1,115,000
Subtotal *	$ 10,394,986	$14,858,933	$22,777,643	$ 4,624,479	$ 7,115,503	$16,357,639	$5,589,000
P,E,&D (Plans, Specs, Etc.)	$ 300,000	$ 300,000	$ 300,000	$ 300,000	$ 300,000	$ 300,000	$ 446,000
S.I.O.H. (6.5%)	$ 695,174	$ 985,331	$ 1,500,047	$ 320,091	$ 482,008	$ 1,082,747	$ 290,000
TOTAL	**$ 11,390,160**	**$16,144,264**	**$24,577,690**	**$5,244,570**	**$ 7,897,511**	**$17,740,386**	**$6,325,200**
Annual O&M Cost	$ 120,822	$ 144,857	$ 673,597	$ 78,932	$ 128,607	$ 318,992	$ 129,166
Annual Cost per Acre	$ 1,694	$ 1,590	$ 7,527	$ 1,683	$ 1,906	$ 1,415	$ 1,123

*Subtotal includes all construction costs + LERRDS + 10% contingency.
Note: Costs rounded to nearest dollar.

Through the IWR-PLAN software four alternatives, excluding the no action alternative, were identified as cost effective. These alternatives are 4, 5, 7, and 8. On an unconstrained basis, Alternatives 4 and 7 are identified as "best buys," whereas Alternative 8 does not receive this rating. Alternative 8 fails to receive this rating, on an unconstrained basis, because the marginal cost on a per habitat unit created basis of going from the no action alternative to the Alternative 7 level is lower. When the budgetary constraint (i.e. 1135 funding cap) is considered into the incremental analysis formulation only one alternative is identified as both cost effective and a best buy, Alternative 8.

Table ES-4 Average Cost per Habitat Unit Created

Plan	Total Construction Cost	Total Annual Cost	Net Average Annual Gain in Habitat Units (HUs)	Annual Cost/HU ($/HU)
No Action (Alt 1)	$0	$0	0.00	$0
Alternative 2	$11,390,160	$805,922	20.99	$38,396
Alternative 3	$16,144,264	$1,115,909	26.22	$42,559
Alternative 4	$24,577,690	$2,151,906	125.22	$17,185
Alternative 5	$5,244,570	$394,385	12.04	$32,756
Alternative 6	$7,897,511	$603,630	17.33	$34,832
Alternative 7	$17,740,386	$1,386,048	113.77	$12,183
Alternative 8	$6,325,200	$521,831	41.41	$12,602

[1]50-yr amortization with the FY04 discount rate of 5%

Environmental Impact Assessment

A thorough evaluation of the project's potential affect on the environment was conducted for the DPR, providing an assessment of negative and beneficial impacts caused by the restoration project during the construction and operation phases. For each environmental issue area:

1. Significance criteria were developed to evaluate the potential for environmental impacts (including cumulative impacts),
2. Potential environmental consequences were analyzed, and
3. Environmental commitments were proposed to ensure potential adverse impacts were reduced to less than significant levels.

In general, the project alternatives would result in a positive, long-term environmental benefit to the Agua Fria River. All potential impacts that were identified for the various issue areas can be reduced to less than significant levels or eliminated with the implementation of routine or best management practices (BMPs) during construction, compliance with laws and regulations, incorporation of measures into the design of the project or appropriate management of the restoration site during operation. A summary of the environmental commitments identified as a result of this evaluation is presented in Table ES-5.

Recommended Plan

Alternative 8 was selected as the Recommended Plan. Alternative 8 is an adaptation of Alternatives 2, 4 and 5, based on the considerations identified by the local sponsors, the USACE, and the other key stakeholders. Alternative 8 was designated as the Recommended Plan because it best performed the following actions:

- Utilizes the existing outflow of treated wastewater near the AWWTP site to substantially enhance the existing habitat by restoring more natives species
- Restores several types of critical riparian habitat to the I-10 site
- Minimizes water needs and associated costs by limiting irrigation to the I-10 site
- Reduces permitting requirements and costs associated with constructing groundwater wells by utilizing an existing COA well for irrigation
- Avoids potential land use impacts with the nearby Goodyear Airport associated with bird air-strikes
- Minimizes the amount of land that has to be acquired from private owners
- Enhances the aesthetic and recreational value of the areas around the I-10 site by providing natural riparian habitat that supports native wildlife better than the existing degraded habitat
- Is both cost effective and a best buy when budgetary constraints are considered in the incremental analysis formulation.

Restoration at the two sites for Alternative 8 would involve eight primary actions:

1. Removal and control of exotic, invasive species throughout the entire restoration site
2. Construction of riparian strips along the eastern and western levees with terrace bank armor protection
3. Establishment of Vegetation Management Areas between the riparian strips and at the AWWTP site
4. Introduction of water from an external source at the I-10 site
5. Retain 1 MGD of effluent from the AWWTP as a source of water at the AWWTP restoration site
6. Installation of filtration galleries and a system of pumps to recirculate shallow groundwater and infiltrated effluent at the AWWTP site from the downstream to the upstream end to help support vegetation cover
7. Non-construction measures to enhance habitat resources (e.g. microtopographic variation, creation of plant regeneration areas, etc.)
8. Measures to eliminate or reduce impacts from adjacent park and trail users.

Table ES-5 Environmental Commitments

Environmental Issue	Effects Assessment	Environmental Commitments
Biological Resources	Project would have long-term net **benefit** to river, commitments identified to ensure effective implementation of restoration program	**BIO-1** Prior to construction, a Wildlife Resource Protection Plan (Plan) should be developed that outlines measures for minimizing potential disturbances to wildlife during construction of the restoration areas. The plan should include, but is not limited to the following measures: • Prior to construction and operation, a qualified biological monitor will be designated and assigned the task of ensuring the measures in the Plan are implemented. • The Plan will require that the designated biological monitor conduct pre-construction biological surveys to determine if any wildlife species are at risk. Particularly, for special status wildlife species, the surveys will include a search for nesting birds within and in the vicinity of the construction activities. The Plan will also specify measures to be taken in the event special status species are encountered prior to or during construction activities. • The Plan should include construction timing "windows" that minimize potential disturbance to wildlife, particularly during critical periods such as breeding and nesting. **BIO-2** Prior to any on-site activities, a Vegetation Management and Monitoring Plan will be developed that outlines measures for establishing and monitoring native vegetation in the Agua Fria River restoration areas. The measures should include, but are not limited to, the following: • Prior to construction remove existing exotic vegetation using mechanical and chemical controls (see HW-2 for herbicide application). • During construction, excavated topsoil should be removed and replaced with suitable non-degraded soil (e.g., fine to medium sands). • Prior to construction, delineate the location of existing native plant species (e.g., mesquite and palo verde) that are considered under native plant law to ensure that appropriate replacement is achieved in the restoration effort. • Establish irrigation-timing controls to minimize the establishment and spread of exotic plant species during operation. • Establish revegetation success criterion and a monitoring program that includes measures to maximize restoration success. • Establish measures for hydrological monitoring that address vegetation and flood control issues (e.g., vegetation thinning and removal). • Establish a long-term plan for controlling invasive, exotic species. **BIO-3** Hydrological modeling assumptions should be assessed approximately every five years to address unanticipated vegetation growth or changes in the channel cross-section that may be induced by the restoration project or to address increased discharges and flow rates. If necessary, vegetation clearing or thinning of woody vegetation should be incorporated into periodic maintenance to ensure the model assumptions are maintained. **BIO-4** The minimum criterion for any impacts shall be to reestablish the design condition within the affected area and achieve success criteria over the following five years that will be defined in the Vegetation Management and Monitoring Plan.
Water Resources	Environmental commitments result in no significant effects to water resources	**WR-1** A Stormwater Pollution Prevention Plan (SWPPP) will be developed by the construction contractor to obtain an NPDES construction permit. The SWPPP will include measures for sediment and erosion control to prevent or reduce the effects of earth moving and other disturbances in the channel that may cause accelerated erosion, scouring, and loss of sediments in the project area, as well as sedimentation downstream. The plan shall consider the most optimum construction and implementation schedule compatible with local environmental conditions, biological elements of the restoration plan, and flood or flow hazards. **WR-2** Existing wetland areas shall be identified and preserved or replaced in compliance with Section 404 of the CWA. Also see Appendix D of this DPR for the Corps' internal 404(b)(1) compliance report. **WR-3** If required, a study will be completed during the plans and specification phase of this project to identify the potential impact of well placement and ground water pumping for supplying water for habitat restoration in support of necessary ADWR and local permits.

Environmental Issue	Effects Assessment	Environmental Commitments
		WR-4 The operation and maintenance plan for the project shall include periodic monitoring to respond to potential long-term scouring of the protective berms and existing structures in the channel, as well as other potentially project induced changes on conveyance capacity and hydraulic conditions, evaluated in the modeling (e.g., influence of vegetation). **WR-5** Additional sampling of water and sediments will be completed during the plans and specifications phase to provide more definitive conclusions on the presence of runoff contamination from urban and agricultural that may alter project design or construction plans. The effect of contaminant pulses during initial storm events on recently established vegetation may be ameliorated by supplying additional water to ensure that such contaminants do not accumulate in surface soils.
Earth Resources	Environmental commitment results in no significant effects to earth resources	**ER-1** A comprehensive Erosion Control Plan shall be prepared for project construction as part of the SWPPP (see WR-1). The Plan shall identify measures to be implemented to minimize the erosion effects of grading and excavation. Erosion control methods to be described in the Plan and implemented shall include, but not be limited to, the following: • Avoiding soil disturbance during periods of heavy precipitation or high winds • Keeping disturbed areas to the minimum necessary for construction • Reducing surface water flows across graded or exposed areas • Using straw bales, soil mats, or silt fences to stabilize disturbed areas • Using culvert, ditches, water bars and sediment raps to control runoff and sedimentation.
Air Quality	No significant effects to air quality	**AQ-1** The Construction contractor shall obtain an Earth Moving Permit from the Maricopa County Air Division and develop a dust control plan. The project sponsors are responsible for ensuring compliance with this measure.
Socioeconomics	No significant effects to socioeconomics	Not applicable
Cultural Resources	Environmental commitment results in no significant effects to cultural resources	**CR-1** If evidence of subsurface cultural resources is found during construction, all excavation and other construction activity in the area shall cease. A Corps archeologist shall evaluate the findings in consultation with the Arizona State Historic Preservation Officer regarding eligibility for the National Resister of Historic Places, in accordance with federal laws and regulations.
Hazardous Materials	Environmental commitments result in no significant effects from hazardous materials	**HW-1** Contractors shall have an accidental spill prevention and response plan in place for all hazardous materials that may be used on site. In the event of a spill or release of hazardous substances at the construction site, the contaminated soil shall be immediately contained, excavated and treated per federal and state regulations developed by the EPA, ADEQ, ADWR, as well as local hazardous waste ordinances. **HW-2** Only trained licensed contractors or personnel will participate in the application of herbicides. Such personnel shall adhere to regulations and guidelines for the safe application of herbicides, including, but not limited to storage and handling of materials, operation of application equipment, suitable climatic conditions for application, and avoidance of sensitive receptors. Back spraying equipment should be sufficient to cover most areas; however, trained personnel will evaluate the use of truck sprayers where larger areas need to be covered. Large-scale application techniques will not be used if site conditions (e.g., climate, topography and proximity to residences, etc.) are not adequate. **HW-3** Prior to conducting earth-moving activities in areas that overlap with historical sand and gravel operations, a geophysical survey shall be completed to determine the location, extent, and type of fill material used upon closure of the sand and gravel operations. Prior to conducting earth moving, soil sampling and testing of areas of proposed earth moving activities shall also be completed to determine whether pesticides have contaminated the soil. If testing indicates that contamination does exist, the materials shall be removed and disposed of according to applicable federal and state regulations. **HW-4** During construction, should an area of suspected contamination be encountered, construction activity in the area shall cease and soil sampling shall be conducted to determine the nature and extent of the potential contamination. If testing indicates that contamination does exist, the area shall be cleaned up in accordance with applicable federal and state regulations.
Noise	Environmental commitments result in no significant	**N-1** Construction contractor will provide at least 72-hour advance notice at the commencement of construction to all sensitive receptors and residences adjacent to the project construction areas, including haul routes. The announcement shall state

Environmental Issue	Effects Assessment	Environmental Commitments
	effects from noise	specifically where and when construction will occur. Notices shall provide tips on reducing noise intrusion, for example, by closing windows facing the planned construction areas. **N-2** Construction contractor shall establish a toll-free telephone number for dealing with public concerns/complaints about noise and other project-related issues. The notice issued (refer to Environmental Commitment N-1) shall advertise the contact telephone number. **N-3** Construction contractor will maintain properly functioning mufflers on all internal combustion and vehicle engines used during construction to reduce noise to the maximum feasible extent. **N-4** Construction contractor will monitor construction noise levels to ensure compliance with the noise ordinance. In the event of complaints by nearby residents or receptors, the contractor will monitor noise from the construction activity to ensure that construction noise does not exceed limits specified by the project's significance criteria. Measurements shall be conducted at adjacent residential uses. In the event that construction noise exceeds the specified limits, appropriate measures will be implemented to limit noise to acceptable levels. **N-5** If found to be necessary on a case by case basis, the construction contractor shall install temporary noise curtains along the construction perimeter adjoining noise sensitive land uses.
Land Use and Recreation	No significant effects	Not applicable
Public Health and Safety	Environmental commitments result in no significant effects to public health and safety	**PS-1** Transportation agencies, as well as local public works and safety agencies, should be notified of any major scheduled and unscheduled maintenance of the restoration site during periods subject to flood events. Such maintenance will be defined and planned so as not to present a risk to structures or personnel in the channel during flood events, and will consist only of activities that cannot be postponed until the non-flood season. **PS-2** Warnings will be incorporated into educational signs to advise observers of the restoration area not to enter into the channel, especially during flood events. **PS-3** The COA and the FCDMC shall ensure that any and all hazardous waste spills are removed promptly and thoroughly. During such a cleanup period, construction workers and all other unauthorized people will be restricted from the contaminated area until it is thoroughly remediated. **PS-4** The restoration site shall be monitored for the formation of standing water that may serve as a breeding area for mosquitoes that may pose a health risk. The project has been designed to reduce or eliminate this risk; however, if post-construction monitoring indicates this is not the case, then alternate design or control measures will be implemented.
Public Utilities and Services	Environmental commitment result in no significant effects to public utilities and services	**PU-1** Construction and operation of ground water wells shall be subject to the approval and conditions established by the ADWR and COA. **PU-2** The FCDMC shall coordinate with the COA and the appropriate utility agencies to identify all utility lines that may be affected by project construction. **PU-3** If relocation of utility lines is required, the FCDMC shall coordinate relocation actions with the COA and the appropriate utility agencies. Relocation actions shall be done in conjunction with the construction contractor for the project. The FCDMC and the COA shall be responsible for coordinating with the utility providers to notify local residents of any disruption of services.
Aesthetics	Beneficial Impact	Not applicable
Transportation	Environmental commitments result in no significant effects to transportation.	**T-1** If damage to roads and sidewalks occurs, the operator shall coordinate repairs with the affected public agencies to ensure that any impacts to area reads are adequately repaired. Roads and sidewalks disturbed by construction activities or construction vehicles shall be properly restored to ensure long-term protection of road and sidewalk surfaces. Staging areas for the project, which are located in unoccupied, sparsely vegetated areas within the river floodplain, will be cleaned and restored to their prior condition.

1. STUDY INFORMATION

1.1 STUDY AUTHORITY

This report is submitted under the authority of Section 1135(b) of the Water Resources Development Act (WRDA) of 1986, as amended (P.L. 99-662). Section 1135(b) authorizes the Secretary of the Army to review the operation of water resources projects to determine the need for structural or operational modifications for the purpose of improving the quality of the environment in the public interest. The Federal costs to carry out such modifications shall not exceed $5,000,000 for each project without specific authorization by Congress.

As required of all U.S. Army Corps of Engineers (USACE) Civil Works projects, a non-Federal co-sponsor must cost-share the project. Projects authorized under Section 1135 have a non-Federal cost-share of 25 percent. The Flood Control District of Maricopa County (FCDMC) and the City of Avondale (COA) are the non-Federal co-sponsors of the Agua Fria River riparian restoration project (restoration project).

1.2 PROJECT PURPOSE AND SCOPE

In July 2001, the Los Angeles District, USACE, Environmental Resources Branch, submitted a Preliminary Restoration Plan (PRP) (USACE, 2001) under Section 1135(b) of the Water Resource Development Act of 1986 for ecosystem restoration efforts to take place along the southern end of the Agua Fria River in Avondale, Arizona. After further discussion between the USACE, FCDMC and COA, it was determined that the feasibility phase of the project should be initiated. The feasibility phase of the restoration project was divided into two smaller phases: completion of the Baseline Conditions and Preliminary Alternatives Array Report (February 2002), and a subsequent completion of this report, where the EA is integrated into the Detailed Project Report (DPR).[1]

The Baseline Conditions and Preliminary Alternatives Array Report addressed the following:

- Baseline environmental conditions
- Project goals, objectives and constraints
- Preliminary restoration alternatives described at a conceptual level.

The results from the Baseline Conditions and Preliminary Alternatives Array Report were incorporated into the DPR, which contains the majority of the technical, environmental, and engineering analysis for the restoration alternatives, including the recommended restoration plan. The general purpose of the DPR is to complete a feasibility report that recommends modifications for the purpose of improving the quality of the environment in the public interest. Specifically, the DPR provides:

- A complete environmental analysis of all reasonable alternatives for improving habitat within the study area, as well as the potential cost and benefits associated with each of these plans.

[1] The DPR, therefore, also serves as the NEPA document for the restoration project. Since the EA typically contains a significant amount of information that would also be presented in the DPR, the USACE has determined that combining the two documents will provide a more effective presentation of the restoration project to decision-makers and the public.

- A determination of the alternative that maximizes net benefits based on Federal interest, cost, habitat output, and environmental impacts of the identified alternative plans. This determination will ensure the alternative will be in compliance with applicable statutes, executive orders, policies, and current budgetary priorities.
- A sound and documented basis for decision makers at all levels to judge the recommended restoration plan.
- An environmental review in compliance with the National Environmental Policy Act (NEPA).

The DPR evaluates feasible alternatives for the restoration of up to approximately 304 acres of riparian habitat to a degraded ecosystem along portions of a 5.5-mile reach at the south end of the Agua Fria River. The project being modified is the Skunk Creek and the New and Agua Fria Rivers (Arizona Canal Diversion Channel to the Gila River) (Figure 1). (Please note that all figures are provided in Appendix A.) The project modification is located within the channel of the Agua Fria River, in Avondale, Arizona, approximately 15 miles west of central Phoenix (Figure 2). The project is bounded on the north by McDowell Road, on the south by the Gila River, and on the east and west by the river channel.

The channelization of the river and hydrologic controls imposed upon the watershed have significantly altered its natural and biological functions, causing degradation of the ecological system that once existed. In general, riparian ecosystems are declining throughout the southwestern United States, and many have disappeared completely (Briggs, 1996). Riparian ecosystems play a critical part in the life cycles of most wildlife species, particularly in arid environments, but many of these natural systems have been diverted for direct or indirect human consumption, as well as by flood control projects. The restoration project would improve the habitat value of the alluvial, riparian, and wetland systems within this area, as well as help control peak flood discharges, improve water quality and groundwater.

1.3 Location and General Characteristics of the Study Area

The project modification boundaries are located in the Agua Fria River in the southwestern region of the Phoenix metropolitan area, within Maricopa County, Arizona, in the City of Avondale (Figures 1 and 2). Within the city limits of Avondale, the project reach is bounded to the north (upstream) by McDowell Road and to the south by the confluence of the Gila River[2]. Within this reach of the river, the width varies from approximately 1,200 feet in the narrowest portions at the northern end of the project site, to roughly 2,500 feet at the widest portions at the confluence; however, flowage easements extend beyond this width. The average elevation in the project area ranges from approximately 894 to 1,019 feet above sea level (fasl).

Soil cement levees provide flood control protection along the east and west banks of the Agua Fria River, from approximately Indian School Road (north of McDowell Road) to Buckeye Road. The western levee extends 1/4-mile south of Lower Buckeye Road for a total length of approximately 3-1/2 miles within the project area, while the eastern levee is approximately 2 miles within the project area. There are other bank protection structures associated with private developments or bridge crossings

[2] The following boundaries have been used for the purpose of data research: (1) Latitude 33° 30' 00" and 33° 23' 30"; Longitude 112° 21 30 and 112° 18' 30"; and (2) T1N: R1W: Sections 02, 03, 10, 11, 14, 15, 16, 21, 22, 23, 26, 27, 28, 33, 34, and 35.

(such as a 1/4-mile levee around a residential neighborhood on the east side of the river at Lower Buckeye Road).

Residential development is currently replacing much of the agricultural lands surrounding the project area. Sand and gravel mining within the lower reaches of the Agua Fria River still occurs from Indian School Road to Camelback Road and further downstream near lower Buckeye Road. The project area is also used informally by birders, hikers, equestrians and off-road vehicles.

The regional climate is semi-arid, with mean monthly temperatures ranging from around 50°F in December-January to around 85-90°F between July and August. Scarce rainfall occurs in a bimodal pattern during the months of January-February and July-August. The Agua Fria River watershed covers approximately 2,250 mi^2, but 83 percent of it is controlled upstream by several manmade structures, including the New Waddell Dam, the Arizona Diversion Canal, and dams along the New River and Skunk Creek. The watershed is located within the Sonoran floristic province of the Lower Colorado River Valley subdivision, described by Shreve in 1951 and Brown in 1994. Vegetation within and adjacent to the restoration project area consists of disturbed/ruderal, early successional, riparian, upland and agricultural. The Agua Fria River, at its confluence with the Gila River, is within the Pacific Flyway and provides resting, foraging and nesting habitat for a variety of migratory and non-migratory birds.

The Agua Fria River flood control project was constructed for the pre-New Waddell Dam Standard Project Flood of 92,000 to 102,000 cubic feet (cfs) through the project reach. This discharge is approximately three percent to nine percent higher than the post-New Waddell Dam 100-year discharge. The New Waddell Dam, constructed in 1991, reduced the Standard Project Flood to approximately 83,000 to 94,000 cfs through the project reach. The 100-year discharge was reduced to approximately half the Standard Project Flood.

Average streamflow on the Agua Fria River is close to zero. There is generally no flow at all for the months of April, May, June, October, and November. Sporadic flows occur in the remaining months depending upon rainfall. On average, there is no measurable flow on the Agua Fria River 99 days out of one hundred. There are several discharges or drainages to the Agua Fria River from the Avondale Wastewater Treatment Plant (AWWTP), the I-10 channel outflow (north of I-10 and also known as the Papago Diversion Channel), the Durango Regional Outfall Channel (north of Buckeye Road), and smaller irrigation and stormwater runoff drains.

Arizona is continuing to experience a significant loss of riparian habitat. The Agua Fria River is one of three primary river corridors in the Phoenix area that have been subjected to significant development pressures. Within the channel of the Agua Fria River, existing riparian habitat is limited to a few isolated areas, which are determined by surface water discharges and shallow ground water. Overall, the habitats are of low value and declining because of chronic disturbance and alteration of basic ecosystem processes. Future without-project conditions will continue to follow this trend of declination. Without restoration, the sparse condition of plant life in the project area would not adequately support quality habitat, which would continue to decline and be threatened. Figure 3 illustrates these gradual

habitat changes over time. Although the resolution of the photographs from 1959, 1985 and 2000 does not allow identification of specific vegetation types, it does illustrate significant changes in project area, including the changes in vegetated areas versus unvegetated areas, the channelization of the River, and the conversion of agricultural and flood plain zones to residential and commercial uses. The darkest (most densely vegetated areas) in the 2000 photo are associated with known discharges of effluent or nuisance runoff.

1.4 HISTORY OF THE INVESTIGATION

In response to the study authority, the reconnaissance phase of the study (the PRP) was initiated in July 2001. This phase of the study resulted in the finding that there was a Federal interest in continuing the study into the feasibility phase. In response to the findings of the PRP, the FCDMC, and the COA as the non-Federal sponsors, and the USACE initiated the feasibility phase of the study in November 2001. A baseline conditions report and preliminary alternatives array was produced in February 2002. Development of this Detailed Project Report (DPR) began in March 2002.

1.5 PRIOR REPORTS AND EXISTING PROJECTS

Prior reports, as well as ongoing projects or studies, are listed below. Section 9 of this document provides a complete list of references.

Agua Fria River Riparian Restoration Project - Section 1135 Preliminary Restoration Plan (USACE, 2001). In July 2001 the USACE completed a Section 1135 Preliminary Restoration Plan (PRP) for the restoration project. The PRP provides a brief description of the environmental conditions in the project area, as well as the goals, objectives and constraints that will shape the restoration alternatives. It describes the major elements of the restoration.

Agua Fria River Watercourse Master Plan (FCDMC, 2001a). The FCDMC Agua Fria River Watercourse Master Plan outlines specific recommendations relative to floodplain management strategies, recreation opportunities, and habitat preservation for the corridor. Throughout this DPR, data from the Agua Fria River Watercourse Master Plan and its technical appendices were used because of its direct relevance to the restoration project site.

Final West Valley Multi-Modal Transportation Corridor Master Plan (Maricopa Association of Governments, 2001). The Final West Valley Multi-Modal Transportation Corridor Master Plan created a long-term regional planning framework for a 42-mile trail network for pedestrians, equestrians, bicyclists and other non-motorized trail users. The planning area includes the Agua Fria River and therefore served as a reference for identifying recreational and non-motorized transportation uses.

Tres Ríos Aquatic Ecosystem Restoration Project. The Tres Ríos Aquatic Ecosystem Restoration Project was developed under Section 206 of the Water Resources Development Act (WRDA). Jointly sponsored by the USACE and the City of Phoenix, this project covers the confluence of the Gila, Agua Fria and Salt Rivers. The focus of the project is to use constructed wetlands to alleviate water quality

problems associated with point and non-point effluents, along with improving riparian and wetland habitat.

1.6 PLANNING PROCESS AND REPORT ORGANIZATION

The USACE's DPR planning process consists of six major steps: (1) specification of water and related land resources problems and opportunities; (2) inventory, forecast and analysis of water and related land resources conditions within the study area; (3) formulation of alternative plans; (4) evaluation of the effects of the alternative plans; (5) comparison of the alternative plans; and (6) selection of the recommended plan based upon the comparison of the alternative plans.

Sections of this DPR relate to the six steps of the planning process; they also satisfy NEPA reporting requirements. It should be noted that the DPR also contains additional information, such as technical appendices, beyond that which are listed below. Please see the Table of Contents for a complete list of all sections, tables, figures, and appendices.

- *Section 1: Study Information* – Introduces the study authority, purpose, location and history of the project.
- *Section 2: Need for and Objectives of the Project*– Describes the need for and purpose of the project. This section covers the first step of the planning process
- *Section 3: Environmental Setting* – Describes the existing, baseline condition of the environment that could be impacted by the proposed project. This covers the second step in the planning process.
- *Section 4: Alternatives* – Compares alternative plans, and selection of the recommended plan based upon the comparison of the alternative plans. This covers the third and sixth step in the planning process.
- *Section 5: Environmental Consequences* – Analyzes potential impacts on the environmental and human resources in the study area. This covers the fourth step in the planning process.
- *Section 6*: *Public Involvement, Review and Consultation* – Describes the review coordination, review and public participation process. This covers portions of the third and fourth step in the planning process.
- *Section 7*: *Compliance* – This section briefly describes how the project ensures compliance with applicable Federal, State, and local laws.

2. NEED FOR AND OBJECTIVES OF THE PROJECT

This Section presents the need for and planning objectives of the project, in a national and local context. These objectives reflect the concerns registered by the public and local sponsors and the opportunities and constraints that helped define the project alternatives.

2.1 PROJECT NEED

One hundred years ago, the Agua Fria River project area was a tree-lined river with dense vegetation throughout the riverbed and vicinity. But during the 1900s, the river channel experienced significant changes due to direct loss from floodplain encroachments and alterations to natural hydrology and groundwater conditions as a result of agriculture, population growth, urbanization, groundwater pumping and the need for flood control measures along the Agua Fria River. The New Waddell Dam, constructed in 1991, controls flows for a significant portion of the watershed. The New Waddell Dam significantly reduces peak flows above 10-year events by approximately one-half, and the frequency of flows is reduced.

According to the Lateral Migration Report for the Agua Fria Watercourse Master Plan (FCDMC, 2001a), the hydrology of the Agua Fria River watershed downstream of New Waddell Dam has been significantly modified over the past century due to the following:

- **New Waddell Dam.** Together with its predecessor, Carl Pleasant Dam, aka, Waddell Dam, these dams have impounded most of the natural flow runoff from the upper watershed since 1927. Therefore, the natural low flow hydrology has little impact on the existing channel morphology. Currently, floods up to the 10-year flood event are completely impounded behind the dam. Depending on the pre-flood storage capacity, even less frequent floods could be totally retained in Lake Pleasant.
- **Other Dams.** Other dams in the Agua Fria watershed include the New River Dam, Adobe Dam, Cave Creek and Cave Buttes Dams, McMicken Dam, and White Tanks Flood Retarding Structure #3. These flood control dams further reduce the low flows, peak flood discharges, and sediment supply delivered to the lower Agua Fria River.
- **Diversions.** The Arizona Canal Diversion Channel (ACDC), the McMicken Dam, and the Interstate 10 channel expand the watershed area that ultimately drains the lower portion of the river, potentially increasing the volume of water delivered to the lower portion of the river during large floods. In part, this increase in drainage to the lower portion of the river motivated construction of the levees in the project area.
- **Urbanization.** Urbanization of the west valley downstream of New Waddell Dam has changed the natural hydrology in the lower river in conflicting ways. Urbanization typically results in more frequent runoff, higher peaks, higher flow volumes, reduced sediment supply, and flashier floods relative to non-urbanized watersheds, due to less infiltration and other losses. However, enforcement of storm water retention requirements in areas that were developed in the past 15 years may have reduced flood volumes and peak discharges in some watersheds. Of the 460 miles not controlled by dams, more than half is urbanized or will be within ten years.
- **Return Flows.** Irrigation return flows, discharge from water and wastewater treatment plants, and other point sources of manmade runoff supply water to the lower river at different rates, locations, durations and seasons than the natural water supply.

Within the project area, low bank terraces and meanders that held significant riparian and wetland areas have been eliminated or restricted by high, steep, stabilized levees of soil-cement. These levees were added, in part, to accommodate flows from Cave Creek and other water diversions into the channel.

Riparian ecosystems are declining throughout the southwestern United States, and many have disappeared completely (Briggs, 1996). Riparian ecosystems are dependent on perennial, ephemeral or intermittent surface or near subsurface water. However, these natural systems have been significantly degraded in the Phoenix area and the project area through: (1) flood control projects; (2) groundwater depletion; (3) direct or indirect water consumption; (4) exotic species invasions; and (5) urban and agricultural land development.

The restored[1] habitat conditions would support an increased diversity of wildlife and provide linkages with existing riparian habitat downstream of the project site. Riparian areas are important to all wildlife, even if that wildlife does not rely on a riparian system as its home habitat. Riparian systems are especially important in an arid climate because they provide places for animals to eat, drink, and cool off (England and Laudenslayer, 1995). Due to the project's location on the Pacific flyway, there is a critical need for riparian habitat that can provide resting and foraging areas for migratory bird species. The restored habitats proposed in this project would also provide additional environmental benefits (USACE, 2001). Riparian systems can operate as filters and sinks for pollutants typically associated with urban or agricultural runoff (i.e., nitrates, ammonia, hydrocarbons). Vegetation in a riparian system removes and stores nutrients such as nitrogen and phosphorous from water that may otherwise pollute groundwater and surface water. Removal of these pollutants from river systems, such as the Agua Fria, benefits the entire watershed, and therefore the Gila River downstream may also benefit from this restoration project.

2.2 PLANNING OBJECTIVES

2.2.1 National (General) Planning Objectives

The national or Federal objective for ecosystem restoration is to contribute to the nation's environmental health through the restoration of degraded ecosystems, with contributions measured by changes in the amounts and values of ecosystem or habitat outputs. Consistent with water and related land resources development projects undertaken by the USACE, ecosystem restoration projects are evaluated according to their net benefit to the nation's ecosystems. In a practical sense, however, the net value of the restoration project is most readily evaluated in a regional or local context.

The following general objectives, set forth in the Project Restoration Plan (PRP) (USACE, 2001), are listed below to guide the formulation of specific objectives:

- Restore riparian habitat in a manner promoting ecological resiliency and self-sustaining qualities
- Establish habitats in a manner that supports the greatest diversity of target and beneficial wildlife species including mammals such as: desert cottontail (*Sylvilagus auduboni);* raccoon (*Procyon lotor*); desert mice or rats (*Peromyscus, Perognathus* and *Dipodomys* spp.); resident and migratory songbirds and other birds such as crissal thrasher *(Toxostoma dorsale)*, Abert's towhee *(Pipilo aberti)*, brown towhee *(Pipilo fuscus)*, Say's phoebe *(Sayorinis saya),* black-tailed gnatcatcher *(Polioptila melanura),* Gambel's quail *(Lophortyx gambelii)*, and mourning and white-winged doves *(Zenaida macroura* and *asiatica)* (Brown, 1994); raptors such as red-

[1] The use of the word "restoration" in this report is intended to maintain consistency with USACE program terminology. It is unlikely that true restoration, defined as restoring predevelopment conditions at the site, will be achieved. Rather the goal of the present project is to rehabilitate the site and achieve a sustainable ecosystem compatible with present environmental conditions.

tailed hawk (*Buteo borealis calurus*) and Swainson's hawk (*Buteo swainsoni*); and resident or migratory waterfowl such as great blue heron (*Ardea herodias*) and white-faced ibis (*Plegadis chihi*)

- Establish riparian plant communities that represent natural conditions in the region to include species such as Fremont cottonwood (*Populus fremontii*), Goodding willow (*Salix gooddingii*), desert broom (*Baccharis sarothroides*), mule fat (*Baccharis viminea*), desert hackberry (*Celtis pallida*), desert willow (*Chilopsis linearis*), burrobush (*Hymenoclea monogyra*), and arrow-weed (*Tessaria sericea*) (Brown, 1994). Vegetation communities should demonstrate structural and species diversity, which are important for the success of riparian ecosystems.

2.2.2 Specific Planning Objectives

The project goals will be achieved through the following specific objectives, some of which have been adapted from Briggs (1996) and Shafroth et al. (1999).

- Identify functional characteristics of the ecosystem that are critical for defining restoration opportunities and constraints. How does the current ecologic condition of the site affect what can or cannot be accomplished? What are the causes of changes from pre-development times and can they be reversed or improved?
- Identify opportunities for maximizing the availability of surface water and ground water inputs to biota. Characterize the depth to saturated soils, streamflow, and channel morphology.
- Develop the recovery effort from a watershed perspective. Ensure continuity with restoration and conservation efforts within the Gila River. Ensure that the flood control capacity of the channel is maintained consistent with existing and future conditions within the watershed.
- Motivate adjacent communities to view the restoration project as a means of reclaiming the cultural and natural history of the area. Maximize the participation and commitment from the adjacent community.
- Create a plan that is compatible with the local trail and park system without compromising the opportunities to maximize habitat output (i.e., emphasize perimeter recreational use of the area only).
- Minimize the need for complicated operation and maintenance measures. Among other strategies, facilitate processes of natural regeneration that are self-sustaining, and develop an adaptive management plan for post-implementation to deal with unpredictable or likely events that may affect success of the project.
- Minimize chronic disturbances in the restoration project area.
- Utilize knowledge gained from existing restoration efforts in the region and minimize experimentation.
- Emphasize essential habitat elements for wildlife in addition to water and vegetation (e.g., soil flora and fauna, substrate for burrowing animals, soil chemistry woody debris, etc.).

This project would modify as much as 304 acres within the Agua Fria River to rehabilitate a degraded ecosystem. The entire segment from McDowell Road approximately 5.5 miles to the confluence with the Gila River was considered. However, within this segment, three areas were considered in greater detail because of intermittent surface water inputs and significant areas of existing vegetation (Figure 4): (1) I-10 restoration site, (2) Durango Regional Outfall Channel / Buckeye Road restoration site, and (3) AWWTP restoration site. Additional opportunities adjacent to the channel were also considered during the early stages of planning, but most of these were discarded because of other land use commitments or because they were incompatible with the objectives of the Section 1135 program.

Some of the specific objectives originated from the opportunities and constraints defined in the following text. The specific objectives helped to define and shape the management options considered in the development of the final array of alternatives.

It is very important to recognize that unlike a landscaping project, the restoration of native ecosystems is not based on constructing and arranging features and vegetation in a static form in a single season. Successful implementation of the project will require a sound program for monitoring and responding to problems and unforeseen events. Management of the site should recognize the inherently dynamic nature of riparian systems dependent on alluvial processes and the need to encourage natural processes.

2.3 PUBLIC CONCERNS AND REGIONAL NEEDS

Riparian ecosystems play a critical role in the life cycles of numerous plant and animal species, particularly in arid environments. Well-functioning riparian ecosystems help control peak flood discharges, improve water quality, and increase ground water recharge. Unfortunately, riparian ecosystems are declining throughout the southwestern United States (Briggs, 1996), as they have been largely removed, channeled, diverted, or altered by increasing agricultural and urban demands. The Agua Fria River has experienced intense development pressures in the last 100 years, resulting in its current state as a highly disturbed and degraded riverine system.

The COA and the FCDMC have expressed a public interest in improving riparian habitat in the Agua Fria River within the study area. The agencies want to use the restoration project to:

- Rehabilitate a portion of the area's natural environment
- Improve regional connectivity of habitat areas
- Encourage an increased public appreciation for natural environments
- Improve the ability of people to enjoy the river corridor by incorporating recreational amenities such as parks and trails[2]
- Accomplish incidental groundwater recharge[3]
- Motivate other agencies to restore additional portions of the Agua Fria River by demonstrating the success of this project.

2.4 PLANNING OPPORTUNITIES AND CONSTRAINTS

2.4.1 Planning Opportunities

At the initiation of the feasibility phase the following opportunities were identified for the restoration project.

[2] Under the 1135 program guidelines, recreation included as part of ecosystem restoration projects must be compatible with the ecosystem restoration purpose of the project, and appropriate in scope and scale to the opportunity provided by ecosystem restoration projects. Recreation development should not require additional lands, and should be ancillary to restoration benefits. Recreation facilities may be added to take advantage of the education and recreation potential of the ecosystem project if the separable costs of such facilities are justifiable by the recreation opportunities, but the project cannot be specifically formulated for a recreation purpose. The impact of recreational amenities on the restoration project is considered in this DPR; however, construction of recreational amenities has been undertaken by the COA as a separate project.

[3] Modifications which provide for the addition of a new project purpose such as water supply shall not be pursued using section 1135 authority. Water recharge in and of itself cannot be included as a project objective under this authority; however, this does not preclude incidental benefits.

Excess Flood Control Capacity. Portions of the study area currently have excess flood control capacity available, relative to the channel's engineered design capacity, as modeled for the Standard Project Flood (SPF). This extra capacity would allow modifications to be made within the channel without affecting the design capacity of the channel itself, thereby not lowering the intended flood protection the channel provides. Within areas with excess capacity options, restoration features could be added to improve habitat in the area. Please see Section 3 of this report for a complete description of which portions of the study area have the greatest likelihood for excess capacity.

Surface water inputs. It is anticipated the project will take advantage of a portion (approximately 1 million gallons per day) of effluent inflow from the AWWTP, as well as intermittent flows of water from the I-10 and Durango Regional Outfall Channels.

Groundwater Irrigation. The COA has stated its interest in the restoration project and its willingness to consider using groundwater for the purpose of planting and sustaining the proposed habitat areas.

Groundwater Levels. In the lower half of the project area, groundwater levels are shallow enough to support woody vegetation. There is also the possibility that regional groundwater recharge projects could cause a rise in groundwater levels, thereby benefiting the restoration project.

Proximity to Habitat Areas. The proposed project would help create links to existing riparian habitat downstream in the Gila River and upstream in the upper reaches of the watershed. Linking of these habitats would have a synergistic effect, extending habitat resources over a larger area and supporting a greater number of species and larger wildlife populations. Problems associated with habitat fragmentation and high edge-to-interior ratios would also be partially alleviated by the restoration project.

In-channel Structures. Two grade control structures appear to retain surface water and subsurface groundwater, which can be incorporated into the physical environment of the restored habitat. Despite the sandy, gravelly soil, water from the I-10 outfall is retained within three feet of the surface weeks after precipitation events. Bridge abutments provide micro-topographical variation for accumulation of finer sediments and establishment of wetland species. Transmission towers provide perching areas for raptors. In addition, the overpasses provide opportunities for shelter and reduced exposure to wildlife and plants.

2.4.2 Planning Constraints

At the initiation of the feasibility phase the following constraints have been identified for the restoration project.

Flood Control Capacity. The alternatives developed for this project must be evaluated for their effect on flood capacity, such that the design capacity of the channel cannot be adversely affected. Although some areas have excess flood control capacity, which would allow some modifications to the channel to be made, the amount of excess capacity is finite. Other areas have no room for modifications, such as

the area just north of Buckeye Road. Therefore, the design flow capacity restricts the amount of alterations that may be made to the in-channel areas.

Sediment Reduction. The reduction of peak discharges from upstream and urbanization have generally reduced sediment volumes within the channel. Although sediments may be carried from the upper to the lower reaches (J.E. Fuller, 2001), the net result is a loss of input of fine material that helps to retain water and provide suitable substrate for plant regeneration and growth. The bed materials of the river are generally highly permeable. As a result, it may be necessary to add soil amendments to retain soil moisture.

In-channel Maintenance. Maintenance of the flood control structures is minimal; however, coincidentally one of the areas most subject to maintenance is at the I-10 restoration site. Maintenance of the tributary drainage channel north of I-10 (I-10 channel) is a chronic source of disturbance that prevents establishment of native vegetation, encourages invasives, and disturbs soil conditions within the I-10 channel, among other things. Although flood protection for the Buckeye Bridge has been completed, construction of additional scour protection is still pending. Any construction would temporarily alter all habitats under and immediately around the existing bridge.

Urbanization and Surrounding Land and Resource Use. Urbanization results in trash inputs, human disturbance, invasive species, pet and feral predators, increased edge effects, and contamination into natural areas. It has led to the installation of dams and levees along portions of the river (including the New Waddell Dam and the existing soil-cement levees) for flood control purposes, which has altered the natural flow patterns of the system. Development has led to a general encroachment on the river's historic floodplain, thereby disturbing, degrading, or removing much of the habitat that was historically located on the floodplain. Private ownership adjacent to or within the channel imposes economic and other constraints upon the extent of restoration opportunities, particularly in the southern portion of the study area.

Groundwater Levels. Regional groundwater use has lowered groundwater levels beyond the reach of many native plants. During drier periods of the year, average groundwater levels are approximately 100 to 70 feet at the I-10 site, 30 to 75 feet at the Durango Regional Outfall Channel site, and 15 to 30 feet at the AWWTP site.

Regional Trail Network. The West Valley Multi-Modal Transportation Corridor Plan is a long-term regional plan that proposes trails within the Agua Fria River (Appendix G). The restoration project would be more successful if trails are restricted to the perimeter of the restoration area. In addition, the planting palette for the West Valley Multi-Modal Transportation Corridor Plan includes native species in areas designated for conservation (Appendix B), but also includes many non-native and landscape plants that would be inconsistent with the goals of the restoration project.

Existing Physical and Biological Conditions. The following physical and biological conditions currently restrict restoration efforts at the site. They are directly or indirectly related to anthropogenic modifications to the river and surrounding watershed.

- Limited surface water and ground water
- Reduced peak discharges, frequency and volume of flood flows
- Reduced sediment input
- Surface and ground water with elevated nutrients, salts and other contaminants
- Coarse, highly permeable soils with limited water holding capacity
- Invasive species
- Fragmented habitat.

Contaminated Soils. In-channel and fill soils may be contaminated from polluted agricultural and urban runoff or from past landfill activities. Contaminated soils would restrict the use of certain areas for restoration opportunities or as fill material. This potential constraint was subsequently addressed for the impact analysis. Limited sampling was undertaken for the presence of pesticides at the I-10 outfall and the results were negative (see Section 3.4.5 and Appendix F).

Budget and Administrative. The restoration alternatives are in part defined by the total project cap of $6,666,666 split between $5,000,000 for the Federal contribution and the local sponsor's contribution of 25 percent of the total gross investment, or up to $1,666,666. The economic analysis determines the "best buy" plan under these assumptions. However, the total gross investment can exceed this if the local sponsors incur 100 percent of the additional amount. Also, administrative and other actions such as permitting of new wells, acquisition of lands, and establishment of use agreements make additional demands on resources and time for the USACE or local sponsors.

3. ENVIRONMENTAL SETTING

3.1 GENERAL SETTING

The project modification boundaries are located in the Agua Fria River in the southwestern region of the Phoenix metropolitan area, within Maricopa County, Arizona, in the City of Avondale (Figures 1 and 2). Within the city limits of Avondale, the project reach is bounded to the north (upstream) by McDowell Road and to the south by the confluence of the Gila River.[1] Within this reach of the river, the width varies from approximately 1,200 feet in the narrowest portions at the northern end of the project site, to roughly 2,500 feet at the widest portions at the southern sections; however, flowage easements extend beyond this width. The average elevation in the project area ranges from approximately 894 to 1,019 feet above sea level.

Soil cement levees provide flood control protection along the east and west banks of the Agua Fria River, from approximately Indian School Road (north of McDowell Road) to Buckeye Road. The western levee extends further south to 1/4-mile south of Lower Buckeye Road for a total length of approximately 3-1/2 miles within the project area, while the eastern levee within the project area is approximately 2 miles, extending to Buckeye Road. There are other bank protection structures associated with private developments or bridge crossings (such as a 1/4-mile levee around a residential neighborhood on the east side of the river at Lower Buckeye Road). See Figure 4 for an illustration of the levees in the study area.

Residential development is currently replacing much of the historically agricultural lands surrounding the project area. Sand and gravel mining within the lower reaches of the Agua Fria River still occurs from Indian School Road to Camelback Road and further downstream near lower Buckeye Road on both the east and west banks. Birders, hikers, equestrians, and off-road vehicles also use the project area informally.

The regional climate is semi-arid, with mean monthly temperatures ranging from around 50°F in December and January to around 85-90°F between July and August. Scarce rainfall occurs in a bimodal pattern during the months of January and February and July and August. The Agua Fria River watershed covers approximately 2,250 mi^2, but is controlled upstream by several manmade structures, including the New Waddell Dam, dams along the New River and Skunk Creek, and the Arizona Diversion Canal. The watershed is located within the Sonoran floristic province of the Lower Colorado River Valley subdivision, described by Shreve in 1951 and Brown in 1994. Vegetation within and adjacent to the restoration project area consists of disturbed/ruderal, early successional, riparian, upland, and agricultural. The Agua Fria River at its confluence with the Gila River is within the Pacific Flyway and in general, provides resting, foraging and nesting habitat for a variety of migratory and non-migratory birds.

The Agua Fria River flood control project was constructed for the pre-New Waddell Dam Standard Project Flood of 92,000 to 102,000 cubic feet (cfs) through the project reach. This discharge is

[1] The following boundaries have been used for the purpose of data research: (1) Latitude 33° 30' 00" and 33° 23' 30"; Longitude 112° 21 30 and 112° 18' 30"; and (2) T1N: R1W: Sections 02, 03, 10, 11, 14, 15, 16, 21, 22, 23, 26, 27, 28, 33, 34, and 35.

approximately three percent to nine percent higher than the pre-New Waddell Dam 100-year discharge. The New Waddell Dam, constructed in 1991, reduced the Standard Project Flood to approximately 83,000 to 94,000 cfs through the project reach. The 100-year discharge was reduced to approximately half the Standard Project Flood.

Average streamflow on the Agua Fria River is close to zero. There is generally no flow at all for the months of April, May, June, October, and November. Sporadic flows occur in the remaining months depending upon rainfall. On average, there is no measurable flow on the Agua Fria River 99 days out of 100. There are several discharges or drainages to the Agua Fria River from the Avondale Wastewater Treatment Plant (AWWTP), the I-10 channel outflow (north of I-10), the Durango Regional Outfall Channel outflow (north of Buckeye Road), and smaller irrigation and stormwater runoff drains.

Arizona is continuing to experience a significant loss of riparian habitat. The Agua Fria River is one of three primary river corridors in the Phoenix area that have been subjected to significant development pressures. Within the channel of the Agua Fria River, existing riparian habitat is limited to a few isolated areas, which are determined by surface water discharges and shallow ground water. Overall, the habitats are of low value and declining because of chronic disturbance and alteration of basic ecosystem processes. Future without-project conditions will continue to follow this trend of declination. Without restoration, the sparse condition of plant life in the project area would not adequately support quality habitat, which would continue to decline and be threatened. Figure 3 illustrates these gradual habitat changes over time. Although the resolution of the photographs from 1959, 1985 and 2001 does not allow identification of specific vegetation types, it does illustrate significant changes in project area, including the changes in vegetated areas versus unvegetated areas, the channelization of the River, and the conversion of agricultural and flood plain zones to residential and commercial uses. The darkest (most densely vegetated areas) in the 2001 photo are associated with known discharges of effluent or urban runoff.

3.2 BIOLOGICAL RESOURCES

3.2.1 Regulatory Setting[2]

Federal

National Environmental Policy Act (NEPA), The Environmental Quality Improvement Act of 1970, as amended (42 U.S.C. 4371 *et seq.*). NEPA is the basic national charter for protection of the environment. It includes and defines requirements for preparation of Environmental Impact Statements, coordination with other agencies, and obtaining input from the public.

Endangered Species Act of 1973 (16 U.S.C. 1531 *et seq.*). The Endangered Species Act (ESA) protects threatened and endangered species, as listed by the U.S. Fish and Wildlife Service (USFWS) or the National Marine Fisheries Service (NMFS), from unauthorized take, and directs Federal

[2] In this Section 3, a regulatory setting is provided for each environmental area, which emphasizes the regulations that determine the type of baseline information that should be provided to evaluate impacts. However, see Section 7 of this report for a presentation of compliance with these regulations.

agencies to ensure that their actions do not jeopardize the continued existence of such species. Any potential take of a listed species would first require consultation with the USFWS or NMFS for Federal actions under Section 7 of the ESA or for non-Federal actions under Section 10 of the ESA.

U.S. Fish and Wildlife Coordination Act (16 U.S.C. 661). The U.S. Fish and Wildlife Coordination Act (FWCA) propose to assure that fish and wildlife resources receive equal consideration with other values during the planning of water resources development projects. The Act requires Federal agencies to consult with the USFWS whenever they plan to conduct, license, or permit an activity involving the impoundment, diversion, deepening, control, or modification of a stream or body of water. The FWCA also requires consultation with the head of the State agency that administers wildlife resources in the affected state. Although the recommendations of the USFWS and State officials are not binding, the Federal agency must give them full consideration.

The Migratory Bird Treaty Act (MBTA). The MBTA prohibits the taking or harming of any migratory bird, its eggs, nests, or young without an appropriate Federal permit. Almost all native birds are covered by this Act. The take of all migratory birds is governed by the MBTA's regulation of taking migratory birds for educational, scientific, and recreational purposes and requiring harvest to be limited to levels that prevent over-utilization. Section 704 of the MBCA states that the Secretary of the Interior is authorized and directed to determine if, and by what means, the take of migratory birds should be allowed and to adopt suitable regulations permitting and governing take. Disturbance of the nest of a migratory bird requires a permit issued by the USFWS pursuant to Title 50 of the Code of Federal Regulations (CFR).

State

State of Arizona - Native Plant Law. Arizona native plants that are protected under this law cannot be removed from any lands, whether they are owned by a private individual or managed by a government agency, without permission and a permit from the Arizona Department of Agriculture. Lessees of State or Federal land must obtain specific authorization from the landlord agency to remove protected native plants.

By law, Arizona landowners have the right to destroy or remove plants growing on their land, but 20 to 60 days prior to the destruction of any protected native plants, landowners are required to notify the Arizona Department of Agriculture. Arizona landowners also have the right to sell or give away any plant growing on the land. However, protected native plants may not be legally possessed, taken or transported from the growing site without a permit from the Arizona Department of Agriculture.

There are five categories of protected plants:

1. *Highly Safeguarded (HS)* – No collection allowed
2. *Salvage Restricted (SR)* – Collection with permit only
3. *Export Restricted (ER)* – Transport out of State is prohibited
4. *Salvage Assessed (SA)* – Permit required to remove live trees
5. *Harvest Restricted (HR)* – Permit required to remove plant by-products.

State of Arizona - Wildlife of Special Concern in Arizona. The Arizona Game and Fish Department (AGFD) has prepared a listing of plant and animal species (State of Arizona–Wildlife of Special Concern) that are believed to be in peril within the State of Arizona. These species may have management guidelines established by the State. The species on this list do not have any regulatory protection. The State has also published the *Habitats in Jeopardy* listing with recommended management techniques. The guidelines recommend that Resource Category I habitats (wetlands, perennial streams) be protected with a goal of no loss of habitat and Resource Category II habitats (Sonoran Upland) be managed for no net loss. Where practical, proposed activities should be conducted within the AGFD guidelines.

Local

Maricopa County. According to the Flood Control District of Maricopa County, there are currently no County environmental regulations that are germane to the restoration project that would offer additional protection beyond Federal or State laws (FCDMC, 2002).

City of Avondale General Plan

Currently, there are no specific policies that provide extra protection to sensitive plant or animal species in the City of Avondale. However, Avondale's most current General Plan recommends the adoption of a local native plant protection law.

3.2.2 Plants and Vegetation

3.2.2.1 *General Description*

Vegetation in the project region still demonstrates influence by a subtropical climate that was changed as a result of large-scale shifts in rainfall patterns which historically increased drought conditions in this region. The bimodal rainfall pattern that currently exists in the Sonoran Desert results in relatively greater diversity than in other North American Deserts. The region can be grossly classified as tropical-subtropical desert lands, with further classification placing vegetation within the Lower Colorado River Valley Subdivision of the Sonoran Desert scrub Division. Low-density vegetation cover on top of sandy alkaline soils marks these areas. Sonoran Riparian Deciduous Forest is also found in areas with sufficient water availability (Brown, 1994), and in these areas, intermittent or perennial flows, urban water runoff, and shallow groundwater can support a higher density of trees, as well as herbaceous species associated with mesic or hydric conditions (i.e., facultative wetland species). In addition to climate and other natural influences, the floristic and physiognomic characteristics of vegetation in the project area are determined by: disturbance from channel maintenance; sand and gravel mining within one mile upstream of McDowell Road and near Lower Buckeye Road; indiscriminate trash dumping; hydrological controls; groundwater depletion; and agricultural and residential land use. Two of the most noticeable end results of these development pressures have been loss of the native plant species in favor of non-natives and reduced vegetation cover.

Riparian species, such as desert broom (*Baccharis sarothroides)*, salt cedar (*Tamarix ramosissima)*[3], blue palo verde (*Parkinsonia floridum*), cottonwood (*Populus fremontii)*, and athel tamarisk (*Tamarix aphylla*), occur in and along the channel (USACE, 2001). In the disturbed wash communities, buffel grass (*Pennisetum ciliare*), Russian thistle (*Salsola iberica*), Johnson grass (*Sorghum halapense*), and desert broom dominate the disturbed areas. In the lower reaches, the channel broadens substantially and riparian vegetation continuously intergrades into characteristic outwash vegetation more typical of areas adjacent to the channel, with species such as mesquite (*Prosopis juliflora)*, greasewood (*Sarcobatus vermiculatus)*, palo verde, four-winged saltbush (*Atriplex canescens*), desert willow (*Chilopsis linearis*), and catclaw acacia (*Acacia greggii).* The area occupied by typical outwash vegetation is minimal outside the channel banks due to agriculture and urbanization (USACE, 2001).

3.2.2.2 *Survey Results*

Kimley-Horn & Associates completed a vegetation survey of the Agua Fria River during 2000 (Kimley-Horn, 2001a) for the Agua Fria River Watercourse Master Plan (FCDMC, 2001a). The survey area extended from New Waddell Dam to the confluence of the Agua Fria and Gila Rivers, inclusive of the restoration project area, as depicted in Figures 4 through 8. For this restoration project, Harris Environmental Group also completed a reconnaissance level vegetation survey in December 2001 (HEG, 2001). The Harris Environmental Group survey focused on areas that have the most likely opportunity for restoration: (1) Agua Fria River near Interstate 10, (2) Agua Fria River at the Avondale Wastewater Treatment Plant, and (3) Agua Fria River near the railroad crossing and Buckeye Road in the study area. Descriptions from both surveys are provided below.

Kimley-Horn Survey

As stated above, this evaluation of the Agua Fria River corridor extended beyond the reach of the restoration project, from the New Waddell Dam to the Gila River Confluence.[4] The survey identified five general categories of vegetation communities:

[3] Salt cedar (*Tamarix*) taxonomy is still confusing. The number of species in the genus has fluctuated widely because members of the genus have few constant differentiating features, and taxonomists have disagreed over which features are most important. Eight species have been listed as introduced into the United States and Canada. These species can be effectively divided into two groups. Athel tamarisk (*Tamarix aphylla)*, an evergreen tree, does not sexually reproduce in this climate and propagates by root and branch stock so it is not seriously invasive. Deciduous, shrubby species, including *T. pentandra, T. tetranda, T. gallica, T. chinensis, T. ramosissima,* and *T. parvifolia,* as described by various authors, are more serious invasive threats (Rodman, 1989). Some authors continue to distinguish many species, while others consider these shrubby plants as one variable species or hybridizing group best designated by the single name *T. pentandra* (Sudbrock, 1993). In the project area however, *T. rasmosissima* is more common.

[4] The species list and descriptions from this study include references to the upper and middle reaches of the Agua Fria River. The restoration project is located within the lower reach.

- Early Level Successional
- Sonoran Upland
- Agricultural
- Mesic/Hydric Riparian
- Commercial/Residential.

Several of the vegetation communities are a function of land use and are named accordingly. Each community is composed of several physiognomic and floristic groups, and several communities share numerous common species. The communities identified along the corridor are noted below in addition to a brief description of the community and a non-inclusive species list. A potential plant palette consistent with the native plant communities existing at the site is provided in Appendix B.

A brief discussion of some of the major forces affecting the community is also included. Figure 4 illustrates the general locations of the various communities. Small inclusions of each of the different communities are interspersed along the corridor and within areas mapped as a different community.

Early Level Successional Community

The Early Level Successional Community is located within the low terrace banks of the Agua Fria River channel from south of the State Route (SR) 74 Bridge crossing (north of the restoration project area) to near the confluence with the Gila River. In leveed portions, this component of the river morphology may be lost or lessened. At the confluence, this area generally encompasses the majority of the braided sub-channel system of the "active Gila River channel." The channel system varies in width from several hundred feet to over a thousand feet. Historical aerial photography and narratives suggest that this community, or variations of it, has been in place for at least 75 to 100 years. Some accounts suggest the early community historically contained more large growth woody species. While the existing community is relatively homogeneous throughout the corridor, it is broken in several places by sand and gravel mining activity and infrastructure intrusions. Species composition changes slightly from area to area, but remains generally early successional vegetation. It is also interspersed with small inclusions of the mesic/hydric riparian community in several areas. Very small inclusions of the Early Level Successional Community are located in areas of recent or continued disturbance outside of the channel.

The community is generally composed of ruderal, invasive, or early level successional species with isolated inclusions of mid-level successional species. The Early Level Successional Community has a low-floristic value because most of the species represented are not habitat specific. The Early Level Successional Community is dominated by annual/perennial herbaceous and low-growth shrub species. Many portions of the low-flow channels are barren, and others exhibit dense stands of snakeweed or rabbitbrush. Ground cover density varies greatly, primarily as a function of substrate and moisture. Areas of increased moisture have greater densities and some moist areas have nearly 100 percent vegetation cover. Tree canopy cover is very limited, except for occasional patches of tamarisks, cottonwood, willow, mesquite, and paloverde (see Riparian Community).

Vegetation community development appears to be mostly a function of the unique landforms of the occasionally active Agua Fria channel. The bottom of the channel contains a series of very braided, low-flow sub-channels separated by narrow islands of slightly higher elevation (interfluves of generally no more than three feet). These interfluval islands can withstand isolated low-flow events but are susceptible to scour during prolonged or moderate volume flows. Thus, the interfluve areas may exhibit more advanced vegetation structure than the low-flow channel. In areas of recent or repeated disturbance the vegetation community is dominated by annuals or is barren. Typical events that cause disturbance of the vegetation are recent flow events, off road vehicle tracks, and mining operations. Thus, the community is interspersed with inclusions of annual vegetation and areas of more established (but still early level successional) vegetation.

The Early Level Successional Community forms ecotones with several of the upland communities located along the middle and upper terrace banks of the channel. The transition zone between this community and the adjacent communities is relatively abrupt. It is driven by the moisture regime (for the mesic/hydric riparian community), by the development of hard-pack desert soils along the terrace banks, or by disturbance history.

Table 3.2-1 is a non-inclusive species list for the Early Level Successional Community. Some of the species listed are transitional to the various other vegetation communities. The community includes many other annual and short-lived perennials that are not included in Table 3.2-1.

Table 3.2-1 Early Level Successional Community

Common Name	Scientific Name	Comment
	Trees	
Mesquite	*Prosopis* spp.	Scattered along margins of ephemeral wash tributaries
Saltcedar	*Tamarix* spp.	Invasive species, dominant in some areas
Cottonwood	*Populus fremontii*	Native, at margins of mesic/hydric areas
	Shrubs	
Saltbush	*Atriplex* spp.	Throughout corridor (T/O)
Burrobush	*Hymenoclea monogyra*	Scattered T/O, primarily on interfluves
Desert broom	*Baccharis sarothroides*	Scattered T/O
Brittlebush	*Encelia farinosa*	Scattered T/O, primarily on interfluves
Rabbitbrush	*Chrysothamnus nauseosus* or *C. viscidiflorus*	Native perennial, T/O
Bursage	*Ambrosia* spp.	Primarily as transition species to Sonoran Upland community in southern upper and middle reaches. Associated with creosotebush
Creosotebush	*Larrea tridentata*	Mainly as transitional species to middle reach Sonoran Upland community. Scattered occurrence in other areas
Apache plume	*Fallugia paradoxa*	Native, Scattered T/O
Winter fat	*Eurotia lanata*	Native, Scattered T/O
	Herbaceous	
Broom Snakeweed	*Gutierrezia sarothrae*	Native perennial, primarily in central corridor forming dominant community.
Tumble pigweed	*Amaranthus albus L.*	Native annual, T/O
Annual bursage	*Ambrosia acanthicarpa*	Native annual, T/O
Knapweed	*Centaurea* spp.	Introduced invasive biennial, isolated T/O corridor
Quackgrass	*Elytrigia repens*	Scattered in moist areas and along disturbed areas
Cudweed	*Gnaphalium palustre*	Annual, in moist areas
Pineapple-weed	*Matricaria matricariodes*	Scattered in isolated areas
Cocklebur	*Xanthium stumarium L.*	Native annual, isolated T/O corridor
Creeping bellflower	*Campanula rapunculoides L.*	Perennial, middle and lower
Nettleleaf goosefoot	*Chenopodium murale L.*	Introduced annual, T/O corridor
Halogeton	*Halogeton glomeratus*	Introduced annual
Yellow nutsedge	*Cyperus esculentus L.*	Introduced perennial, in moist areas
Horsetail	*Equisetum arvense L.*	Native perennial, in moist areas

Common Name	Scientific Name	Comment
Rush	*Juncus spp.*	Native perennial in moist areas
White horehound	*Marrubium vulgare L.*	Introduced perennial, T/O
Brome grass	*Bromus* spp.	Perennial, Scattered T/O
Bermudagrass	*Cynodon dactylon*	Introduced perennial, T/O in moist areas
Saltgrass	*Distichlis spicata*	Perennial, at drainage outlets and grade control structures
Mexican sprangletop	*Leptochloa uninervia*	Annual, in wet areas.
Bush muhly	*Muhlenbergia porteri*	Along margins w/ Sonoran upland vegetation in upper reach
Dallisgrass	*Paspalum dilatatum*	Introduced perennial, in moist areas

Source: Kimley-Horn 2001a

Sonoran Upland Community

The adjacent overbanks of the Agua Fria River channel form an important vegetation and habitat component of the corridor. These areas are vegetated with species typical of open-range desert communities found in the valley and foothills of the Phoenix area. The corridor traverses an area that contains two of the major subdivisions of the Tropical-Subtropical Desert land vegetation communities as described in Brown, 1994. In general, the northern portion of the corridor is considered part of the Arizona Upland Subdivision, Paloverde–Cacti–Mixed Scrub Series (also considered thornscrub) and is located on alluvial fans and bajadas along the channel.[5] The lower portion of the river corridor, along the valley floor, is considered part of the Lower Colorado River Valley Subdivision, Creosotebush–White Bursage Series and Saltbush Series. These are noted as KO41-Creosotebush, KO42-Creosotebush/Bursage and KO43-Paloverde/cactus shrub in the Kuchler Plant Association nomenclature (Kuchler, 1964). This vegetation community has a high floristic value and provides excellent wildlife habitat.

Tree species (paloverde) and succulent species dominate the Arizona Upland Subdivision (generally north of the restoration project area), while the Lower Colorado River Valley community is dominated by creosotebush and bursage. The difference in vegetation is a function of moisture, elevation, and aspect. Both communities have sub-divisions that are very similar. The margins of these two communities are not well defined, and boundaries are indistinct. The resulting ecocline between the two communities is normally quite wide and easily encompasses the entire study corridor. Additionally, from a habitat aspect, the two communities, especially in this transition zone, offer relatively similar functions (although the Arizona Upland Community is generally more diverse habitat). Therefore, for purposes of this study, the two communities were considered as one and are identified as the Sonoran Upland Community. Also included in this community is the xeric-riparian community normally associated with established ephemeral washes.

Vegetation density within the Sonoran Upland Community varies as a function of the surrounding landform. Other factors being equal, cover densities tend to decrease from north to south across the corridor. The decline in cover density correlates with the vegetation change from typical Arizona Upland vegetation to the less diverse and more open, Lower Colorado Creosotebush dominated

[5] This community is generally represented north of the restoration area; however because of the overlap between this community and the Lower Colorado Valley Subdivision and to maintain continuity in the survey description, reference to northern reaches of the Agua Fria have been retained in the text.

community. Species diversity is high in the Arizona Upland areas and is much lower in the Lower Colorado community.

The northern portion of the Agua Fria corridor has numerous incised, ephemeral washes that exhibit some of the highest vegetation cover densities along the corridor. These so-called xeric-riparian communities are composed of woody desert scrub vegetation that is concentrated mainly along the margins of the washes. The slight increase in moisture provided by the wash enhances vegetation growth, and in many areas, the woody vegetation forms a closed canopy cover. Species composition in the wash areas is similar to the surrounding upland areas, although succulents are less evident and woody species are more prevalent. The surrounding upland areas also contain some of the same woody species but are primarily dominated by succulents or small shrubs. Groundcover density outside of the ephemeral channels is low to moderate with many non-vegetated open areas.

This community (particularly the northern portion) is a highly diverse mixture of small inclusions of various vegetation groupings (including those that occur in association with physical features such as xeric-riparian corridors, alluvial fans, desert pavement, and ephemeral washes) that form a mosaic of sub-habitat types. This provides excellent habitat that is heavily traveled by area wildlife. The relatively intact nature of the northern portion of this community and its proximity to open water and mesic riparian habitat further contribute to the community's significance.

An evaluation of historical photography, narratives, and floristic inventories suggests that this community has been established for a significant period. Based on this evidence, the community originally extended down the Agua Fria River corridor to near the confluence with the Gila River. Current field evidence suggests that lower undisturbed portions of this community remain similar to the historic community, with only minimal shifts in densities or species composition.

In the southern portion of the corridor within the restoration project area, the community has been significantly altered or displaced by other vegetation communities. The few remaining relevant areas in the southern portion of the corridor suggest the species composition is more similar to the lower Colorado subdivision. The species listed in Table 3.2-2 were noted within the Sonoran Upland Community. This community also contains some of the early seral species noted in the Early Level Successional Community. These species are most evident at the community margins and in disturbed areas.

Table 3.2-2 Sonoran Upland Community

Common Name	*Scientific Name*	Comment
	Trees	
Paloverde	*Parkinsonia* spp.	Dominant woody species. Scattered throughout corridor (T/O), concentrated in wash areas.
Saltcedar	*Tamarix* spp.	Invasive species concentrated in channel/wash bottoms
Ironwood	*Olneya tesota*	Very scattered, in northern Upper Reach
Desert willow	*Chilopsis linearis*	Very limited, in margins of xeric and mesic riparian interface with Sonoran upland
Mesquite	*Prosopis* spp.	Several dense stands in Upper and Middle Reach
Catclaw	*Acacia greggii*	Scattered along wash and channel banks
Crucifixion thorn	*Canotia holacantha*	Limited to Upper Reach
	Shrubs	
Creosotebush	*Larrea tridentata*	Dominant in Lower and Middle Reach

Common Name	Scientific Name	Comment
Saltbush	*Atriplex* spp.	Scattered T/O
Burrobush	*Hymenoclea monogyra*	Scattered T/O
Brittlebush	*Encelia farinosa*	Scattered T/O
White and Triangle bursage	*Ambrosia dumosa* and *A. deltoidea*	Scattered T/O, but co-dominant in portions of Middle and Lower Reaches
Broom Snakeweed	*Gutierrezia sarothrae*	Scattered T/O, prevalent along community margins
Jojoba	*Simmondsia chinensis*	Scattered
Ocotillo	*Fouquieria splendens*	Scattered along ridgelines and bajadas
Desert broom	*Baccharis sarothroides*	Common T/O
Succulents		
Saguaro	*Carnegiea gigantean*	Scattered T/O northern portion of corridor
Cholla	*Optunia fulgida*	Isolated stands in Upper and Middle Reaches
Barrel cactus	*Ferocactus* spp.	Scattered T/O Upper Reach
Queen of the Night	*Peniocereus gregii*	Very scattered Upper Reach
Pincushion	*Mammillaria* spp.	Scattered Upper Reach, concentrated in rock areas
Hedgehog	*Echinocereus* spp.	Scattered in Upper Reach
Herbaceous		
Bladderpod	*Isocoma acradenia*	Scattered T/O
Wooly plantain	*Plantago insularis*	Lower Reach
Tumbleweed	*Salsola* spp.	Scattered T/O

Source: Kimley-Horn, 2001a.

Agricultural Community

This vegetation community inhabits areas that are currently (or were in the past) under agricultural production for row crops, orchards or structured pasture areas. Also included in this classification are the scattered residences or other buildings that are associated with the agricultural activity. This community is not assigned a floristic value. It does provide some wildlife habitat value, particularly in the form of forage and cover.

Most of these areas have been cleared of native vegetation and have been graded to promote irrigation. Tilling has disturbed soil profiles, and many areas have been compacted by agricultural traffic. The active agricultural fields are irrigated and may produce multiple crops per year. Many of the fields are chemically treated for control of pests and receive fertilizer. The agricultural species include cotton, alfalfa, and citrus. Active irrigation ditches are normally maintained but exhibit some herbaceous growth and are sometimes lined by woody species. Fallow agricultural areas are vegetated with remnant agricultural species and ruderal or invasive species. Mesquite and creosotebush are normally among the first woody species to colonize the fallow areas.

The majority of the active agricultural areas are in the southern portion of the corridor, south of the I-10 Bridge. Orchards are noted in the upper reach of the corridor, north of Calderwood Butte and south of the Central Arizona Project (CAP) crossing. Isolated active and fallow agricultural areas are noted in scattered areas along the corridor.

Mesic/Hydric Riparian Community

The Mesic/Hydric Riparian Community includes the vegetation along the intermittent or perennially wet portions of the Agua Fria River corridor. It includes woody vegetation as well as the herbaceous vegetation associated with the ponded areas. This community is a combination of the vegetation

communities classified by the USFWS as palustrine emergent, scrub-shrub, and riparian wetland (Cowardin et al., 1979). The vegetation communities associated with the mesic/hydric portions of the river channel are also included. This community differs from the xeric-riparian community included in the Sonoran Upland Community by the inclusion of more moisture dependent species such as sycamore, cottonwood, and willow. Many of the vegetation species included in this community are considered facultative or obligate wetland species, indicating a high dependence on a near perennial source of moisture. The community normally has a moderate-to-high floristic value, depending on the degree of disturbance.

Historically, the cottonwood/willow riparian community represented the dominant vegetation community along the perennial and intermittent river channels of the southwest. It was located along most of the perennial and intermittent drainages and along some ephemeral channels. The Cottonwood - Willow Association was often the transition zone to the palustrine areas. It provides the highest habitat value of the communities identified along the corridor.

Palustrine emergent communities are perennially wet areas that exhibit vegetation along the shoreline and within the shallow shelves of the open water areas. This emergent vegetation normally exhibits a distinct boundary from the adjacent vegetation community, unless the Cottonwood-Willow Association borders it. The woody vegetation associated with the riparian and scrub-shrub communities have a less distinct boundary-line and are more blended with the edge of the surrounding vegetation community. In most cases, the early level successional vegetation borders the riparian vegetation. In the northern portion of the corridor, the Sonoran Upland Community borders some of the riparian areas. This particular interface (Sonoran to riparian) provides a unique and very limited habitat type.

The Mesic/Hydric Riparian Community is represented in the northernmost portion of the corridor from the New Waddell Dam to below the SR 74 crossing. It is also noted in several areas where near permanent surface discharge outfalls to the Agua Fria channel (i.e., at I-10 at the Papago Diversion Channel), at wastewater treatment facilities, and at sand and gravel mining operations.

Species characteristic of the Mesic/Hydric Riparian Community are listed in Table 3.2-3 on the following page. The outer edges of this community contain many of the species listed in the Early Level Successional and Sonoran Upland Communities.

Commercial/Residential/Disturbed Areas

This vegetation community includes the landscaped species associated with residential and commercial development. For this report, this community includes golf courses, landscape medians, buildings, paved areas, and other areas associated with commercial/residential development. In most cases, the native vegetation community and site topography have been altered. Most of the landscaped areas are irrigated and are maintained.

Many times the landscaped portions of the residential and commercial areas provide satisfactory wildlife habitat. Wildlife usage is normally limited to small mammals, reptiles, and birds, which are attracted to the increased vegetation and moisture. Open water areas are the most attractive landscape

amenity to most wildlife species. Waterfowl commonly use open water areas in fairly urbanized environments. Many golf course communities provide better than average habitat for nocturnal species, which utilize the vegetation, open water, and increased moisture from irrigation during the time the courses are normally not in use.

Table 3.2-3 Mesic/Hydric Riparian Community

Common Name	*Scientific Name*	Comment
Woody Species		
Cottonwood	*Populus fremontii*	Native, co-dominant species of historical community
Willow	*Salix gooddingii* (may be hybridized)	Native, other co-dominant species of historical riparian community
Ironwood	*Olneya tesota*	Native, scattered primarily in northern reach
Seep willow	*Baccharis glutinosa*	Native, Scattered at interface w/other community
Mesquite	*Prosopis* spp.	Native, scattered throughout corridor (T/O)
Salt Cedar	*Tamarix chinensis*	Invasive, dominant in some areas, particularly at confluence with Gila
Desert broom	*Baccharis sarothroides*	Scattered in disturbed areas and along drier margins of community
Herbaceous		
Cattail	*Typha* spp.	Limited to northern upper reach and at scattered point discharge sites, obligate water species
Bulrush	*Scirpus* spp.	Limited to northern upper reach and at scattered point discharge sites, obligate water species
Rush	*Juncus* spp.	Limited to northern upper reach and at scattered point discharge sites, obligate water species
Spike rush	*Eleocharis* spp.	Limited to northern upper reach and at scattered point discharge sites, obligate water species
Reed	*Phragmites* spp.	Noted Glendale Road Bridge site.
Brome	*Bromus* spp.	Scattered

Source: Kimley-Horn, 2001a.

Wetlands Determination

A Jurisdictional Determination report was submitted to the USACE Arizona Field Office in June 2000 for the purpose of taking sediment samples as part of the Agua Fria River Watercourse Master Plan.

Where a wetland area occurred within the confines of the otherwise dry river channel, its boundary was approximated and noted on the aerial photography. Riparian areas or other potentially higher functional value areas were also noted on the aerial photography. The suspected hydrologic source for each wetland/riparian area was also noted, although the delineation process did not differentiate between artificial or natural water sources.

Where ephemeral hydrologic conditions were present, the field evaluation was concerned with establishing an ordinary high water mark as the boundary of the jurisdictional channel. The ordinary high water mark delineation is based on discernable field evidence such as erosion scars, bank definition, sediment deposition, debris flows, vegetation patterns and other field indicators. The aerial photography was utilized to determine overall trends and channel patterns that were combined with the field information to develop a likely ordinary high water mark boundary. Therefore, in some instances an "outer" defined bank was chosen as representing the ordinary high water mark for the channel reach. This approach may result in the inclusion of interfluvial areas within the jurisdictional boundary that otherwise might not be considered jurisdictional under the strictest of field interpretations. Where

the Agua Fria Channel is confined within armored or stabilized banks, the armored bank was noted as the boundary.

Within the restoration project area most of the jurisdictional features were identified as waters of the U.S. by the second method, rather than by the presence of jurisdictional wetlands. Within this area seasonal or perennial wetlands were identified in the three areas where there is significant surface water drainage, i.e., I-10 channel (Papago Diversion Channel), Durango Regional Outfall Channel at Buckeye Road, and AWWTP. Other features were noted in the report such as braided streams, generally downstream of the drainages and an area with evidence of standing water downstream of Durango Regional Outfall Channel.

Harris Environmental Group Reconnaissance Survey

The Harris Environmental Group survey was performed for the specific reach of the restoration project, and focused on the three key areas that had the highest likelihood for restoration.

Agua Fria River Near Interstate 10

This area is regularly disturbed by levee maintenance. The natural channel of the Agua Fria River is wide and flat here, and hence the water flows are shallow. The soil has a large clay component. In the moist areas in and around the channel, camphorweed (*Heterotheca subaxillaris*), amaranth (*Amaranthus* sp.), horseweed (*Conyza canadensis*), and London rocket (*Sisymbrium irio*) were common. The area directly below the I-10 overpass provides habitat for escaped landscape plants (palms and additional unidentified species), as well as problematic exotics such as buffel grass (*Pennisetum ciliare*) and Johnson grass (*Sorghum halapense*). The higher and drier areas that flank the channel are covered in several native and exotic weedy species, such as: tansy mustard (*Descurainia pinnata*), Russian thistle (*Salsola iberica*), and Bermuda grass (*Cynodon dactylon*), as well as four-wing saltbush (*Atriplex canescens*). There also are scattered individuals of mexican paloverde (*Parkinsonia* sp.), mesquite (*Prosopis* sp.), tamarisk (*Tamarix ramossisima*), and eucalyptus (*Eucalyptus* sp.). Table 3.2-4 summarizes the vegetation found at this site.

Table 3.2-4 Vegetation in the Agua Fria River Restoration Project Area

Species	Common Name	Habit	Native/ Exotic	I-10 (Papago Diversion Channel)	Durango Regional Outfall Channel	AWWTP
Amaranthus sp.	Pigweed, amaranth	annual	N	common	NO	NO
Atriplex canescens	four-wing saltbush	shrub	N	higher, drier parts of the site	NO	NO
Avena fatua	wild oat	annual grass	E	not common	NO	NO
Baccharis sarothoides	desert broom	shrub	N	common throughout	common throughout	common throughout
Carex sp.	sedge	perennial	N	NO	NO	small clump in standing water
Centaurea sp.	star thistle	annual	E	scattered individuals	NO	NO
Malva parviflora	cheeseweed	annual	N	NO	NO	scattered
Conyza canadensis	horseweed	annual	N	common	NO	NO

Species	Common Name	Habit	Native/ Exotic	I-10 (Papago Diversion Channel)	Durango Regional Outfall Channel	AWWTP
Cynodon dactylon	Bermuda grass	stoloniferous perennial grass	E	widespread throughout the site, especially in the wet areas	NO	widespread throughout the site, especially in the wet areas
Descurainia pinnata	tansy mustard	annual	N	extensive areas at the higher, drier parts of this site	NO	NO
Echinochola colona	junglerice	annual grass	E	Not common	NO	NO
Eleagnus angustifolia	Russian olive	tree	E	NO	NO	growing with athel trees
Eucalyptus sp.		tree	E	scattered individuals	NO	scattered individuals
Euphorbia prostrata	groundfig spurge	annual	N	common	NO	NO
Helianthus annuus	common sunflower	annual	N	scattered individuals	NO	NO
Heteotheca subaxillaris	camphorweed	tall coarse annual or biennial	E	Wet areas	NO	Wet areas
Lepidium sp.	peppergrass	annual	N	common	NO	NO
Isocoma acradenia	pale-leaf goldenweed	shrub	N	NO	dry areas	dry areas surrounding ponds
Nicotiana glauca	tree tobacco	tree	E	NO	adjacent to drainage	provides mid-structure at pond area
Pappophorum mucronulatum	pappus grass	perennial bunch grass	N	Not common	NO	NO
Parkinsonia aculeate	Mexican paloverde	tree	E	escapee from landscaping	escapee from landscaping	NO
Parkinsonia floridum	blue paloverde	tree	N	NO	NO	scattered individuals
Pennisetum ciliare	buffel grass	perennial bunch grass	E	beneath bridge	beneath bridge	NO
Physalis sp.	ground cherry	perennial	N	not common	NO	NO
Prosopis sp.	Mesquite	tree	N/E	scattered individuals	scattered individuals	NO
Salsola iberica	Russian thistle, tumbleweed	shrub-like annual	E	scattered at this site	scattered at this site	scattered at this site
Sisymbrium iro	London rocket	annual	E	common in wetter areas	NO	common in wetter areas
Solanum eleagnifolium	silverleaf nightshade	annual	N	NO	NO	scattered
Sorghum halapense	Johnson grass	vigorous perennial grass	E	areas that remain wet	NO	NO
Tamarix aphylla	athel tree	large tree	E	NO	NO	surrounding standing water, these are the tallest trees at the site
Tamarix ramossisima	tamarisk, salt cedar	shrub	E	widespread	widespread	NO
Typha latifolia	cattail	perennial	N	NO	NO	standing water
Xanthium strumarium	cocklebur	annual	N	not common	NO	NO

NO: Not observed.
Source: HEG, 2001.

Agua Fria River Near the Union Pacific Railroad Crossing and Durango Regional Outfall Channel

The dry channel of the Agua Fria is very flat and wide at this site, similar to that found at the I-10 site. The channel is scattered with tamarisk, desert broom (*Baccharis sarothoides*), and mexican paloverde.

There is a population of buffel grass at the base of the steep cement levee. The area is heavily disturbed with off-road vehicle use. Table 3.2-4 summarizes the vegetation found at this location.

Agua Fria River near the Avondale Wastewater Treatment Plant

This site has permanent standing water surrounded by a thick grove of athel trees (*Tamarix aphylla*), Russian olive (*Eleagnus angustifolia*), and other vegetation that provide a multi-layer canopy for wildlife habitat. The area is surrounded by agricultural fields and a gravel mine. The athel tree is different from the shrub-form tamarisk (*Tamarix ramossisima*), which is also scattered throughout this site. Although the athel tree does produce flowers, it does not produce viable seeds. It can, however, spread vegetatively. The exotic athel trees have replaced the large native riparian trees such as cottonwood, sycamore, and net-leaf hackberry that might be expected at this site. Exotic eucalyptus trees supplement the canopy of Russian olive and athel trees, and there is a middle layer of tree tobacco and desert broom. Pale-leaf goldenweed provides shrub cover, and the perimeter of the pond is fringed with cattails and sedges. The soil at the AWWTP site is sandier that at the I-10 site. Table 3.2-4 summarizes the vegetation at this location.

3.2.2.3 *Vegetation Patterns within the Restoration Project Area*

All five of the vegetation types identified in the Kimley-Horn survey exist within and adjacent to the restoration project area. However, as also noted in their report it is hard to delineate boundaries for native vegetation types because of natural gradients in environmental characteristics as well as the influence that disturbance and introduction of non-native species has on diluting native plant community characteristics. Figure 4 provides a general delineation of vegetation types within the project area utilizing 2001 aerial photos and the plant community types identified by the Kimley-Horn survey. Several important observations can be made from the photos and field observations:

- Gradient control structures (Figure 4) have an effect on near surface water retention and hence, vegetation cover. Within the project area there are two gradient control structures: the "first gradient control structure" is located approximately 650 feet downstream of I-10; and the "second gradient control structure" is located about 2000 feet upstream of Buckeye Road and the Durango Regional Outfall Channel. Vegetation cover is greatest in the area upstream of the first structure, which in part helps to retain surface runoff from the I-10 outfall (i.e., > 100 percent in some areas for all strata, but generally approximately 30 to 60 percent). Between the first and second gradient control structure vegetation cover is diminished (i.e., estimated at 15 to 50 percent), but is greater than the area immediately down stream. Between the first and second grade control structure, cover is dominated by buffel grass. Immediately below the second grade control structure, vegetation cover is the lowest.
- Vegetation established near the I-10 outfall and the MC-85 outfall (Durango Regional Outfall Channel) has persisted historically (see Figure 3) and the low flow channels created by these outfalls are resistant to frequent flood events.
- In the lower portion of the Agua Fria River shallow groundwater becomes an important factor in sustaining higher vegetation cover over a more extensive area.
- Non-native vegetation has a strong influence on plant community characteristics and its dominance is perpetuated by continual disturbance directly in the channel as well as indirectly from surrounding land uses.
- Most vegetation within the Agua Fria River can be classified as Sonoran upland and within bursage, desert broom or saltbush series, and hydric/mesic riparian woodland and Sonoran riparian scrubland.

The following is a description of vegetation types or plant communities that are associated with the project area.

Upper Sonoran Desert Scrub

The flora of the Sonoran Desert is derived from subtropical elements to the south, residual influences and is a result and indicators of regional shifts in climate. Over time, drastic reductions in winter rainfall produced more arid conditions and a shift from woodland to desert; however, the bimodal rainfall in the Sonoran Desert allows for sustains greater diversity than in other deserts of the southwest. High temperatures and low precipitation determine that plant growth be open and simple. The same species may be found in the drainage ways as in the interfluves or upland areas, but physiognomy may be different. Soil conditions may be variable depending on physical processes, including extensive areas of densely packed pebbles known as "desert pavement," sand and gravel alluvium (such as that found in the Agua Fria channel) or clay lenses. Conditions are generally alkaline; however, the level of salts, cations and ions in the surface soil depends on precipitation, hydrology and infiltration rates. Plant species associated with this community are adapted to extended periods of drought and have developed strategies to take advantage of limited water availability (Brown, 1994; Robichaux, 1999).

Sonoran Riparian Scrubland – Mesic/Xeric

In and along drainages within the Sonoran Desert are scrublands of low to medium height (1.5 to 3.0 m), too dense to be considered desertscrub or strand (see above). Although these scrublands usually contain plant species also found in adjacent desertscrub (e.g., *Lycium brevipes*, *Acacia greggii*, *Celtis pallida*), the actual stream channel dominants are usually distinctive riparian species. Seepwillow (*Baccharis salicifolia*) is abundant nearest water, with desert broom (*B. sarothroides)* in drier places. Arrow weeds and burrobrush may dominate on sandy soils. These and other evergreen shrubs have adapted to successional situations as befits their restricted occurrence to flood-prone areas. Along the saline portions of the lower Colorado and Gila rivers are dense and taller "thickets" of introduced salt cedar and the evergreen athel tamarisk (*Tamarix aphylla*). In the less disturbed sites, these may be accompanied by native screwbean mesquite or western honey mesquite. The species list may overlap with the upper Sonoran desertscrub and mesic/xeric Sonoran riparian woodland described below, but has different physiognomic characteristics (e.g., structure and density intermediate of the two). The value of these thickets is well known, and such places often support a high density of birds and small mammals (Brown, 1994).

Sonoran Riparian Woodlands – Mesic/Xeric

Desert riparian communities are diverse, but generally defined by their distance from the water source (depth to ground water and distance from the drainage), as well as the type of surface flow within the drainage (perennial, intermittent or ephemeral). One example of a desert riparian community is the mesquite bosque (bosque is Spanish for woodland), which are winter deciduous woodlands that attain their maximum development on alluvium of old dissected floodplains, especially those laid down at the

confluence of major watercourses and their larger tributaries (Brown, 1994). While there are no mesquite bosques in the project area, the species itself present an environmental condition suggesting potential historical occurrence.

Bosques are formed primarily along perennial to ephemeral streams at elevations below 1200 m elevation (Brown, 1982) and have greatest development at the confluence of rivers and long floodplains of large rivers with low gradient (0.004±0.001 m/m) that flow through wide, unconstrained valleys. Mesquites are commonly found 5 to 20 feet (1.5 to 6.0 m) above the river channel. Mesquite generally cannot reach water much below 46 feet (14 m), but have been known to reach up to 60 feet. Velvet mesquite (*Prosopis velutina*) is the typical mesquite that forms bosques, because it is the only species to reach heights greater than 35 feet (15 m) (Brown, 1994). Most bosques are composed of high densities (200-800/ha) of young or second growth, multi-trunked trees, with overstory cover ranging from 55 to 94 percent.

In general, mesquite bosques owe their existence to shallow alluvial water tables. Mesquite trees are facultative phreatophytes. Although mesquite has deep roots and tolerate some water stress, lowering of the water table below 49 ft (15 m) can result in the death of a mesquite tree or cause conversion from tree to shrub form. Water table decline from groundwater pumping has caused reduced leaf size and high levels of canopy mortality in the bosque along Tanque Verde Creek in Tucson (Stromberg, Tress et al., 1992).

Sonoran Riparian Woodlands and Wetlands - Hydric

The cottonwood/willow community is the most commonly recognized riparian community in the Sonoran Desert, perhaps because of its symbolic association with pre-development conditions along Arizona's formerly perennial streams. It is restricted to the immediate floodplains of perennial streams (Brown, 1994). The cottonwoods (*Populus fremontii*) and willows (*Salix gooddingii, S. exigua*), for which the community is named, make up a large percentage of the cover of overstory species in mature woodlands. Other important components in this community include ash (*Fraxinus velutina*) and elderberry (*Sambucus mexicana*) in mesic areas, and a variety of mesquite (*P. velutina*, *P. torryana* and *P. pubescens*) in the drier areas. In Arizona, these forests often occur along floodplains of large, low-gradient, perennial streams (usually below 1250 m elevation) in wide, unconstrained valleys. Optimal conditions for forest development are long depositional environments where fine-grained alluvial substrates are present in the floodplain. Such streams often have multiple historic and/or active channels, which undergo continual lateral adjustment, as they meander and form new alignments (Stromberg, 1993). They often occur with other riparian types, including: (1) Sonoran riparian scrubland (riparian plant community dominated by small bushy trees, shrubs and herbaceous plants), dominated by seepwillow (*Baccharis salicifolia*), burro brush (*Hymenoclea* spp.), arrow weed (*Tessaria sericea*), seepweed (*Suaeda torreyana*), or saltbush (*Atriplex* spp.); and (2) Sonoran riparian mesquite (*Prosopis* spp.) bosque (Brown, 1994).

3.2.3 Wildlife

3.2.3.1 *General Description*

The riparian, wetland and outwash plant communities along the flowage easements of the Agua Fria River provide a diversity of habitats suitable for wildlife. Different growth forms within these plant communities—such as trees, shrubs, and herbs—serve to increase the number of feeding, roosting, and nesting niches available to wildlife. Adjacent agricultural fields provide an additional food source. Wildlife that would be located in the project area include amphibians and reptiles, such as toads, snakes and lizards; numerous birds; and mammals, such as bats, skunks, rodents, jackrabbits and coyotes (USACE, 1986). A more extensive wildlife description is given below.

Wildlife populations along the river channels in the study area are variable in size. Because of sand and gravel mining operations, these reaches contain the most highly disturbed vegetation in the study area. Off-road vehicle use and illegal trash dumping have also contributed to habitat degradation in the channel area. Urbanization and agricultural conversion has removed nearly all wildlife habitat located on the flood plains. Nevertheless, remaining habitats may support fairly diverse wildlife populations.

3.2.3.2 *Wildlife Survey*

A field reconnaissance along the Agua Fria River corridor was conducted by Kimley-Horn & Associates to identify wildlife usage patterns and evaluate habitat potential (Kimley-Horn & Associates, 2001a). The field visits were conducted in late December, early January, early March, early June, and late September in early morning or late afternoon (some of the December surveys were all day). The field reconnaissance was timed as a function of seasonal variation in wildlife usage patterns and habitat development. The field reconnaissance included pedestrian meander transects, blind surveys, and identification of animal sign.

The resulting species list was modified to exclude wildlife found only in the upper or northern reaches of the Agua Fria River. Table 3.2-5 summarizes the results of the field reconnaissance conducted for the wildlife survey, as modified for the boundaries of this project.

Table 3.2-5 Agua Fria River Corridor Wildlife Population*

Common Name	Scientific Name	Comment
	Reptiles	
Western diamondback rattlesnake	*Crotalus atrox*	Single sightings in northern most and southern most areas. Possible resident throughout corridor (T/O)
Garter Snake	*Thamnophis marcianus*	Sighted in Lower Reach. Likely a resident T/O
Western banded gecko	*Coleonyx variegatus*	Sighted Upper and Lower Reaches. Resident
Whiptail lizard	*Cnemidophorus* spp.	Sighted T/O corridor. Resident
	Amphibians	
Lowland leopard frog	*Rana yavapaiensis*	Sighted at George's Pond and Gila Confluence. Resident in noted areas – Open water obligate
Bullfrog	*Rana catesbeinana*	Vocalizations at Upper Reach and Gila Confluence – Open water obligate. Non native.
	Birds	
Mourning dove	*Zenaida asiatica*	Sighted T/O corridor. Nest T/O. Resident
Red-tailed hawk	*Buteo borealis calurus*	Sighted T/O corridor. Active nest in northern portion. Resident
Swainson's hawk	*Buteo swainsoni*	Pair sighted in Upper Reach, nest in Lower Reach. Likely Resident.
Western meadowlark	*Sturnella neglecta*	Sighted Upper and Lower Reaches. Resident
Pyrrhuloxia	*Cardinalis sinuatus*	Sighted T/O Upper Reach. Resident

Common Name	Scientific Name	Comment
Western mockingbird	*Mimus polyglottos leucopterus*	Sighted T/O. Resident
Sparrows	*Passer* spp.	Sighted T/O. Resident
Killdeer	*Charadrius vociferus*	Sighted in Upper and Lower reaches
Great blue heron	*Ardea herodias*	Sighted nesting at Gila confluence (Lower Reach) – Open water obligate – Historical Records (1930s) note a 60 bird rookery south of Avondale, AZ on the Gila River
White-faced ibis	*Plegadis chihi*	Sighted at confluence w/ Gila River (Lower Reach) – Open water obligate
		Mammals
Coyote	*Canis latrans*	Sighted/tracks/den Upper and Lower Reaches. Resident
Raccoon	*Procyon lotor*	Sighted and tracks T/O corridor. Resident
Black-tailed jackrabbit	*Lepus californicus*	T/O corridor. Resident
Mouse	*Peromyscus* and *Perognathus* spp.	Never sighted. Numerous burrows, scat, tracks T/O. Assumed Resident
Desert cottontail	*Sylvilagus auduboni*	Sighted T/O. Resident

Source: Kimley-Horn, 2001a
T/O: Throughout
* Wildlife excluded from this list because they were not sighted within the study area and identified only in the middle and upper reaches of the river include: desert spiny lizard, roadrunner, cactus wren, Gambel's quail, screech owl, curved bill thrasher, Gila woodpecker, hummingbirds, kit fox, California myotis, peccary, bobcat, and kangaroo rat.

3.2.4 Special Status Species

Previous Findings

In 1978, when the USFWS issued its Coordination Act Report (CAR) for the flood control project, they did not identify any Federal or State threatened or endangered species that were observed or known to occur within the Agua Fria River portion of the project. However, the Yuma clapper rail (*Rallus longirostris yumanensis*) was cited as potentially nesting in the wetland areas. The blue palo verde (*Parkinsonia floridum*) and the honey mesquite (*Prosopsis julifora*) are native plant species that occur in the restoration project area and that are protected by the State of Arizona (1981 Arizona Native Plant Law: Arizona Revised Statutes, Chapter 7).

Current Findings

According to the 2002 U.S. Fish and Wildlife Service Coordination Act Report for this project, there are no special status species that are known to occur in the study area (USFWS, 2002). However, according to this report, habitats near the confluence of the Agua Fria River with the Gila River may provide nesting, roosting or foraging opportunities for the endangered Yuma clapper rail (*Rallus longirostris yumanensis*), southwestern willow flycatcher (*Empidonax traillii extimus*), and cactus ferruginous pygmy-owl (*Glaucidium brasilianum cactorum*), or the candidate yellow-billed cuckoo (*Coccyzus americanus occidentalis*) (USFWS, 2002). Native plant species such as Fremont cottonwood are also of special concern (Frank Baucom, pers. comm., 2001; USFWS, 2002).

An updated evaluation of the 1978 USFWS CAR report of special status species potentially present along the Agua Fria River was completed from USFWS and Arizona Game and Fish Department (AGFD) databases by Kimley-Horn (2001a). Special status species include Federally threatened or endangered species listed under the Endangered Species Act (ESA), and species that are considered at risk by other agencies or organizations because of habitat loss or other threats to their populations and may be subject to special management requirements or limitations by these entities.

Protected species that exist or may potentially exist in or near the Agua Fria River are identified in Table 3.2-6. Table 3.2-6 lists the common and scientific name, the protection status, and comments about critical habitat designation, special circumstances, or other pertinent information that the survey found, as modified for the boundaries of the Agua Fria Riparian Restoration Project (e.g., protected species found outside the study area were removed). The table also notes residency and potential habitat within the corridor. Species listed as threatened or endangered under the ESA are in bold.

None of the species listed in Table 3.2-6 that are protected by the AGFD or USFWS were sighted during field surveys conducted by Kimley-Horn in 2000 or Harris Environmental Group in 2001, nor was evidence of residency identified (field sign—such as nests, tracks, scat, etc). However, the black necked stilt, a U.S. National Forest Service sensitive species, was observed at the Durango Regional Outfall Channel restoration site (MCDOT, 2000). Based on recent historical surveys, and some surveys in the Gila River, some of the waterfowl cited in Table 3.2-6 could be present in the open water and wetland areas around the AWWTP. Native mesquite and paloverde are also protected under Arizona's native plant law. Portions of the Gila/Agua Fria River confluence contain closed canopy dense stands of tamarisk that are potential southwestern willow flycatcher habitat. These areas may also provide suitable habitat for the Yuma clapper rail. Historical records indicate clapper rails in the general area in the early 1970s. If restoration activities are planned at either the Durango Regional Outfall Channel or the river confluence, the Arizona Game and Fish Department and the Arizona Field Office of the USFWS should be contacted to determine if protocol specific surveys are needed.

The bald eagle may be a transient species throughout the Agua Fria River study area and potential nesting habitat is noted along the corridor (Kimley-Horn, 2001a. If activity is planned within potential habitat areas, a pre-construction field reconnaissance should be conducted to verify nesting activity.

Table 3.2-6 Special Status Species that May Potentially Occur within the Restoration Project Area

Common Name	Scientific Name	Protection Status	Study Corridor Habitat Status	Comment/Likelihood of Occurrence
Avian				
Bald eagle	*Haliaeetus leucocephalus*	ESA- Threatened	Nesting habitat throughout corridor (T/O), most prevalent in northern portion	On ESA delisting track
Black necked stilt	*Himantopus mexicanus*	Forest – S	Grassy marshes, mudflats, pools, and shallow lakes	Observed near Durango Regional Outfall Channel restoration site (MCDOT 2000)
Western burrowing owl	*Athene cunicularia hypugea*	ESA – SC BLM – S WCSA –WC	Lower and Middle Reaches, Open Areas	None sighted, likely resident
Cattus ferruginous pygmy-owl	*Glaucidium brasilianum cactorum*	ESA - SC	Dense desert scrub	Observed outside project area
Great egret	*Ardea alba*	WSCA –SC	Upper and Lower Reach, Open Water	Rookery nester
Snowy egret	*Egretta thula*	WSCA – WC		
Southwestern willow flycatcher	*Empidonax trailli extimus*	ESA – Endangered	Potential habitat at Gila confluence and at George's pond	Coordinate w/USFWS and AGFD for survey requirements
Yuma clapper rail	*Rallus longirostris yumanensis*	ESA – Endangered	Potential at Gila River. Marginal at George's pond	Coordinate w/USFWS and AGFD for survey requirements
Western snowy plover	*Charadrius alexandrinus nivosus*	Forest –S WSCA – WC	Northern Upper and Gila River, Shorelines	Migrant
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	Forest –S WSCA – WC	Upper and Lower Reaches, Riparian	Parasitic Nester Migrant. Reported by AGFD within five miles of project area; may forage in area
Black-bellied whistling-duck	*Dendrocygna autumnalis*	WSCA –WC	Northern Upper and Gila River, Open Water	
Fulvous whistling duck	*Dendrocygna bicolor*	ESA – SC BLM –S	Northern Upper and Gila, Open Water/Marsh	
Mississippi kite	*Ictinia mississippiensis*	WSCA – WC	Possible T/O	Extreme western edge of range
western least bittern	*Ixobrychus exilis hesperis*	ESA – SC WSCA – WC	Northern Upper and Gila, marshes	Reported by AGFD within five miles of project area
black hawk	*Buteogallus anthracinus*	Forest – S WSCA – SC	Northern Upper and Gila, Riparian	
Mammals				
Lesser long-nosed bat	*Leptonycteris curasoae yerbabuenae*	E	Migratory species that occurs as summer resident in desert scrub habitats in southeastern and central Arizona	Project site out of known geographical range, no possible roosting sites or foraging resources
Western red bat	*Lasiurus blossevillii*	WSCA – WC	Marginal northern Upper Reach and Gila	Scattered reports in County. Summer resident only
Cave myotis	*Myotis velifer*	ESA –SC BLM – S	All Reaches, best in Upper, Desert scrub	Will nest under bridges. Sighted in Middle Reach
Yuma myotis	*Myotis yumanensis*	ESA – SC	Upper and Gila (water obligate for insects)	Likely winter migrant
Fish				
Desert pupfish	*Cyprinodon macularius*	ESA – Endangered	Lower Gila River	Reintroduced in four locations
Longfin dace	*Agosia chrysogaster*	ESA – SC BLM – S	Gila River basin	Adapted to flash flood prone waters
Desert (Gila Mountain) sucker	*Catostomus clarki*	ESA – SC BLM – S	Gila River basin	

Common Name	Scientific Name	Protection Status	Study Corridor Habitat Status	Comment/Likelihood of Occurrence
Sonora (Gila) sucker	*Catostomus insignis*	ESA – SC BLM – S	Gila River basin	
Bonytail chub	*Gila elegans*	ESA – Endangered WSCA – WC	Gila River basin	Extirpated from Gila River
Gila topminnow	*Poeciliopsis occidentalis occidentalis*	ESA – Endangered	Gila River	Currently limited to 7 natural sites
Razorback sucker	*Xyrauchen texanus*	ESA – Endangered	Extirpated from Gila River basin, Gila River is suitable habitat	Critical habit designated, re-introduced in Gila and Salt?
Insects				
Maricopa tiger beetle	*Cicindela oregona maricopa*	ESA – SC BLM – S Forest –S		
Squaw peak talussnail	*Sonorella allynsmithi*	ESA – SC Forest –S		
Herptofauna				
Great Plains narrowmouth toad	*Gastrophryne olivacea*	WSCA – WC	Potential Habitat Present (Open water areas surrounded by creosote/mesquite etc)	Very secretive species. Diet is almost exclusively ants. Unlikely resident
Arizona toad	*Bufo microscaphus microscaphus*	ESA-SC Forest –Sensitive	Potential Habitat Present (Permanent ponds, rock bottomed creeks)	Also called Southwestern toad. Known in Gila River drainage.
Lowland leopard frog	*Rana yavapaiensis*	ESA –SC Forest – S WSCA – WC	Habitat Present (Deep pools along streams/rivers)	Known in Gila River
Redback whiptail	*Cnemidophorus burti xanthonotus*	ESA – SC BLM – S Forest – S	Potential Habitat	Positive identification difficult
Arizona skink	*Eumeces gilberti arizonensis*	ESA – SC BLM – S Forest – S WSCA – WC		
Sonoran desert tortoise	*Gopherus agassizii* (Sonoran Population)	ESA –SC WSCA –WC	Potential Habitat	AGFD recommended Survey and Handling Guidelines
Maricopa leafnose snake	*Phyllorhynchus browni lucidus*	Forest – SC		
Mexican garter snake	*Thamnophis eques megalops*	ESA –SC Forest – S WSCA – WC	Habitat present (Dense vegetation surrounding water)	Historical records in Gila River
Desert rosy boa	*Charina trivirgata gracia*	ESA –SC BLM – S Forest –S		
Plants				
Ironwood	*Olneya tesota*	State identified	Scattered species in all three reaches. Most evident Upper Reach	No official status Task Force formed to devise management
Tonto basin agave	*Agave delamateri*	ESA – SC Forest – S NPL – HS	Minimal Habitat Present	Possible Scattered Occurrence
Hohokam agave	*Agave murpheyi*	ESA – SC BLM – S Forest – S	Minimal Habitat Present	Possible Scattered Occurrence

Common Name	*Scientific Name*	Protection Status	Study Corridor Habitat Status	Comment/Likelihood of Occurrence
		NPL – HS		
Toumey agave	*Agave toumeyana* var. *Bella*	NPL – SR	Minimal Habitat Present	Possible Scattered Occurrence
Flannel bush	*Fremontodendron californicum*	BLM – S NPL – SR		
Varied fishhook cactus	*Mammillaria viridiflora*	NPL – SR	Habitat present. Species noted in all three reaches	Salvage where practical
Straw-top cholla	*Opuntia echinocarpa*	NPL – SR	Habitat Present (Xeric sand and gravel areas)	
Fish creek rock daisy	*Perityle saxicola*	ESA –SC Forest – S	Habitat Present (Dry rock slopes/washes)	
Tumamoc globeberry	*Tumamoca macdougalii*	BLM – S Forest – S		
Arizona rosewood	*Vauquelinia californica* ssp. *sonorensis*	ESA – SC BLM – S Forest – S	Potential habitat (Requires desert paloverde/cacti, creosote/bursage)	Outside of current range
Listed Habitats				
Wetlands. Perennial streams, riparian areas	*N/A*	Arizona Recommendation Considered Resource Category I	Northern most Upper Reach, Southern Most Lower Reach	No loss of existing habitat value. Conserve areas, recharge groundwater, manage for ecosystem

ESA – Threatened listed under the Endangered Species Act (ESA) as threatened, with imminent jeopardy of becoming endangered. Regulation prohibits taking or in some instances impacts to habitat without permit and mitigation (protection status similar to endangered)
ESA – Endangered listed under the Endangered Species Act (ESA) as endangered, with imminent jeopardy of extinction. Regulation prohibits taking or in some instances impacts to habitat without permit and mitigation
ESA – SC listed under the Endangered Species Act (ESA) as species of concern. The USFWS has concerns about their conservation status. They are former C2 species and do not have a regulatory status.
ESA – C candidate species, ready for listing
BLM – S Species listed by the Bureau of Land Management as sensitive species and might have special management requirements.
Forest – S US Forest Service listing for species considered sensitive by Regional Forester. Most have management requirements.
WSCA – WC, Wildlife of Special Concern in Arizona. Species indicated as WC are currently the same as those listed as Threatened Native Wildlife in Arizona. AGFD has established management guidelines for many of these species.
NPL – HS, Arizona Native Plant Law - Highly Sensitive. No collection allowed. Does not prohibit removal, requires opportunity to salvage.
NPL – SR, Arizona Native Plant Law - Salvage Restricted Collection permit required. Does not prohibit removal, requires opportunity to salvage
Source: Kimley-Horn & Associates 2001a

Description of Special Status Wildlife Species

The following is a brief description of the special status wildlife species that are most likely to use, or be present within the project reach.

Southwestern Willow Flycatcher. An uncommon summer resident in Arizona and adjacent states, the southwestern willow flycatcher *(Empidonax trailii extimus)* is a Federally listed endangered species. In Arizona, the southwestern willow flycatcher breeds very locally along the Colorado River, the Alamo Lake area, at the headwaters of the Little Colorado and San Francisco rivers, along the middle of the Verde River, at Roosevelt Lake, and along the middle Gila and San Pedro rivers.

In Arizona, the southwestern willow flycatcher is found principally in dense willow, cottonwood, and tamarisk thickets and woodlands along streams and rivers, and pure, streamside stands of Geyer willow. Southwestern willow flycatchers typically arrive in suitable breeding habitat between late April and mid-May. The flycatcher has one or more territories within a home range during the breeding season. Although territory size varies considerably, flycatchers are generally found in habitat patches ranging from 1.2 to 2.7 acres in size.

Western Yellow-billed Cuckoo. The western yellow-billed cuckoo *(Coccyzus americanus occidentalis),* a Federal candidate species and a wildlife species of concern in Arizona, is relatively widespread, occurring in the southern, central, and extreme northeastern portion of the State. This species is most common along the San Pedro River, which is imperiled but still contains extensive riparian forests. A small number of birds can be found at the Bill Williams River delta and along the Gila River.

It prefers open woodland with clearings and low, dense, scrubby vegetation, often associated with watercourses. In Arizona, the western yellow-billed cuckoo uses desert riparian woodlands comprised of open-canopied Fremont cottonwood, willow groves, and large mesquite bosques for migrating and breeding.

Yuma Clapper Rail. The Yuma clapper rail *(Rallus longirostris yumanensis)* is a Federally endangered species and a wildlife species of concern in Arizona. It occupies a narrow range of habitats that include tall cattails and bulrushes along the margins of shallow, stable ponds of freshwater marshes. In Arizona, the Yuma clapper rail is known from a few scattered locations in freshwater marshes along the lower Gila River and along the Colorado River from Mojave Valley, Arizona southward.

Yuma clapper rails feed on crayfish, small fish, clams, isopods, and a variety of insects. They remain on their breeding grounds in Arizona from mid-April to mid-September, when they migrate south to Mexico for the winter.

3.2.5 Local Restoration Projects

The following restoration projects, regional parks or preserved areas along the Gila River all serve to reverse the serious habitat fragmentation, degradation and loss of riparian, wetland and aquatic habitat

that has occurred within Arizona. The Agua Fria ecosystem restoration project is compatible with these efforts. The following is a brief description of compatible restoration projects in the area.

Casey Abbot Recreation Area. Located near the confluence of the Gila River, this has been designated as open space by the City of Phoenix.

Tres Ríos Demonstration Constructed Treatment Wetland Project. This project consists of approximately 12 acres of emergent marsh, and free-water wetlands, and is located adjacent to and within the confines of the 91st Avenue Wastewater Treatment Plant. There are currently three operational wetlands sites: Cobble (4 acres), Hayfield (6 acres), and the Research Cells (1 acre). The formal Demonstration Project is a $3.6 million dollar study funded by the City of Phoenix/ Sub-Regional Multi-Cities Operating Group (SROG), U.S. Bureau of Reclamation (BOR), U.S. Environmental Protection Agency (EPA), Army Corps of Engineers, the Arizona Department of Water Resources (ADWR), and Arizona Game and Fish (AGFD) with three primary objectives:

- Determine if wetland systems can polish pre-treated wastewater to a level that would meet perceived future discharge requirements.
- Develop scale-up parameters for an approximately 800 acre full-scale system.
- Determine the net environmental benefit such a system and associated riparian habitat would have in the Salt/Gila, and Agua Fria River area.

This project can provide useful information on the use of treated water for habitat improvement. Along with the restoration project, it helps to contribute to overall habitat resources within the Gila and Agua Fria Rivers.

Tres Ríos Ecosystem Restoration Project. The purpose of this feasibility study is to investigate and recommend appropriate solutions to accomplish ecosystem restoration in the Tres Ríos study area. In developing these solutions attention would be given to reducing flood damages to surrounding developed and agricultural areas, providing additional water supply for municipal, industrial and agricultural purposes, and offering recreational opportunities consistent with maintaining a healthy ecosystem.

3.3 WATER RESOURCES

3.3.1 Regulatory Setting

Clean Water Act (CWA) - The CWA, a 1977 amendment to the Federal Water Pollution Control Act of 1972, is the primary Federal law that protects our nation's waters, including lakes, rivers, aquifers and coastal areas. Its main objective is to restore and maintain the chemical, physical, and biological integrity of the nation's waters. Under the CWA, discharges into waters of the United States are regulated through the National Pollutant Discharge Elimination System (NPDES) program. The NPDES program regulates point sources and storm water into waters of the United States, but not other discharges, such as dredged or fill material.

Three Sections of the Act are applicable to this project.

Section 401 of the Act requires that any activity that requires a Federal permit, license, or approval and may result in a discharge into a water body must be certified by the State regulatory agency. This certification ensures that the proposed activity will not violate State and Federal water quality standards. Section 404 dredge and fill permits and Section 402 (NPDES) permits are the most common actions requiring Clean Water Act Section 401 certification in Arizona.

The purpose of the law is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. Clean Water Act Section 401 requires a review of Federal permits, actions, and approvals that may result in a discharge to waters of the State (including wetlands and many washes) to ensure compliance with State water quality standards.

The Arizona Department of Environmental Quality is responsible for Section 401 State water quality certification of Federal permits, such as Sections 404 and 402. EPA issues water quality certification on tribal lands in Arizona.[6]

Section 402 of the Act requires that owners/operators of construction sites where one or more acres of land will be graded or disturbed must apply for coverage under EPA's General Permit for storm water discharges associated with construction activities. EPA Region IX (in San Francisco) administers the NPDES program because Arizona is one of six states not authorized to implement their own program. Arizona is in the process of obtaining State authorization.

The application of the NPDES program to construction activities is to improve water quality by establishing a permit system to reduce erosion potential, minimize sedimentation, and eliminate non-stormwater discharges from construction sites. A project cannot be phased to avoid permit compliance or application for a permit. With respect to the application of aquatic herbicides, an AZPDES permit is not required for application of aquatic pesticides/herbicides in Arizona. To date, the Arizona Department of Environmental Quality has not finalized a general permit for this and there are no immediate plans to do so. The ADEQ assumes however, that herbicides will be applied by a licensed applicator in accordance with the label requirements and that herbicides be FIFRA-approved for aquatic use (Varga, pers. comm., 2004).

Section 404 of the Clean Water Act regulates the discharge of dredged or fill materials into the waters of the United States, including rivers, streams, and wetlands. The USACE administers the Section 404 permit program. In the case of projects such as this that are undertaken by the USACE and that include activities regulated by Section 404, an evaluation is completed to demonstrate compliance; the USACE does not issue itself a permit. However, the local sponsor is issued a permit to maintain the project after it has been constructed. See Appendix D for the Section 404(b)(1) evaluation.

[6] The Ninth Circuit Court of Appeals in Defenders of Wildlife v. EPA vacated EPA's delegation of authority to AZ to issue 402 permits. However, pending further action by the Ninth Circuit Court responding to EPA's request for a rehearing, EPA still considers AZ program to remain in effect. Depending upon the decision of the Ninth Circuit on the motion for rehearing, the issuance of Section 402 permits may go back to the EPA.

Executive Orders 11988 and 11990, Floodplain Management and Protection of Wetlands, respectively - These Executive Orders require Federal agencies to provide leadership to protect the natural and beneficial values served by floodplains and wetlands. Federal agencies are directed to avoid development in floodplains where possible, and to minimize the destruction or degradation of wetlands.

River and Harbors Act of 1899 - The Rivers and Harbors Acts address projects and activities in navigable waters and harbor and river improvements. Section 10 of this Act (33 U.S.C. 403) prohibits the unauthorized obstruction or alteration of any navigable water of the United States. In Arizona, Section 10 only applies to the Colorado River and is therefore, not applicable to this project.

State of Arizona, Groundwater Management Act - To address the over-drafting of Arizona's groundwater supplies, the Arizona State Legislature passed the Groundwater Management Act in 1980. The Groundwater Management Act specified areas that are depleting groundwater resources to be designated as Active Management Areas or AMAs. The Phoenix metropolitan area and four other areas with severe groundwater overdraft fall into these categories. The goal of the Phoenix AMA is to reach Safe Yield by 2025. Safe Yield is defined as the hydrologic concept of achieving and maintaining a long-term balance between the annual amount of groundwater withdrawn in an AMA and the annual amount of natural and artificial recharge in the AMA. The Groundwater Management Act divided the time period between 1980 and 2025 into five intervals. Each interval has an associated Management Plan that will incrementally move the Phoenix AMA into Safe Yield. All large municipal providers (e.g., City of Avondale) within the Phoenix Active Management Area must comply with reducing groundwater use and achieving Safe Yield (Avondale, 2002a. Refer to Section 3.3.2.2 for more information on the Phoenix AMA.

3.3.2 Groundwater

This section reviews information obtained from a number of sources: USACE, FCDMC, USGS, ADWR, City of Avondale, Salt River Project and the Buckeye Irrigation District. These sources of information have been used to compile a general picture of hydro geologic and groundwater conditions in the project area for the purpose of assessing the quantity and quality of groundwater resources available for restoration efforts under existing and future with project conditions. A definitive groundwater study directly applicable to the restoration project area has not yet been identified from these sources; therefore, site specific investigations on this subject will be continued in the plans and specifications phase of study. Given that the restoration alternatives assume the pumping and use of groundwater, quantitative data on ground water supplies and pumping rates will need to document current and future groundwater conditions within the restoration project area.

3.3.2.1 *General Aquifer Description and Trends*

Along the Agua Fria River, depth to water table steadily declines upstream from less than 15 feet at the Gila River-Agua Fria River confluence to approximately 55 feet in the vicinity of Avondale, to approximately 155 feet at the New River – Agua Fria River confluence (USACE, 1986).

The Phoenix Basin consists of quaternary and tertiary alluvial fill deposits that extend to depths of several thousand feet near the center of the basin. There are three hydro geologic units within these deposits: the Lower Alluvial Unit, Middle Alluvial Unit and Upper Alluvial Unit (Corkhill et al., 1993). These units are differentiated by their general composition. The lower alluvial unit consists of conglomerate and gravel, the middle alluvial unit consists of silt and clay, and the upper alluvial unit consists of gravel and sand. The groundwater within these units is generally unconfined. The Upper Alluvial Unit is 200 to 400 feet thick and has been dewatered in some areas, but in the project area this unit is still the source of groundwater. Small water supplies can also be obtained within the basin from the crystalline and consolidated sedimentary rocks in the mountains bounding the basin. Significant occurrences of fine-grain materials do, however, create local semi-confined or confined conditions. Water-well data indicate that local perched or semi-perched conditions also exist (USACE, 1986). During the operations of sand and gravel pits, open pits that are no longer being mined are often filled with reject materials including fine-grained materials that have been washed from the coarser materials and are deposited in the bottom of pit. The presence of fines in the former pits can create perched water conditions. Because of the extensive history of backfilled sand and gravel operations along the Agua Fria, it is anticipated that perched water will occur at locations within the project site. The current sand and gravel operations near the AWWTP Restoration Site may have wells that pump groundwater. However the effect on the groundwater table will be localized to an area that is adjacent to the well. While it is possible that an expansion in sand and gravel operations could be accompanied by greater groundwater pumping and some drawdown of local groundwater, given the general amounts of groundwater permits held by sand and gravel operators (see Section 3.3.2.2), the long term effect on the groundwater table of the site is likely to be minor.

Groundwater flows generally east to west from the Salt River toward a major cone of depression near Luke Air Force Base, approximately 5 miles west of the project area at its closest extent. Groundwater movement toward this cone of depression from the confluence of the Gila and Agua Fria Rivers is in a more northwestward direction toward a second cone of depression in the Deer Valley area. These cones of depression have occurred in the groundwater table as the result of local concentrated overpumpage. Recharge to the groundwater basin is derived from seepage of irrigation waters, streamflow, rainfall underflow of groundwater and active recharge. Recharge from streamflow and rainfall is minor, and the amount of recharge from the remaining sources has not offset the progressive lowering of the water table (USACE, 1986).

Long-term groundwater withdrawal has resulted in a general decline in water levels in the Phoenix Basin. West of the Agua Fria River and in Deer Valley, the average water-level decline has been about 250 feet and in some locations more than 350 feet since 1923. Near the New and Agua Fria Rivers this decline has been about 120 feet. Water-level declines continue to decrease southward toward the Gila River, where declines have generally averaged less than 50 feet. Most of the decline has occurred since the 1940s when intense groundwater development began. The overall trend indicates a progressive decline in water levels northward from the Gila River.

In a 1996 ADWR modeling report, the groundwater change between 1983 to 1991 for the Agua Fria between McDowell Road and the Gila River was reported to have remained constant to having lowered

by up to 25 feet (Hipke et al., 1996). In part, this may be because a decrease has occurred in the groundwater pumpage since the mid-1960s because of the progressive change from agricultural to residential. Modeling performed by Integrated Water Technologies, Inc. in 1997 for the City of Avondale in association with their recharge permit application suggests that over 20 years of recharge, the overall water level increases will be relatively minor and only affect the area within less than a mile radius of the infiltration point (just north of McDowell Road, at the northern boundary of the restoration project). Their modeling suggests that at the Phoenix-Goodyear Airport Superfund site (4.5 miles southeast of the recharge site), the groundwater will continue to drop 10 to 20 feet within the next 20 years.

3.3.2.2 *Phoenix Active Management Area*[7]

General Description

The groundwater supply beneath the study area is regulated by the Arizona Department of Water Resources (ADWR) and falls within the Phoenix Active Management Area (AMA) of ADWR. To understand the complexity of water issues and how this might affect water supplies to the restoration project, it is necessary to understand the general purpose and function of the Phoenix AMA. The Phoenix AMA is one of five AMAs in the State (along with Prescott, Pinal, Tucson, and Santa Cruz), which were established pursuant to the 1980 Groundwater Management Code (GMC). The Code provides the management framework to ensure that dependable water supplies are available well into the future. To do this, the Code places conservation requirements on municipal and agricultural water use and promotes the use of renewable supplies, such as Colorado River water delivered via the Central Arizona Project (CAP) and effluent.

The Phoenix AMA is located in central Arizona and covers 5,646 square miles (Figure 9). The AMA is defined by geopolitical boundaries as well as watersheds and groundwater basins. It includes the majority of Maricopa County and small portions of Yavapai and Pinal Counties, and also includes 23 incorporated cities and towns, 37 irrigation districts and one Air Force Base. The Fort McDowell and Salt River Pima Maricopa Indian communities are located in the AMA, along with portions of the Gila River Community.

Part of the basin and range physiographic province, the Phoenix AMA consists of gently-sloping alluvial plains separated by predominantly north to northwest trending mountain ranges. Land-surface elevations range from less than 800 feet above mean sea level at Gillespie Dam to over 6,000 feet above mean sea level in the Superstition Mountains. Elevations on the basin floors typically range from 1,000 to 2,500 feet above mean sea level.

The Phoenix AMA is drained by five major rivers: Salt, Gila, Verde, Agua Fria, and Hassayampa (Figure 10). The Salt River below Granite Reef Dam is ephemeral, flowing only in response to local flooding and releases from upstream reservoirs. The Gila River between Ashurst-Hayden Dam and the confluence with the Salt River also is ephemeral, flowing only in response to flooding and reservoir

[7] All of the information in this section was taken from the Arizona Department of Water Resources (ADWR) website: http://www.az.gov/WaterManagement/Control/AMAs.

releases. Below the confluence, the Gila River flows perennially due to effluent discharge from the City of Phoenix 91st Avenue Wastewater Treatment Plant. The Verde River within the AMA is perennial; the Agua Fria and Hassayampa Rivers are ephemeral.

The Phoenix AMA consists of seven groundwater sub-basins: East Salt River Valley (ESRV), West Salt River Valley (WSRV), Hassayampa, Rainbow Valley, Fountain Hills, Lake Pleasant, and Carefree. The restoration project area falls within the WSRV where a large majority of the population also lives. Agricultural water use occurs predominately in the east and southeast areas of the East Salt River Valley sub-basin and in the west and southwest areas of the West Salt River Valley (e.g., agricultural areas adjacent to the restoration project area).

Phoenix AMA Goal

The Phoenix AMA has a statutory goal of achieving safe yield by the year 2025. Safe yield means that the amount of groundwater pumped from AMA aquifers on an average annual basis must not exceed the amount that is naturally or artificially recharged. This safe-yield goal applies to the AMA as a whole. This means that water level declines in one sub-basin of the AMA can be offset by recharging water in another part of the AMA.

Phoenix AMA Water Supplies and Demand

Agricultural Water Supplies and Demand Within the Phoenix AMA

Agricultural water use in the Phoenix AMA has always comprised a significant percentage of the total water use within the AMA. Irrigation districts within the Phoenix AMA acquire water supplies from four primary sources: (1) groundwater, (2) surface water, (3) CAP water, and (4) effluent. The restoration project area overlaps with or is adjacent to the Salt River Project area, the Buckeye Irrigation District, and the Roosevelt Irrigation District.

The Roosevelt Irrigation District (RID) receives effluent from the City of Phoenix, and pumps groundwater. Of the total amount of groundwater that RID pumps, approximately 85 percent is pumped from its own well field in the southwest portion of the Salt River Project (SRP) just east of the Agua Fria River. The district annually purchases about 5,000 acre-feet of effluent from the City of Phoenix's 23rd Avenue Wastewater Treatment Plant. In addition, RID began taking 30,000 acre-feet of effluent from the City of Phoenix in 1995 through a water exchange agreement.

Buckeye Irrigation District (BID) averages 12 to 18 percent groundwater, uses approximately 30,000 acre-feet of effluent that is produced by the 91st Avenue Wastewater Treatment Plant in Phoenix, and the balance of deliveries are from diverted Gila River water. This effluent use by Buckeye is water exchanged for groundwater with the City of Phoenix. Most of the surface water used in the Buckeye Irrigation District is effluent discharged by the City of Phoenix. The District has a surface impoundment protected by dikes immediately west of the confluence of the Gila and Agua Fria Rivers.

The Salt River Project is the Phoenix AMA's largest irrigation district. Groundwater deliveries have varied from 2 to 44 percent of the total water delivered over the last 10 years, with spill and surface water from the Salt and Verde Rivers making up the balance.

Non-Indian Agriculture. There are a total of 37 active irrigation districts in the Phoenix AMA. These districts served 90 percent of all Irrigation Grandfathered Rights (IGFRs) (6756 IGFRs of 7478 IGFRs) and served 74 percent of all water delivered to agriculture in 1994 (745,368 AF of 1,002,188 AF).

The six largest irrigation districts delivered approximately 65 percent of all agricultural water used and 87 percent of all agricultural water delivered to irrigation district customers. These six irrigation districts are SRP, RID, RWCD, MWD, BID and New Magma irrigation district. Table 3.3-1 identifies the irrigation districts in the project area, the irrigation acres, 1994 allotment and 1994 water use figures.

Table 3.3-1 Non-Exempt IGFR Characteristics for Irrigation Districts Within or Adjacent to the Restoration Project Area

Irrigation District	Number of Rights	Irrigation Acres	1994 Allotment	1994 Total Water Use	1994 % GW
Buckeye	186	18,581	123,353	97,693	15 %
Salt River Project	1,465	70,373	410,536	265,940	32 %
Roosevelt I.D.	375	36,674	237,938	146,885	98 %

Source: ADWR website, 2003.

In 1994, small irrigation grandfathered rights were deregulated by legislative initiative. Small IGFRs (called exempt rights) are those rights of 10 acres or less that are not part of a larger farming operation. This deregulation was designed to remove most regulatory provisions associated with IGFRs, such as conservation requirements (water duties), groundwater withdrawal fees and annual reporting provisions. The exempt rights only account for 4 percent of the total water use in the agricultural sector.

Non-exempt IGFR characteristics for the Buckeye and Roosevelt Irrigation Districts for 1994 are provided in Table 3.3-1

Crop type and the number of acres dedicated to each crop has been relatively stable over time in the AMA. During the 1975 through 1979 period (the period of record for establishing water duties), the primary crops grown were cotton, wheat, barley, and alfalfa. During the 1990 through 1994 period, the same crops dominated the scene. Although the total number of acres cropped has declined significantly between these two periods,[8] the type of crops grown and the percent they comprise of total crops grown remains similar.

Indian Agriculture. Indian communities are major agricultural water users in the Phoenix AMA. The Fort McDowell Indian Community, the Salt River Indian Community and portions of the Gila River Indian Community are located within the AMA. In 1986, the U.S. Bureau of Indian Affairs and tribal officials estimated that 29,423 acres were irrigated using an estimated 152,889 AF of water, 69 percent

[8] From 1975 to 1979 and then from 1990 to 1994, the production acreage of the four major crops dropped as follows (in millions of acres): cotton 1.0 to 0.73; alfalfa 0.38 to 0.26; wheat 0.31 to 0.11; and barley 0.11 to 0.05.

of which was groundwater. These cropped acres represent approximately 50 percent of the total irrigable farmland within the communities in 1986. Indian cropping patterns are similar to those of non-Indian.

Economic Conditions. Farm economics is the most significant variable in agricultural production, acreage, and water use. The agricultural economy tends to be cyclical and difficult to predict. There is a positive correlation between the main crop prices of cotton, wheat, alfalfa, and agricultural water use in the Phoenix AMA.

Municipal and Industrial Supplies and Demand Within the Phoenix AMA

Renewable Water Sources. These currently supply 73 percent of municipal demand, which is a reduction of groundwater dependence by 11 percent from 1985. Renewable supplies used by municipal providers in the Phoenix AMA include Salt and Verde River water from SRP and other diversions, Colorado River water through Indian Water Rights Settlements and other agreements, both treated and untreated CAP water, and effluent.

Renewable supplies used for potable uses were established by the City of Phoenix in 1931. Since that time, the larger communities in the valley have built treatment facilities to utilize their Salt River Project (SRP) surface water supplies; however, groundwater continued to be the primary source of potable water.

As the per capita use of groundwater has declined over the past ten years, the use of renewable supplies has increased. Additionally, as the total water use increases in the municipal sector, renewable supplies are being utilized instead of groundwater. The use of CAP water has increased 28 gallons per capita per day (GPCD) while groundwater use declined 20 GPCD. Surface water from SRP continues to be the primary surface water supply in the Phoenix AMA. This supply of water for member lands is the least expensive source of water and in wet years the availability of free water, "spill water," encourages the use of this supply. Direct use of effluent has increased as a replacement source of potable water for non-potable uses (i.e., turf landscape watering and aesthetic lakes). As potable demands increase, effluent reuse will play an increasingly important role in water management.

Groundwater Supplies. Historically, municipal providers in the Phoenix AMA relied solely on groundwater supplies to provide a potable water source for its residents and industries.

Since the beginning of the First Management Plan period, groundwater use in the municipal sector has decreased approximately 7 percent. As a percent of total municipal water use, groundwater is becoming a smaller ingredient, decreasing from 44 percent of total municipal use in 1980 to 27 percent of total municipal use in 1994. Municipal providers in the Phoenix AMA have made significant capital investments to acquire and build infrastructure to utilize renewable resources. Cooperative planning by the large municipalities has aided in the development of a regional recharge facility, the Granite Reef Underground Storage and Recovery Project, and establishment of intergovernmental agreements to provide for the transportation, treatment and use of renewable supplies.

Industrial Water Supplies. Forty-six percent of industrial program demand is met by groundwater, 29.4 percent is met by effluent, surface water accounts for 20.9 percent and CAP makes up the remainder at 3.4 percent. It should be noted that most effluent use is at Palo Verde Nuclear Generating Station. If this use were excluded from the total, effluent use would constitute only 7 percent of all industrial program demand.

The primary industrial users in the Phoenix AMA consist of turf-related facilities, sand and gravel operations, dairies, and electric power generating stations. The industrial classification is given to all non-irrigation users of water, which pump or receive groundwater.

Industrial demand represented approximately 5.8 percent of all water use in the AMA in 1994.

Turf-related Facilities. Turf-related facility demand is met through a number of different sources, including: non-irrigation grandfathered rights and general industrial use permits (groundwater); irrigation districts; municipal providers; contracts with CAWCD; and wastewater treatment plants.

Overall 50 percent of turf-related facility water use was groundwater, followed by surface water, effluent, and CAP. Effluent and CAP use have increased steadily, mainly by golf courses. Turf-related facility use has remained fairly stable although it fluctuates yearly with weather conditions, rising in hot dry years and dropping in relatively cooler and wetter years. Use has ranged from a low of 79,500 AF in 1992 to nearly 97,000 AF in 1989.

Turf-related facilities apply water to ten or more acres of water-intensive landscaped area and include golf courses, parks, schools, cemeteries, common areas and other facilities. The turf-related facility program is wide ranging and includes facilities such as Turf Paradise, Sky Harbor International Airport and the Phoenix Zoo. There were a total of 396 turf-related facilities in the Phoenix AMA in 1994, an increase of 38 facilities since 1987. One hundred five facilities are industrial users.

Water is used at turf-related facilities to irrigate turf and low water use landscaping and to maintain lake levels due to evaporative and seepage losses.

Golf Courses. Golf courses account for over two-thirds of turf-related facility water use. Use has fluctuated since 1987, peaking in 1994 at 65,820 acre-feet (the latest year data are available). There were 125 golf courses in the industrial program in the Phoenix AMA in 1994, 69 of which are industrial right or permit holders. Golf courses are the largest turf facilities, usually having more than 80 acres of water intensive landscaping. The average turf application rate in 1993 is higher than for most other turf-related facilities, driven chiefly by concerns for appearance and playability. Overseeing with ryegrass in the winter is common.

Golf course demand is chiefly met by groundwater (59 percent) and surface water (23 percent), with other supplies meeting the rest of the demand. Recent efforts by the City of Scottsdale to provide CAP water (as interim measure to ultimately provide effluent) to a number of courses in its service area have increased use of that source considerably (9 percent). Effluent use has steadily increased to 7 percent in 1994.

Homeowners Associations. Twenty-five percent or 2,440 AF of homeowner association demand is met through industrial groundwater rights or permits. Effluent use by three facilities led to this supply accounting for 19 percent of all common areas use in 1994.

Homeowners associations used over 9,900 acre-feet of water in 1994. There are 28 homeowner association common areas in the program. Most of the areas were completed or underway prior to the passage of the 1987 Lakes Bill, which limited lake development. As a result, many have large expanses of lakes, which contribute greatly to their water demand. Homeowners associations have a comparatively high average turf application rate.

Parks. Most park demand is met by municipal providers (35 percent) or irrigation districts (60 percent), while only three parks hold industrial groundwater rights. As a result, only 23 percent of park demand is met by groundwater. Eighty-seven parks used over 8,900 AF of water in 1994. Parks are usually deficit irrigated and generally do not oversee. Probably the greatest determining factor for a park's water use rate is the age and efficiency of a park's irrigation system.

Schools. Similar to parks, most school demand was met by municipal providers and irrigation districts (38 percent and 58 percent, respectively) in 1994. Only 11 schools hold groundwater rights. Groundwater accounted for 13 percent of all water use in 1994. There are 128 schools that are turf facilities, which have used about 8,200 AF of water in 1994. Compared to other turf-related facilities, average school acreage is small, with nearly three-quarters of all schools having less than 20 acres of water-intensive landscaping. Application rates are low for schools and deficit irrigation is common. Overseeding is rare. There are no schools currently regulated in the industrial program in the Phoenix AMA, which receive effluent for irrigation.

Cemeteries. Forty-five percent of cemetery demand is met through industrial groundwater rights or permits, while the remainder is surface water. The 13 cemeteries that are turf-related facilities in the Phoenix AMA used approximately 1,600 acre-feet of water in 1994. Most cemeteries have less than 30 acres of water intensive landscaping in the Phoenix AMA. The average application rate for cemeteries is highest of all turf-related facilities.

Miscellaneous Turf Facilities. Thirty-seven percent of the use by turf-related facilities classified as "miscellaneous" is groundwater and 63 percent surface water.

Dairies. Dairy use is entirely groundwater and has been steadily increasing from 6,970 acre-feet in 1987 to 7,460 acre-feet in 1994. Dairies hold rights or permits to withdraw approximately 15,800 acre-feet of groundwater in 1994. The dairies subject to conservation requirements in the Phoenix AMA are clustered southeast of Chandler and Gilbert and in the West Valley. Water use at dairies is for animal drinking needs, barn clean-up, animal cooling and udder washing.

Sand and Gravel Operations. All sand and gravel water use is groundwater. There are 21 sand and gravel facilities in the AMA, primarily clustered along the Salt and Agua Fria riverbeds. Sand and gravel facility water use follows construction needs in the area and so is highly variable from year to

year, ranging from a low of 7,200 in 1994 to a high of 13,400 in 1992. The total allotment associated with these facilities is over 25,000 acre-feet.

Water is used at sand and gravel facilities to wash unconsolidated alluvial deposits after mining to remove fine-grained particles. The wastewater is sent to disposal ponds where the sediment is allowed to settle out and is recycled back to the plant, allowing for considerable recycling. Water is also used to control dust, wash vehicles and equipment and to produce concrete, bricks, block and asphalt.

Electrical Power Plants. Including the Palo Verde Nuclear Generating Station in the water use by industrial power plants, 93 percent of power plant use in the Phoenix AMA is effluent (used by Palo Verde), the remaining water use is by plants using groundwater.

With the exception of 1989 which had notably higher use, groundwater use by the three electric power generation plants in the Phoenix AMA has been very stable year to year, approximately 3,300 acre-feet. The electric power companies hold rights with a combined allotment of over 12,000 acre-feet.

One facility in the program is the Palo Verde Nuclear Generating Station. It uses primarily effluent piped in from the 91st Avenue Treatment Plant. Annual use has been approximately 42,000 acre-feet the last several years.

Feedlots. Water demand by feedlots is met with groundwater. There are 10 feedlots in the AMA in 1994 accounting for less than 1 percent of all industrial water use. Water use by feedlots appears to be generally declining since 1987. Many feedlots have been pushed out of the AMA due to urban encroachment in the past several decades. Feedlots held groundwater right allotments of approximately 2,155 acre-feet in 1994.

Water use at feedlots is for animal drinking needs, dust control, and other uses. Holding pens are cleared of dust by applying water to the land surface using either a mobile tank and a gun sprinkler, portable water lines or a permanently installed sprinkler system.

General Industrial Users. General industrial users, by definition, are issued permits to use groundwater. General industrial users represent a wide range of industrial uses that are not regulated under sector-specific portions of the industrial conservation program, including electronics and aerospace, food processing and water and ice production. Use by general industrial users was about 9,200 acre-feet in 1994 or 5.5 percent of industrial program demand. Water use by general industrial users has trended downward from nearly 17,500 acre-feet since 1987. The total allotment associated with general industrial users is approximately 66,581 acre-feet.

Municipal. Municipal water providers include cities, towns, private water companies or irrigation districts serving potable water to residential users and both potable and non-potable supplies to non-residential customers. In 1980, total municipal water use was estimated to be approximately 20 percent of the total AMA water use. By 1994, municipal water use totaled 750,878 acre-feet, representing 40 percent of the total Phoenix AMA water use.

Municipal providers in the Phoenix AMA are comprised of 33 large municipal providers (those individually serving over 250 acre-feet annually), which account for approximately 99 percent of the AMA's total municipal water supply, and 80 active small providers, comprised primarily of private water companies, well cooperatives, and home owner associations. The City of Phoenix provides the majority of the municipal water, supplying 41 percent of the municipal water to approximately 45 percent of the AMA's population.

Large municipal providers have strict regulatory requirements. Of the current 33 large municipal providers in the Phoenix AMA, 14 are publicly owned and operated systems within municipalities, and 19 are private water companies (including well cooperatives, home owner associations, and institutional facilities).

Private water companies in the Phoenix AMA have historically relied on groundwater supplies as a source for their customers. Since 1985, water use by private water companies has increased 30 percent, with only four providers actively utilizing renewable supplies.

Municipalities in the Phoenix AMA account for 92 percent of the total water used by large providers and 93 percent of the total AMA population. Since 1985, water use in these service areas has increased 25 percent. Renewable supplies make up 78 percent of the total water delivered by municipalities. Municipalities also account for 99 percent of all renewable supplies used in the municipal sector.

Providers serving untreated water, primarily for urban irrigation, through a system separate from their potable distribution system are classified as untreated providers. Thirty-one large untreated providers have been identified in the Phoenix AMA. Sources of untreated water include groundwater, CAP and Salt and Verde River water. These providers reported delivering 128,726 acre-feet of untreated water in 1993 to approximately 395,071 acres.

Distinct differences in water use characteristics exist between large water providers in the eastern and western portions of the Phoenix AMA. Providers in the western portion of the AMA, except the City of Glendale, are primarily serving groundwater to their customers. The location of the CAP canal and extent of the Salt River Project service area has limited the ability to provide renewable supplies to west side water users. Most east valley providers, including the entire City of Phoenix service area, have acquired new sources of water in addition to developing and implementing large recharge and recovery projects.

Historic Trends: 1985 - 1994

Table 3.3-2 illustrates historic Phoenix AMA total population, total water use (includes spill water), and gallons per capita per day (GPCD) rates for the years 1985 through 1994.

Table 3.3-2 Historic Water Use Trends in the Phoenix AMA (1985-1994)

Year	Population	Total Use (AF)	Total GPCD	Res GPCD	Non-Res GPCD
1985	1,808,409	492,594	243	152	75
1986	1,882,230	518,836	246	143	82
1987	1,960,320	553,618	252	157	67
1988	2,007,473	569,634	253	157	69

1989	2,085,538	596,724	255	155	83
1990	2,089,025	566,574	242	146	76
1991	2,137,034	579,853	242	145	73
1992	2,197,259	549,695	223	133	69
1993	2,260,819	581,012	229	139	68
1994	2,326,906	619,167	238	146	70

Source: ADWR website, 2003. AF: Acre-feet; GPCD: Gallons Per Capita Per Day

The total per capita rate for the Phoenix AMA has decreased 6 percent from 252 GPCD in 1987 to 238 GPCD in 1994. GPCD rates have fluctuated from a high of 255 GPCD in 1989 to a low of 223 GPCD in 1992. Since 1987, AMA total GPCD rates have consistently declined with the exception of 1989 and 1994, which have been shown to be years with high evapotranspiration.

Phoenix AMA Issues

Agricultural Sector Issues

Farmers contend that the current water duty program restricts their ability to maximize profits. The ADWR is currently evaluating whether alternatives to the current water duty and maximum farm allotment program may be developed and implemented.

General Industrial Use Permits

Industrial users (as opposed to individual users) rely heavily on mined groundwater. Industrial users beyond distribution lines of municipal providers or other sources may apply for a General Industrial Use permit (GIU). Although there are statutory provisions that limit use of GIUs and non-irrigation grandfathered rights to prevent unnecessary and unreasonable use of groundwater and prevent the drilling or redrilling of wells where damage may be caused to surrounding land or to other water users from the concentration of wells, the examination of sub-basin wide effects as a pre-condition to pumping groundwater is not addressed. Pre-existing groundwater levels in a sub-basin or future effects on groundwater levels that may be caused by use within the sub-basin are not conditions for permit issuance. New industrial users who apply for GIU permits or convert or convey non-irrigation grandfathered rights may be doing so in areas where groundwater drawdown is potentially severe.

There is a large volume of unused groundwater allotment associated with the industrial sector. Rights and permits held by industrial users in 1994 totaled nearly 192,000 acre-feet. Use pursuant to these rights and permits in 1994 was 35 percent of the total allotment. For example, electric power used 26 percent of their approximately 7,000 acre-feet allotment; mineral extraction used 32 percent of their approximately 32,000 acre-feet allotment; Type I non-irrigation rights used 19 percent of their 61,000 acre-feet allotment and Type II non-irrigation rights used 48 percent of their 79,000 acre-feet allotment in the AMA. Type II non-irrigation rights are not appurtenant to the land and may be used anywhere in the AMA for any non-irrigation purposes. They may be bought or sold or leased in whole and in part. This gives them the greatest flexibility for potential use in the future, possibly in areas or sub-basins where groundwater drawdown is already or will be severe. With over 40,000 acre-feet of Type II rights unused in 1994, these rights may prove to be an obstacle toward reducing groundwater dependence in the industrial sector.

The industrial user's ease at obtaining further groundwater withdrawal authority and access to large quantities of unused groundwater allotments, which have been described in the previous sections, illustrates how capable the sector is at further contributing to the problem of overdraft.

Users in other sectors have limits imposed on their abilities to mine groundwater. The industrial sector has none of these restrictions to pump groundwater. It can continue to pump or establish pumping in areas or sub-basins where other local entities have undertaken great expense to stop groundwater pumping to improve physical availability in the area.

The Role of Resource Based Planning

The goal of safe-yield has been defined as a balance between total recharge in the AMA and total withdrawals. To accomplish this goal requires the knowledge of groundwater movement, groundwater volumes, and locations of withdrawals and recharge. Because of the large size of the AMA, hydrologic conditions vary considerably across the AMA resulting in various water management implications. The Department needs to examine the role of recharge in reversing areas of major groundwater drawdown, as well as water quality, soil aquifer treatment, and long-term storage issues.

3.3.2.3 *Groundwater Recharge*

The ADWR administers an Underground Water Storage, Savings and Replenishment Program (also known as the Recharge Program), which is an effort to replenish the AMA aquifers. This program allows for the artificial recharge of waters that can be retrieved at a later time. The recovery of these waters is not limited to the area of recharge, but can occur anywhere within the AMA as long as adjacent existing wells are not negatively impacted. Because many water users in Arizona do not use their full yearly allotment of CAP water, this program encourages the users to recharge the aquifer with the portion of the allotment that would otherwise not be utilized and receive credits for future groundwater withdrawal.

A Groundwater Recharge Report of the Watercourse Master Plan was issued for the Flood Control District in 2001. This report ranked reaches of the Agua Fria as follows: from the confluence of the New River to Indian School Road as potentially favorable; Indian School Road to I-10 as favorable; from I-10 to MC-85 as potentially favorable; and from MC-85 to the confluence as unfavorable. These rankings considered regulatory ("unreasonable harm", odor, bird strike, and vector) concerns, infiltration rate, aquifer storage, benefit of recharge, proximity to existing water sources, impacts of flooding, and impacts on other watercourse users. The unfavorable ranking was based on the shallow groundwater and depth to aquifer storage potential combined with permitting obstacles. This ranking was reached because as groundwater levels approach the ground surface, less water can be recharged. Mounding of the water surface may result in "unreasonable harm to nearby wells or landowners, or a negative impact on the hydrologic feasibility of the project. The report indicates that this issue would not eliminate a reach from consideration, but would require additional contingency plans in the Underground Storage Facility Permit and, if effluent is recharged, the Aquifer Protection Permit. In addition, these reaches have potential permitting obstacles caused by increasing bird strikes by

airplanes, causing odor in nearby residential areas, impact to facilities from flooding or lateral stream migration, and potential well impact from groundwater contamination or contaminated soil.

There are currently three operational recharge facilities on the Agua Fria River. There is a CAP facility located between the CAP canal and Jomax Road, a SROG facility (Sub-regional Operating Group) at 91st Avenue and a City of Avondale facility immediately north of McDowell Road.

CAP Facility

The Central Arizona Project began recharging water into the Agua Fria in September 2001. Water is discharged into the Agua Fria from the CAP canal, located 22 miles north of McDowell Road at the project area, and flows within the riverbed to Jomax Road. South of Jomax Road, the water is channeled into constructed recharge basins. As of April 2002, approximately 25,000 AF of water has been recharged at this facility. The permit issued to CAP allows up to 100,000 AF per year to be recharged. Currently, the groundwater levels have risen approximately 15 feet near the CAP canal, and there has been an increase in the groundwater depths as far south as Jomax Road.

SROG Facility

The SROG is a partnership of the cities of Glendale, Mesa, Phoenix, Scottsdale and Tempe, which owns and operates the 91st Avenue Wastewater Treatment Plant. SROG is in the preliminary stages of stakeholder coordination and consensus plan to develop a recharge program (Turek, pers. comm., 2002). They will not begin recharging water until 2008-2010. The proposed concept is to transport water from the 91st Avenue plant to the north as far as Bell Road with lateral discharge to the Agua Fria at each mile. By incorporating several points of discharge into their design, SROG is attempting to avoid negative impact to operating sand and gravel pits or other adjacent wells by having flexibility in the rates of recharge at all locations. The program is still in the conceptual stage; however there are currently no plans to discharge water in the area of the restoration sites (south of McDowell). When the SROG facility becomes operational, they plan to recharge approximately 40,000 to 60,000 acre-feet per year.

City of Avondale

The City of Avondale began recharging water into the Agua Fria in February 1999 (COA, 2002d). Water is recharged at the northeast corner of the intersection of McDowell Road and the Agua Fria River. The City of Avondale has recharged 10,000 acre-feet per year since 1999 as allowed by their permit. Currently, the City of Avondale is applying to modify their permit to allow 15,000 acre-feet of recharge per year. The groundwater levels in nearby monitoring wells experience fluctuations based on recharge rates, but no significant changes in water levels have been observed (COA, 2002d).

As stated at the beginning of this section, modeling performed by Integrated Water Technologies, Inc. in 1997 for the City of Avondale in association with their recharge permit application suggests that over 20 years of recharge, the overall water level increases will be relatively minor and will only effect the area within less than a mile radius of the infiltration point. Their modeling suggests that at the Phoenix-Goodyear Airport Superfund site, (4.5 miles southeast of the recharge site), the groundwater will

continue to drop 10 to 20 feet within the next 20 years. Since extraction of the majority of the recharge water is expected, there will only be a relatively small long-term net storage in the aquifer. Therefore, the actual water level build-up will primarily be concentrated between the infiltration basins and the City of Avondale's production well locations (located west and north of the recharge site). The gradient created by drawdown in the production wells to the northwest of the recharge sites (which are north of the restoration project area) will induce the water to preferentially flow in that direction, thereby minimizing the likelihood that groundwater levels in the restoration project area will increase significantly.

Additional Recharge Facilities along the Agua Fria include:

- **Sun City West.** Sun City West has a recharge facility located less than one-half mile east of the Agua Fria River between Beardsley Road and Bell Road (12 miles north of McDowell). The recharge facility consists of basins that recharge effluent water. This facility is permitted to recharge up to 3,042 AF per year.
- **City of Peoria.** The City of Peoria also has a recharge facility at Beardsley Road (14 miles north of McDowell Road), also less than one-half mile east of the Agua Fria River. The recharge facility consists of basins that recharge effluent water. This facility is permitted to recharge up to 2,470 AF per year.
- **City of Surprise.** The City of Surprise has a recharge facility at Bell Road (12 miles north of McDowell Road) 2 miles west of the Agua Fria River. The recharge facility consists of basins that recharge effluent water. This facility is permitted to recharge up to 3,584 AF per year.
- **City of Glendale.** The City of Glendale has a recharge facility at Bethany Home Road (4 miles north of McDowell Road) less than one-half mile east of the Agua Fria River. The recharge facility initially consisted of basins, trenches, vadose wells and injection wells that recharge effluent water. The pilot program indicated that basins were sufficient for recharge and the wells will not be necessary. This facility is permitted to recharge up to 5,000 AF per year but has applied for an increase to 7,842 AF per year.
- **City of Goodyear Soil Aquifer Treatment (SAT) Facility.** The City of Goodyear has a recharge facility at Buckeye Road approximately 3.5 miles west of the Agua Fria River. The recharge facility consists of basins that recharge effluent water. This facility is permitted to recharge up to 3,360 AF per year.

3.3.2.4 *USGS Groundwater Data*

USGS statistics profile the general groundwater status in the vicinity of the study area, as shown in Table 3.3-3, obtained from http://water.usgs.gov/nwis/gwlevels accessed December 2001. Based on the location and elevation of the wells, it is likely that groundwater is within approximately 20 feet of the surface at the lower extreme of the project area and within 80 feet at the upper end. Since most of the data are at least ten years old, changes induced by agriculture to urban conversion and implementation of programs under the Groundwater Management Code may not be fully reflected in these data. These results tend to be consistent with groundwater levels elsewhere in the Phoenix AMA. Groundwater depths near the Phoenix and Tempe reaches of the Río Salado were 23 to 43 feet and 56 to 130 feet with indications that groundwater levels in both areas are rising (USACE, 1997a).

3.3.2.5 *ADWR Well Inventory*

Well data for the area defined by N 33°30'00" to N 33°23'00" and W 112°21'30" to W 112°18'30" (Appendix E) were obtained from the ADWR, and focus was placed on the most recent measurements from 1997 to 2001. These values ranged from 19.5 feet below the surface at 942 feet above sea level

(fasl) recorded in 1997 from a well east of the Agua Fria River near El Mirage Road and Southern Avenue (close to the Gila River) to 108.6 feet below the surface at 972 fasl from a well located within the City of Avondale recorded in 1997. In the northern part of the project area, water depth was in the range of 130 to 170 feet below the surface (Montgomery & Associates, Inc., 2000).

Table 3.3-3 USGS Groundwater Data Within the Vicinity of the Study Area*

USGS Site Number/Location	Date**		Water Level (feet below land surface)
332330112203601	Begin Date:	10/01/1967	41.00
Latitude: 33°23'55"/Longitude: 112°20'36"	Latest Date:	11/26/1991	19.60
332330112185101	Begin Date:	12/19/1962	43.14
Latitude: 33°24'22"/Longitude: 112°18'51"	Latest Date:	11/26/1991	17.50
332330112202401 (site B-01-01 02BCB)	Begin Date:	09/04/1962	160.50
Latitude: 33°27'37"/Longitude: 112°20'51"	Latest Date:	11/18/1991	89.00
332330112202401 (site B-01-01 34AAA)	Begin Date:	02/14/1962	43.50
Latitude: 33°26'58"/Longitude: 112°20'27"	Latest Date:	11/27/1991	15.70
332330112212301	Begin Date:	01/01/1946	36.00
Latitude: 33°25'27"/Longitude: 112°20'18"	Latest Date:	07/06/1993	62.50
332330112184901	Begin Date:	06/01/1929	25.00
Latitude: 33°25'30"/Longitude: 112°18'49"	Latest Date:	11/05/1991	54.50
332330112205301	Begin Date:	10/01/1951	70.00
Latitude: 33°25'58"/Longitude: 112°20'57"	Latest Date:	11/27/1991	66.50
332330112211701	Begin Date:	10/25/1989	80.50
Latitude: 33°26'08"/Longitude: 112°21'17"	Latest Date:	11/13/1991	65.70
332330112210801	Begin Date:	01/01/1959	119.0
Latitude: 33°26'46"/Longitude: 112°21'04"	Latest Date:	11/13/1991	94.30
332330112184501	Begin Date:	03/06/1946	30.89
Latitude: 33°26'56"/Longitude: 112°18'52"	Latest Date:	10/28/1997	68.90
332330112200401	Begin Date:	4/1/1950	54.00
Latitude: 33°26'58"/Longitude: 112°20'04"	Latest Date:	11/19/1991	55.20
332330112202701	Begin Date:	1/16/1956	87.80
Latitude: 33°26'58"/Longitude: 112°20'27"	Latest Date:	10/29/1997	76.90
332330112202101	Begin Date:	12/16/1947	60.00
Latitude: 33°27'51"/Longitude: 112°20'18"	Latest Date:	07/06/1993	113.40
332330112205601	Begin Date:	07/01/1948	68.00
Latitude: 33°27'50"/Longitude: 112°20'56"	Latest Date:	11/18/1991	96.50
332330112202501	Begin Date:	01/01/1954	97.00
Latitude: 33°28'03"/Longitude: 112°20'25"	Latest Date:	11/18/1991	102.30
332330112205701	Begin Date:	01/01/1951	90.00
Latitude: 33°28'16"/Longitude: 112°20'57"	Latest Date:	11/18/1991	109.00
332330112193601 (site name B-02-01 36ADD)	Begin Date:	11/30/1981	103.00
Latitude: 33°28'21.7"/Longitude: 112°18'37.9"	Latest Date:	04/22/1997	96.58
332330112193601 (site name B-02-01 35AAB)	Begin Date:	02/22/1962	124.41
Latitude: 33°28'43"/Longitude: 112°19'36"	Latest Date:	11/18/1991	106.00
332330112205401	Begin Date:	01/07/1972	151.00
Latitude: 33°28'44"/Longitude: 112°20'54"	Latest Date:	08/06/1992	208.50
332330112212301	Begin Date:	01/01/1952	95.00
Latitude: 33°28'57"/Longitude: 112°21'23"	Latest Date:	08/04/1992	184.80
332330112202401	Begin Date:	09/01/1948	102.00
Latitude: 33°23'24"/Longitude: 112°20'24"	Latest Date:	11/11/1991	139.00
332330112195301	Begin Date:	07/01/1996	207.00
Latitude: 33°29'47"/Longitude: 112°19'53"	Latest Date:	11/22/1991	186.10

* USGS groundwater levels are reported only for sites with sampling dates after 1991 that were within the following geographic boundaries: latitudes 33°23'30" south and 33°31'00" north, and longitudes 112°19'00" east and 112°22'00" west.

**Dates represent the first date of sampling by the USGS at the site and the latest date available for the site, as of January 2002.

3.3.2.6 *Other Sources*

Buckeye Irrigation District. The Buckeye Water Conservation and Drainage District, which is generally located immediately downstream of the confluence of the Agua Fria and Gila Rivers, completed a study of groundwater conditions (Montgomery & Associates, Inc., 2000). The study provides a comparison between conditions in 1986-1987 and 2000.

In 1986-1987 the study documented waterlogged conditions in the District and as a result, the Buckeye Irrigation District, the St. John's Irrigation District and the service area of the Arlington Canal company were eliminated from regulation of groundwater for agricultural irrigation during the first three groundwater management periods in the Phoenix Active Management Area.

Analysis of data obtained during the 2000 field investigation indicates that continued pumping for irrigation use and for drainage between 1987 and 2000 has resulted in only limited change in waterlogged conditions. However, wells at the eastern fringe of the study area within approximately 0.25 to 1.5 miles to the west of the confluence of the Agua Fria and Gila Rivers (defined in Section B.1-1 and B.1-2 of the Study) indicate that groundwater levels have dropped one to 20 feet over that time depending on the well (see groundwater levels and well locations in Appendix E). The depth to groundwater ranges from 19 to 57 feet in this area. Only one well within that area (29cbb) registered an increase of six feet in the groundwater elevation.

Salt River Project. The Salt River Project has not completed any groundwater studies in the lower part of the Agua Fria River, but cites a study north of the area near Camelback Road submitted to the FCDMC (Mario Lluria, pers. comm., 2002).

3.3.2.7 *Summary of Groundwater Conditions and Trends in the Project Area*

As of 2001, groundwater was estimated to be about 50 feet below ground surface (bgs) within the channel at McDowell Road for the purpose of determining aquifer characteristics for potential recharge (Fluid Solutions, 2001). In the lower part of the Agua Fria River groundwater levels gradually increase to a maximum of 15-20 feet below ground surface near the confluence with the Gila River (Montgomery & Associates, 2000). The Phoenix area has experienced a large amount of groundwater drawdown over the past 65 years. The overall trend indicates a progressive decline in water levels northward from the Gila River. However, the creation of the Phoenix AMA, the commitment to the use of renewable water supplies (e.g. CAP water) and the increase in recharge programs may help reduce the current rates of drawdown. Currently, the amount of groundwater pumped is still greater than the amount of water recharged by both natural and artificial methods so in general, groundwater levels will continue to decline. Recharge programs in the Agua Fria provide only localized increases in water levels along the Agua Fria due to the presence of the Luke cone of depression to the northwest. This depression in groundwater levels causes the recharged groundwater to flow to the northwest as opposed to down the river channel.

3.3.2.8 *Groundwater Quality*

Several sources were investigated for groundwater quality data within the project area. A search of the USEPA STORET database in Maricopa County provided limited historical data for groundwater quality in the Agua Fria/Avondale areas (Tables 3.3-4a and b). More recent information was not available in this database.

The Río Salado Feasibility Study (USACE, 1997b) provides a summary of groundwater conditions that is also relevant to the restoration project area to the west. When groundwater pumping began in the Phoenix metropolitan area in the 1920s, the groundwater quality, although high in minerals, was considered to be very good quality. Today, there are a number of groundwater quality problems in the Salt River Valley. The problems associated with inorganic chemical constituents include high levels of chloride, total dissolved solids (TDS), nitrates, and salinity. The problems associated with trace organic constituents include the pesticide dibromochloropropane (DBCP) and volatile halocarbons. Most of the regional problems are currently limited to groundwater in the upper and middle aquifers. Hundreds of incidents of volatile halocarbon contamination have been detected in the Phoenix metropolitan area. In some cases, the contamination is limited to plumes and can be associated with specific waste disposal practices or industrial activities. Because of high organic and volatile halocarbon concentrations and decreases in the use of land for agriculture, use of the groundwater in the upper aquifer for public consumption has dropped significantly. New water supply wells that tap the higher quality groundwater stored in the middle and lower aquifer units have been replacing the shallow wells for several decades.

The Buckeye Irrigation District in their 2000 groundwater study also performed chemical analyses on some of the wells. Only one of the wells for which chemical analyses were performed is within a half mile of the restoration project area. Appendix E provides the results of the analysis for this well plus others slightly further to the west.

Within the eastern half of the Buckeye Irrigation District water generally exceeds secondary standards for chloride, sulfate, nitrite/nitrate and TDS. This is generally similar to the conclusions presented above for the Phoenix – Rio Salado study. Fluoride levels were generally below the standard. The pH of the sampled wells was slightly alkaline.

Groundwater quality data for the wells identified in the ADWR search provided limited information and was limited to analysis of fluoride, specific conductivity, pH and temperature. These analyses indicate that the water is generally neutral, low in fluoride and elevated in conductivity (conductivity is directly related to total dissolved solids).

The primary impact of the City of Avondale recharge project on groundwater quality will be to decrease high nitrate values that are already present in the upper part of the water column, within the areas that would likely be affected by the recharge project. Water quality of the recharge water will be regularly monitored prior to recharge to ensure that the recharge water quality, particularly nitrate, will be below maximum contaminants.

3.3.3 Surface Water

3.3.3.1 *Agua Fria River Hydrology*

Background

The Agua Fria River originates in the mountains of central Arizona near Prescott and flows south more than 100 miles before emptying into the Gila River 15 miles west of Phoenix (USACE, 1995). Elevations in the watershed range from over 7000 feet for the highest peaks to about 1600 feet at New Waddell Dam (Figure 11). This dam is located in the Hieroglyphic Mountains 35 miles northwest of Phoenix and controls the uppermost 1,459 square miles (54 percent) of the 2,700 square mile Agua Fria River Drainage Area.

From the New Waddell Dam, the Agua Fria River flows south to the Gila River at a point just downstream from the Salt and Gila River confluence. Two main tributaries are the McMicken Dam-Trilby Wash entering from the west and the New River from the east. Discharge from McMicken Dam, New River Dam, Adobe Dam, and the Dreamy Draw Dam, as well as Skunk Creek, Arizona Canal Diversion Channel (ACDC) and Cave Creek (downstream of Cave Buttes Dam) contribute to the Agua Fria River downstream of New Waddell Dam. The majority of the area between the New Waddell Dam and the New River confluence is not developed (USACE, 1995). Only 17 percent of the 2,700 square mile watershed is not controlled by dams.

According to the Lateral Migration Report for the Agua Fria Watercourse Master Plan (Fuller, 2001a), the hydrology of the Agua Fria River watershed downstream of New Waddell Dam has been significantly modified over the past century due to the following:

- **New Waddell Dam.** Together with its predecessor, Carl Pleasant Dam, a.k.a, Waddell Dam, these dams have impounded most of the natural flow runoff from the upper watershed since 1927. Therefore, the natural low flow hydrology has little impact on the existing channel morphology. Currently, floods up to the 10-year

flood event are completely impounded behind the dam. Depending on the pre-flood storage capacity, even less frequent floods could be totally retained in Lake Pleasant.

- **Other Dams.** Other dams in the Agua Fria watershed include the New River Dam, Adobe Dam, Cave Creek and Cave Buttes Dams, McMicken Dam, and White Tanks Flood Retarding Structure #3. These flood control dams further reduce the low flows, peak flood discharges, and sediment supply delivered to the lower Agua Fria River.
- **Diversions.** The Arizona Canal Diversion Channel (ACDC), the McMicken Dam, and the Interstate 10 channel expand the watershed area that ultimately drains the lower portion of the river, potentially increasing the volume of water delivered to the lower portion of the river during large floods. In part, this increase in drainage to the lower portion of the river motivated construction of the levees in the project area.
- **Urbanization.** Urbanization of the west valley downstream of New Waddell Dam has changed the natural hydrology in the lower river in conflicting ways. Urbanization typically results in more frequent runoff, higher peaks, higher flow volumes, reduced sediment supply and flashier floods relative to non-urbanized watersheds, due to less infiltration and other losses. However, enforcement of storm water retention requirements in areas that were developed in the past 15 years may have reduced flood volumes and peak discharges in some watersheds. Of the 460 miles not controlled by dams, more than half is urbanized.
- **Return Flows.** Irrigation return flows, discharge from water and wastewater treatment plants, and other point sources of manmade runoff supply water to the lower river at different rates, locations, durations and seasons than the natural water supply.

3.3.3.2 *Peak Flow Rates*

The Agua Fria River originates in the mountains of central Arizona and flows south to enter the Gila River approximately 15 miles west of Phoenix. The New Waddell Dam has an attenuating effect on flood flows as described by the Corps of Engineers in a July 1995 study (USACE, 1995). Table 3.3-5 provides a summary of the pre- and post-New Waddell Dam discharges for the Agua Fria River downstream of the confluence with the New River. The current 100-year flood plain is depicted in Figure 12, and Table 3.3-6 provides a partial listing of existing and modified base flood elevations (BFEs) to reflect the New Waddell Dam updated topography (FEMA, 1997).

Table 3.3-5 Agua Fria River Discharges for Study Area

Location	Drainage Area, in Square Miles[1]	Distance from Gila River, in Miles	Peak Flow Rate, in cfs, with and (without) New Waddell Dam[2]						
			Standard Project Flood	100-Year	50-Year	25-Year	10-Year	5-Year	2-Year
Camelback Road	392	9.18	94,000 (102,000)	54,400 (95,000)	39,000 (N/A)[3]	26,000 (N/A)	16,100 (N/A)	10,000 (N/A)	5,500 (N/A)
I-10 Freeway	474	5.29	90,000 (99,000)	52,000 (91,000)	38,000 (N/A)	25,000 (N/A)	15,300 (N/A)	10,000 (N/A)	5,400 (N/A)
Buckeye Road	485	3.73	88,000 (97,000)	50,900 (90,000)	37,000 (N/A)	25,000 (N/A)	15,000 (N/A)	10,000 (N/A)	5,300 (N/A)
At Gila River	485	0	83,000 (92,000)	48,200 (89,000)	35,000 (N/A)	23,000 (N/A)	14,200 (N/A)	9,000 (N/A)	5,000 (N/A)

1 Effective drainage area. Does not include drainage areas controlled by dams.
2 Source: USACE, 1995
3 N/A = Discharge not available.

Table 3.3-6 Partial Listing of Existing and Modified BFEs in the Agua Fria River

Location	Existing BFE (feet)*	Modified BFE (feet)*
At confluence with Gila River	923 c, e	923 c, e
Approximately 400 feet downstream of Litchfield Road	924 a	923 a
Just downstream of Broadway Road	936 a	933 a
Just downstream of Lower Buckeye Road	950 e	948 e
Just downstream of Van Buren Street	971 a	969 a
Just downstream of Thomas Road	999 a, e	997 a, e
Approximately 150 feet upstream of Indian School Road	1,009 d, e	1,007 d, e
Just upstream of Camelback Road	1,024 e	1,023 e
Approximately 3,790 feet upstream of confluence with New River	1,042 b, e	1,035 b, e

Source: FEMA, 1997.
a. within the City of Avondale; b. within the City of Glendale; c. within the City of Goodyear; d. within the City of Phoenix; e. within the unincorporated areas of Maricopa County.

The Standard Project Flood (SPF) was reduced by approximately 10 percent. The 100-year discharge was reduced by nearly half. Other more frequent discharges were not estimated, but based on an analysis by the USACE (1995) for the Agua Fria River upstream of the New River, the 10-year to 50-year discharges (which are important for substrate renewal) were reduced by approximately half by the New Waddell Dam. The 2-year and 5-year discharges were relatively unaffected by the new dam. Less frequent floods (> 10-year discharges) have a duration of less than 24 hours, which illustrates the ephemeral nature of the river.

Some of the sub-basins along the Agua Fria have experienced a significant change in peak discharges (as much as 50 percent less) due to a large percentage of the drainage area changing from agricultural or crop land use to light industrial or low density residential land use. This trend will continue to have a significant impact on peak discharges as drainages become more fully developed (FCDMC, 2000).

3.3.3.3 *Monthly and Daily Stream Flows*

Between 1967 and 1982, the average monthly stream flow recorded by the USGS on the Agua Fria River at Avondale was zero for the months of April, May, June, October and November. The runoff pattern reflects the typical rainfall pattern for this region of Arizona, with large area winter storms occurring in the winter, and smaller-area, short-duration storms in the summer. Total runoff volume amounts to approximately 20,000 acre-feet per year.

The relatively high average monthly runoff rates for the months of December to March do not indicate a dependable source of water. The averages are based primarily on a few isolated storm events that can generate relatively high peaks of short duration. A review of the USGS daily mean flow records reveals that there is flow on the Agua Fria River only about one percent of the time. For the period 1967 to 1982, there was no measurable flow on the Agua Fria River at Avondale on all but 60 of the 5,114 days of record. These 60 days comprised 16 separate flow events.

Inflows from local drainage into the Agua Fria River come from the I-10 channel, Durango Regional Outfall Channel, AWWTP, and local side drains. The AWWTP discharges approximately 3.5 mgd of which the majority may eventually be diverted and used for recharge (Avondale, 2002e). Intermittent

flows from the other two sources are unknown, but are likely to decrease in the future as agricultural inputs are decreased.

3.3.3.4 *Agua Fria River Hydraulics*

Hydraulic information was based on a HEC-RAS computer model prepared for the Agua Fria Watercourse Master Plan by LTM Engineering (LTM, 2001). Discharges for the model were obtained from those presented in Table 3.3-5. Model results under current, post-New Waddell dam conditions for the 2-year, 5-year, 10-year and 100-year discharges between McDowell Road and the Gila River are presented in Figures 13, 14, and 15.[9]

Flow depths (Figure 13) range from approximately one to four feet for the 2-year flood, and from four to ten feet for the 100-year flood. There is no discernable trend in flow depth from upstream to downstream. Flow velocities (Figure 14) are mostly below four feet per second for discharges up to the 10-year flood. 100-year flow velocities range from approximately 4.5 feet per second to more than 11 feet per second. Flow topwidths (Figure 15) are nearly identical for all discharges. Upstream of Buckeye Road, the flow is confined on both sides by levees, and the channel cross section is relatively uniform. Downstream of Buckeye Road flow topwidths increase significantly for floods above the 5-year return period as a result of the lack of confinement on the east side. Two-year flow topwidths downstream of Buckeye Road are variable as a result of a more irregular cross section closer to the natural-condition topography in that reach.

The Agua Fria levee system is designed for the SPF defined by the USACE. The levee freeboard requirement for the SPF is three feet. A hydraulic analysis by LTM (2001) revealed that for the pre-New Waddell Dam SPF, the three-foot freeboard requirement is not met on the east levee at Buckeye Road (freeboard is approximately 2.7 feet), on the east and west levee downstream of Indian School Road, outside the study area (freeboard is approximately 1.9 feet), at the ends of both levees as they transition to natural ground, and at I-10 where the levee is lowered to accommodate flows from the I-10 channel. Figure 16 shows the freeboard for the pre-New Waddell condition. Freeboard is greatest at I-10, and generally decreases in a downstream direction. However, in most areas there is more than three feet of extra freeboard, indicating a possible opportunity for restoration modifications that reduce conveyance without violating the design freeboard requirement.

As described above, the New Waddell Dam has reduced the SPF discharge in the project area by approximately ten percent. Figure 17 shows the available freeboard using the post-New-Waddell Dam discharges. The results are similar to those shown in Figure 16, but without the lack of design freeboard at Buckeye Road. Minimum freeboard at Buckeye Road under the new SPF is approximately 0.5 feet greater, at 3.3 feet.

[9] For the hydraulic modeling completed for the analysis of alternatives and their effect on the Standard Project Flood condition (Appendix I), pre-New Waddell discharges were used.

3.3.4 FCDMC Watercourse Master Plan

Agua Fria - Watercourse Master Plan

The Agua Fria River Watercourse Master Plan was funded by the Flood Control District of Maricopa County. The District's goal is to be able to provide a flood protection strategy that preserves the cultural and archaeological history of the river and also is consistent with the long-term, multi-use vision for the corridor. To accomplish this, it was important for FCDMC to understand the opportunities within the corridor as well as the potential for flood hazards for the communities along its banks. The Watercourse Master Plan outlines specific recommendations relative to floodplain management strategies, recreation opportunities, and habitat preservation for the corridor, presuming full development within the watershed. Maricopa County and communities within the plan area can adapt their current floodplain management programs, and use the Watercourse Master Plan to help prioritize projects for implementation. The Watercourse Master Plan identifies actions that should be undertaken along the study area to prevent or control flood hazards and reduce impacts. Ecological, hydrological, and hydraulic technical information developed for the Watercourse Master Plan has been used in this document because of its relevance to the restoration project.

The Watercourse Master Plan considers structural and non-structural strategies to best fit the needs of the project corridor. In the case of the Agua Fria River Corridor, areas where structural controls already exist may be the most appropriate places to implement or continue to maintain existing structures for flood control. In other areas, limiting encroachment of the river by non-structural methods is a more desirable mechanism for protecting the public.

The preferred alternative of the Agua Fria River Watercourse Master Plan considers no development within the 100-year floodplain unless the impacts to downstream flood flow or the pushing of floodwaters onto other properties can be mitigated. As part of this concept, it is proposed to adopt a lateral migration setback based on the recommended lateral migration erosion hazard zone (LMEHZ). This LMEHZ would be considered a "no encroachment zone" with regards to development. Within the project area, the reach from MC 85 to I-10 is entirely protected by existing levees, so no additional protection were recommended to the District. From Broadway Road to MC 85, most of the west bank and a subdivision on the east bank are protected by existing levees. From the confluence of the Gila River to Broadway Road, the preferred alternative recommends elevating the proposed buildings by two feet above the estimated floodwater surface to offer protection in this area. This does not preclude flood protection in currently unleveed areas undertaken by private landowners.

3.3.4.1 *Sediment Transport*

A sediment trend analysis was conducted to establish existing conditions of the Agua Fria River channel (Fuller, 2001). The conclusions drawn from those models are summarized below.

The Agua Fria River has been significantly influenced by human activity, including the construction of New Waddell Dam, sand and gravel mining, construction of bridged roadway crossings, and channelization. The sediment trend analysis indicates that the Agua Fria River is currently responding

to external influences. The river is generally moving sediment from the upstream reach of the river to the downstream reach. The gradation of the materials in the riverbed is coarser (larger) in the upstream reach and finer (smaller) in the downstream reach indicating the movement of sands and small gravel from upstream to downstream during flood flows. This is a relative conclusion, because overall sediment inputs into the channel will continue to decrease. The sediment transportation process is subject to localized channel conditions that result in inclusions of aggrading and degrading sub-reaches throughout the channel (Fuller, 2001).

3.3.4.2 *Lateral Migration/Erosion*

Archaeological records imply that channel erosion has affected the Agua Fria River for at least 2,000 years. This indicates that lateral erosion is not caused solely by human impacts on the channel and watershed. Natural cycles of stream degradation, local aggradation, lateral migration, and climate change must be accounted for in development of the erosion hazard zones and the watercourse management plan. Climatic changes have been significant factors in long-term lateral erosion and channel development (Fuller, 2001).

An inventory of changes to the Agua Fria River based on historical maps and aerial photographs indicates that human impacts have been substantial in the past 100 years (Fuller, 2001). These impacts include construction of:

- Eleven major bridges
- Three dedicated at-grade road crossings
- Beardsley Canal flume
- CAP and Roosevelt Irrigation District (RID) siphons
- Aggregate mines
- Numerous levees and grade control structures
- Utility crossings (buried and aerial)
- Landfill
- Recreational facilities
- Groundwater recharge facilities
- Water treatment dams
- Airport flood control dams.

Additionally, there has been encroachment by residential development, filling within the floodplain, and illegal dumping.

The existing river bears little resemblance to its prehistoric ancestor. Except for the decrease in low flows and reduction of flood peaks due to construction of New Waddell and other dams, human impacts tend to destabilize stream channels and lead to increased rates of lateral erosion due to reduced sediment supply, increased flood flow peaks, and direct excavation of the channel for mining (FCDMC, 2001b).

Although historical changes in watershed hydrology imply that use of pre-New Waddell Dam channel changes may lead to conservative estimates of future channel movement due to decreased peak flows, historical data do provide the most reliable physical basis for such predictions. While the future lateral movement of the Agua Fria River may be somewhat muted in comparison to past lateral movement, the

historical data changes at minimum represent the upper boundary of predictions of future changes. Furthermore, given the uncertainty in flood storage conditions in Lake Pleasant, the potential for large, sustained, erosive outflows from New Waddell Dam still exists. The scale of lateral erosion during such a large flood would be analogous to the scale of erosion during historical pre-New Waddell Dam floods. Therefore, measurements of long-term and single event lateral and vertical erosion were made for the Agua Fria River from historical maps and aerial photographs to establish a baseline of potential channel movement (FCDMC, 2001b).

Historical channel width and channel position have changed significantly during the past 100 years. Overall, the average channel width decreased from 1,696 feet in 1953 to about 968 feet in 1999, except in the levee reach where the channel was artificially widened during levee construction. Despite this historical narrowing trend, significant lateral movement has occurred. The maximum recorded channel movement was more than 2,200 feet. During the 1980 flood, the channel near Indian School Road widened by more than 1,100 feet. Avulsions were the primary mechanism for the largest long-term channel movements in the study reach. Bed elevations fluctuated throughout the study reach, with an overall decrease (degradation) during the period of record. The maximum measured degradation between 1903 and 1995 was 13 feet, with most of the degradation occurring after 1957. No reaches experienced net aggradation during the period of record, including the reach nearest the Gila River confluence. The rate of lateral movement has been fastest on the youngest, less indurated surfaces and slowest along the margins of the older, more indurated surfaces. Therefore, the older terrace margins serve as a practical limit for predicted future rapid channel change, although the older terraces are also subject to lateral erosion where abutted by the main channel (FCDMC, 2001b).

Analysis indicates that the Agua Fria River is over-widened and under-deepened and will continue to narrow in the future. Concentration of floods within a narrower, deeper channel will result in higher flow velocities, erosion of the main channel banks, and continued long-term degradation, but decreased potential for avulsions, except during the largest floods. Flood velocities in the main channel generally exceed allowable velocity limits for non-cohesive sediments, even for the 2-year flood. However, where the channel abuts more cohesive older surfaces, the channel velocities are generally less than the allowable velocity thresholds. Overbank velocities are generally considered erosive, especially for overbank areas dominated by finer-grained sediments and areas of local flow concentrations (FCDMC, 2001b).

Analysis indicates that the Agua Fria River will continue to degrade during large floods. During smaller floods, the middle reach is expected to remain stable or aggrade slightly. These predictions do not account for the effects of in-stream sand and gravel mining, which tends to accelerate long-term degradation and induce headcutting. In general, the bed material of the Agua Fria River is not large enough to form an armor layer that would prevent long-term degradation. Predicted single-event scour depths are moderate, ranging from about one foot for the 2-year event, to about five feet for the 100-year event. Analysis indicates that lateral erosion and degradation will occur during large floods, but minimal erosion will occur during small floods, except where the channel has been disturbed by human activity (Fuller, 2001; FCDMC, 2001b).

Three erosion hazard zones are defined for the study reach (Fuller 2001; FCDMC, 2001b). These zones are listed and described below.

- Severe Erosion Hazard Zone
- Lateral Migration Erosion Hazard Zone
- Long-Term Erosion Hazard Zone.

Severe Erosion Hazard Zone

The severe erosion hazard zone is comprised of the active stream channels and the channel margin areas likely to be eroded during a single 100-year flood or the area likely to be removed if the bank angle was to be reduced to the natural angle of repose. Areas within the limits of existing sand and gravel mining operations were considered to be in the severe erosion hazard zone since no engineered erosion protection was observed near the mines during field visits (Fuller, 2001).

Lateral Migration Erosion Hazard Zone

The lateral migration erosion hazard zone consists of the channel margin area likely to be eroded by a "typical" series of floods over a 60-year period, plus the erosion that would be caused by a 100-year flood. The lateral migration erosion hazard zone also includes the natural channel movement due to geomorphic processes such as meander migration or channel avulsion. The lateral migration erosion hazard zone includes portions of the floodplain that have been occupied by the main channel during the period of the historical record, unless clear and convincing evidence of future stability was available. In general, the lateral migration erosion hazard zone included areas outside the regulatory floodway of the Agua Fria River (Fuller 2001; FCDMC, 2001b).

Long-Term Erosion Hazard Zone

The long-term erosion hazard zone consists of the channel margin area defined by geologic evidence of channel movement over the past 100 to 1,000 years and represents expected or potential channel movement over the next 60 to 1,000 years in the future. The boundary of the expected long-term erosion hazard zone envelopes the results of all the predictive methods used to assess channel stability, in addition to application of engineering judgment and interpretation of the site geomorphology. Portions of the areas mapped as older geomorphic surfaces, but adjacent to active channels and floodplains, were generally included in the long-term erosion hazard zone. Areas protected by engineered levees or other bank protection were considered the outside limit for the long-term erosion hazard zone.

In general, high rates of single-event and long-term erosion should be expected, except where structural flood control measures are provided (Fuller 2001; FCDMC, 2001b).

El Río Vision – Watercourse Master Plan. The El Río Vision Watershed Master Plan represents a multi-agency planning effort to develop a watercourse master plan along the Gila River from its confluence with the Agua Fria River downstream to SR MC 85. This effort collaborates with the

USACE and other funding sources to carry out a reconnaissance study as part of the overall plan development. This effort is still in the planning stage.

3.3.5 Surface Water Quality

Because surface flows are intermittent and ephemeral, surface water quality data are not readily available within the study area. Measurements for the Clean Water Act, Section 303(d) total maximum daily load (TMDL) program were analyzed as a proxy for a general understanding of ambient conditions. Water quality conditions at nuisance water discharge sites, such as the Avondale Wastewater Treatment Plant, were focused on and analyzed in detail because these water sources will be prerequisites for restoration efforts, along with groundwater quality (Section 3.3.2.4). Additional water quality sampling will be performed as required in future phases of the restoration project.

Ambient Conditions – Section 303 (d) TMDL

The Clean Water Act, Section 303(d), requires states to identify water bodies that are not meeting established water quality standards. The states must designate water quality limited segments (WQLS) based on the level of pollution and the designated uses of water. For each identified pollutant, the State must determine a TMDL, which is the amount of that pollutant that a water body can tolerate without exceeding the water quality standard. TMDLs take into account all sources of a pollutant (both point and non-point), seasonal variations, and safety margins.

As of the end of 2002 Arizona had 148 water bodies on the 303(d) list. No WQLSs have been established for the reach of river that will be analyzed for the restoration project. However, WQLSs have been identified for some sections of the Agua Fria River and the Gila River within the vicinity of the project area, as described by Table 3.3-7.

Table 3.3-7 Water Quality Limited Segments (WQLS) of the Agua Fria River and the Gila River in the Vicinity of the Project Area

River	Segment Description	Stressors	Comments	Within Study Area?
Agua Fria River	Big Bug-Squaw Creek – 16 miles	Turbidity		No
Gila River	Agua Fria-Waterman Wash – 12 miles	Chlordane;DDT metabolites; dieldrin; toxaphene	Based on fish consumption advisory. Pesticide use banned. Source is historic use.	No
Gila River	Salt River – Agua Fria River – 4 miles	Chlordane;DDT metabolites; dieldrin; toxaphene	Based on fish consumption advisory. Pesticide use banned. Source is historic use.	No
Gila River	Centennial – Rainbow Wash – 5 miles	Chlordane;DDT metabolites; dieldrin; toxaphene	Based on fish consumption advisory. Pesticide use banned. Source is historic use.	No
Gila River	Gillespie Dam – Centennial Wash – 5 miles	Selenium; chlordane; DDT metabolites; toxaphene; fecal coliform	Chronic standard violation for Selenium. The rest based on fish consumption advisory. Pesticide use banned. Source is historic use	No
Gila River	Waterman Wash – Hassayampa – 14 miles	Chlordane;DDT metabolites; dieldrin; toxaphene	Based on fish consumption advisory. Pesticide use banned. Source is historic use.	No

Source: Arizona Department of Environmental Quality. 1998b 303(d) List

Discharges – Maricopa County Urban Storm Runoff

The USGS (Lopes, 1992) investigated the properties of urban storm runoff in Maricopa County. Storm runoff samples were collected from four drainage basins with residential, light-industrial, heavy-

industrial, and undeveloped land uses. One of the basins was a tributary to the Agua Fria River, and its contents originated in primarily residential areas. Summary statistics for the US Geological Survey study area are presented in Table 3.3-8.

Table 3.3-8 US Geological Survey Investigation of Stormwater Quality – Maricopa County

Property or Constituent	Maximum	Minimum	Mean	Median	Number of Samples
Suspended Solids (mg/l)	3,390	<1	607	229	16
Dissolved Solids (mg/l)	158	35	81	76	14
Fecal Coliform (col/100 ml)	11,000	970	4,800	4,600	15
Fecal Streptococci (col/ml)	26,000	1,000	9,100	8,500	15
COD (mg/l)	21,000	<10	1,900	140	15
BOD	3,600	<5	310	30	14
Ammonia, total (mg/l)	0.89	0.07	0.39	0.38	15
Nitrite + nitrate (mg/l)	4.7	0.42	1.3	0.77	15
Conductance (µS)	266	52	128	99	15
Nitrogen, ammonia +organic (mg/l)	3	0.60	1.74	1.70	15
Phosphorus, total (mg/l)	1.7	0.11	0.53	0.43	15
Arsenic, total (µg/l)	21	2	7.7	5.0	17
Cadmium, total (µg/l)	6.0	<1	1.5	1.0	17
Chromium, total (µg/l)	120	<1	24	10	17
Copper, total (µg/l)	320	7	110	52	10
Lead, total (µg/l)	620	8	140	51	17
Nickel, total (mg/l)	120	4	37	17	17
Zinc, total (µg/l)	980	30	300	170	17

Source: Selected Physical, Chemical, and Microbial Characteristics of Storm Water, Maricopa County, Arizona, T.J. Lopes, USGS, 1992.

Discharges – Avondale Wastewater Treatment Plant

The Avondale Wastewater Treatment Plant sampled effluent surface water quality to comply with their NPDES permits. Table 3.3-9 shows the water quality data between December 2000 and November 2001.

Table 3.3-9 Avondale Wastewater Treatment Plant Effluent Water Quality

Date	Flow (million gallons/day)	EFF. TSS (mg/l)	EFF. BOD (mg/l)	EFF. TDS (mg/l)	N02 + N03 (mg/l)	TKN (mg/l)	Fecal MPN	EFF pH	Turbidity
December 2000									
Number of Samples	31	2	2	NA	2	2	2	31	2
Maximum	3.22	2.7	2.0		0.2	0.9	26	7.9	0.8
Minimum	2.71	1.1	0		0.1	0.7	4	6.1	0.8
Average	2.91	1.9	1.3		0.2	0.8	15	7.3	0.9
January 2001									
Number of Samples	31	2	2	NA	2	2	2	31	2
Maximum	3.35	2.9	5.0		0.1	3.1	7	8.2	0.9
Minimum	2.63	2.3	5.0		0.2	1.6	4	7.0	0.8
Average	2.97	2.6	5.0		0.2	2.4	6	7.2	0.9
February 2001									

Date	Flow (million gallons/day)	EFF. TSS (mg/l)	EFF. BOD (mg/l)	EFF. TDS (mg/l)	N02 + N03 (mg/l)	TKN (mg/l)	Fecal MPN	EFF pH	Turbidity
Number of Samples	31	2	2	NA	2	2	2	28	2
Maximum	3.37	6.7	5.0		0.3	8.0	17	7.3	0.9
Minimum	2.75	2.4	5.0		0.3	2.4	2	6.8	0.7
Average	3.05	4.6	5.0		0.3	5.2	10	7.2	0.8
March 2001									
Number of Samples	31	2	2	NA	2	2	2	30	2
Maximum	3.67	310	8.0		0.4	21.0	18	7.5	0.9
Minimum	2.21	258	5.5		0.3	16.0	17	6.6	0.9
Average	3.01	284	6.8		0.4	18.5	18	7.2	0.9
April 2010									
Number of Samples	31	2	2	NA	2	2	2	30	2
Maximum	3.34	275	5.0		0.2	6.2	9	6.6	0.7
Minimum	2.74	300	8.3		0.7	11.0	11	7.3	0.9
Average	2.94	280	7.1		0.4	8.6	10	7.1	0.8
May 2001									
Number of Samples	31	2	2	NA	2	2	2	31	2
Maximum	3.26	4.9	6.6		0.9	3.1	80	7.7	0.5
Minimum	2.61	3.6	3.4		0.2	2.2	34	6.8	0.3
Average	2.90	4.3	5.5		0.06	2.7	57	7.3	0.4
June 2001									
Number of Samples	31	2	2	NA	2	1	2	31	2
Maximum	3.32	2.9	8.4		0.2	2.0	32	7.7	0.8
Minimum	2.77	2.4	6.4		0.1	2.0	21	7.1	0.7
Average	2.99	2.7	7.4		0.2	2.0	27	7.4	0.8
July 2001									
Number of Samples	31	4	2	2	2	2	2	31	2
Maximum	3.40	3.8	6.4	75	0.2	2.0	50	7.5	0.9
Minimum	2.85	5.2	4.2	48	<0.1	1.1	9	6.9	0.9
Average	3.10	3.0	5.3	61	0.1	1.6	30	7.3	0.9
August 2001									
Number of Samples	31	3	2	NA	2	2	2	31	2
Maximum	3.74	4.1	7.4		0.4	9.5	64	7.5	0.9
Minimum	3.01	3.2	3.4		0.3	1.4	19	6.9	0.6
Average	3.27	3.5	5.1		0.4	5.5	42	7.2	0.8
September 2001									
Number of Samples	31	2	2	NA	2	NA	2	31	2
Maximum	3.71	4.5	7.0		0.9		27	7.5	0.9
Minimum	3.03	3.8	3.1		0.4		22	7.1	0.9
Average	3.31	4.2	5.5		0.7		24	7.3	0.9
October 2001									
Number of Samples	31	3	2	NA	2	2	2	31	2
Maximum	3.93	3.0	4.3		0.8	1.9	13	7.6	0.9
Minimum	3.52	2.9	3.1		0.7	<0.50	2	6.8	0.8
Average	3.25	3.0	3.7		0.8	1.0	8	7.3	0.9
November 2001									
Number of Samples	31	2	2	NA	2	2	2	31	2
Maximum	3.99	5.5	8.6		0.5	5.9	33	7.6	0.9
Minimum	3.31	4.6	8.2		0.3	5.3	22	7.1	0.9
Average	3.50	5.1	8.4		0.4	5.6	28	7.2	0.9

Source: City of Avondale

Key: EFF TSS = Effluent Total Suspended Solids; EFF BOD = Effluent Biological Oxygen Demand: EFF TDS = Effluent Total Dissolved Solids; NO2 + NO3 = Nitrate and Nitrite; MPN = Most Probable Number

Discharges – Interstate 10 Drainage Channel

Sampling results for the I-10 drainage channel are not available form ADOT. For this road drainage, stormwater sampling is not required under the current NPDES permit, and dry sampling is only required on a subset of road drainages, meaning dry sampling on the I-10 drainage is at best, infrequent. During storm events most of the water comes from the Phoenix and Glendale areas, such that the information presented in Table 3.3-8 may be representative (Gavin, pers. comm., 2002). While these sources, at best, serve only as an ephemeral or intermittent source of water; the quality of the water is important for understanding its potential for limiting native plant growth. Sediment samples taken at two locations where the I-10 drainage empties into the Agua Fria River channel were analyzed for the presence of pesticides. The results of the analysis were negative; however, the timing and design of the sampling effort were intended only to provide a general indication of conditions and should not be considered conclusive. Appendix F provides the laboratory results of that analysis.

3.4 EARTH RESOURCES

3.4.1 Regulatory Setting

Geologic/seismic regulations are primarily focused on building structural safety practices. Since the project would not entail any permanent building structures that would expose any persons to potential seismic or geologic risks, there are no pertinent building code regulations. However, any engineered or designed structures related to the project would be required to comply with any relevant geologic/seismic construction regulations.

3.4.2 Regional and Local Topography

This project area lies in the Phoenix Basin of the Salt River Valley, an alluvial plain bordered by the New River and Hieroglyphic Mountains on the north, the Superstition Mountains on the east, the Sierra Estrella Mountains on the south, and the White Tank Mountains on the west. This part of Arizona is known as the Gila Lowland Section of the Sonoran Desert Subprovince, Southern Basin and Range Physiographic Province. Most of the western Salt River Valley is drained by the Salt and Agua Fria Rivers. Secondary drainages include the New River, Skunk Creek, and Cave Creek. The topography of the regional area is characterized by broad, gently sloping, connected valleys or plains bounded by moderately high, rugged mountain ranges. Numerous low-lying isolated hills that project above the valley surfaces represent eroded mountain peaks that have been almost completely buried in alluvial material (USACE, 1986). Local topography is depicted in Figures 5 to 8, based on surveys completed in 1991 and 1994 and provided by the FCDMC.

3.4.3 Geology

3.4.3.1 *Geologic History*

Many of the older extrusive volcanic rocks in the Salt River Valley area were products of the Mid-Tertiary (late Oligocene to middle Miocene) orogeny that produced great quantities of rhyolitic to andesitic tuffs, breccias, and flows. With the waning of the mid-Tertiary orogeny, an un-conformable

surface was developed. Topographic lows became sites for fanglomerate and lacustrine deposition. Continued minor volcanic activity is indicated by tuff beds and extrusive flows intercalated in the fanglomerates and lacustrine sedimentary strata.

During the late Miocene periods in southwestern Arizona, subsidence, block-faulting, and erosion broke up the region with its existing Precambrian and younger rocks. This gave the area a typical basin and range structure of mountain forming horsts separated by valleys underlain by grabens or half-grabens.

Deposition began in the basins as soon as they were formed. In the Salt River Valley area, the sediments were deposited under oxidizing conditions in fluvial and lacustrine environments and consisted of clastics and evaporite sequences. Included in the thin sedimentary sequence are some interbeds of extrusive volcanic rocks. A thin basalt flow, occurring within lacustrine sediments overlying evaporite deposits near Luke Air Force Base, is the youngest volcanic rock in the Phoenix area. This flow, possibly 10 million years old or less, is late Miocene to early Pliocene in age (USACE, 1986).

3.4.3.2 *Regional and Local Geology*

The rock types found in the mountainous areas beyond the proposed project area consist of the following geologic foundations: (a) an igneous and metamorphic basement complex composed predominantly of Precambrian schist, gneiss and granite, with local quartzite and slate, and Tertiary intrusive granites; (b) Tertiary volcanic rocks in the form of basalt, andesite and rhyolite flows and tuffs; and, (c) Tertiary sedimentary rocks consisting of sandstone to coarse conglomerate (USACE, 1986).

Recent (Quaternary) alluvium, consisting mostly of unconsolidated sand and gravel, fills the channels of the main stream courses and covers the adjacent floodplains. The total thickness of the alluvial materials varies from zero along the mountain fronts to several thousand feet under the valley interior.

Surface materials in the project area consist generally of unconsolidated admixtures of Quaternary (recent) alluvial gravel, sand, silt, and clay. These deposits fill the streambeds and cover the adjacent floodplains of the main watercourses and overlie variably consolidated older Quaternary alluvial fill of similar composition. The Quaternary alluvium overlies Tertiary sediments composed of sand, silt, clay, evaporates and conglomerate. The Tertiary sediments rest on the Precambrian basement complex to a depth of at least 1200 feet.

3.4.4 Geologic Hazards

Faulting

The greatest concentration of faults in Arizona coincides with the transition zone physiographic province and the basin and range mountain region subprovince along the Jerome-Wasatch Structural Zone, which extends from southwest Utah, south to southeast across Arizona into Mexico. The zone is

associated with numerous earthquakes and contains evidence of Quaternary faulting. The edge of the Jerome-Wasatch Zone is over 30 miles northeast of the project area (USACE, 1986).

The most significant fault in Arizona is the 100-mile Main Street Fault, which trends north-south and is approximately 150 miles northwest of the project area. The Verde fault system is approximately 50 miles northeast of the project area at its southern extent, and it has a total length of about 45 miles. The Main Street and Verde faults have each shown signs of Quaternary movement; however, there is no record of historic or Holocene surface ruptures. The third largest fault system (42 miles long) is near Globe, Arizona, approximately 90 miles from the project area, although this system is not considered active (USACE, 1986).

Seismicity

An evaluation of the geologic and seismic conditions within an approximate 100-mile radius of the project area indicates that the project would be in an area of low seismicity (USACE, 1986). Earthquake records indicate that Arizona is outside the circum-Pacific belt that includes the Pacific Coast and adjacent parts of the western mountain region of the United States. The largest known earthquake to occur in Arizona was one of Richter magnitude 5.7 recorded in 1959 near Fredonia, approximately 220 miles from the project area. The largest historical earthquake known to have caused widespread damage in Arizona was the 1887 Sonora, Mexico. This event, although approximately 225 miles from the project site, resulted in rock falls in the project area (USACE, 1986).

Subsidence

Subsidence and Settlement. Subsidence is a localized movement that involves the gradual settling or sinking of the earth's surface, resulting from the extraction of mineral resources, subsurface oil, groundwater, or other subsurface nonsolid resources, such as natural gas. Settlement is gradual downward movement of a structure due to compression of the soil below the foundation. The principal cause of subsidence in the Phoenix area is the extraction of groundwater, whereas settlement results from the compression of soils due to the weight of a structure on the ground surface.

Surface subsidence and associated earth-fissure development have occurred in the Phoenix Basin as a result of major groundwater declines. Subsidence values along the flood control project alignment were estimated in 1986 between zero and one foot. West of the project area, within an approximate 130-square-mile area encompassing Luke Air Force Base, subsidence is estimated to be between one and three feet. The Phoenix Basin will continue to be affected by subsidence as long as groundwater overdraft continues. In the immediate project area, the rate of future subsidence may, in part, be affected by any possible widening or migration of the cone of depression near Luke Air Force Base.

Earth fissure have not been observed in the immediate project area; the closest occurrences are about two and four miles west, near Luke Air Force Base, where subsidence was estimated. Fissures develop where differential subsidence occurs because of irregular alluvial thickness or lithology associated with deep cones of depression produced by groundwater withdrawal. Sufficient data, however, are not

available to determine whether subsidence and/or fissuring will become a problem in the future (USACE, 1986).

3.4.5 Soils

The lower reach of the Agua Fria contains several soil complexes (FCDMC, 2001b). West of the river is the Laveen-Coolidge soils, and along the Gila River–Agua Fria River confluence is the Carrizo soil. The Laveen-Coolidge soil is composed of nearly level sandy loams, loams, and clay loams on old alluvial fans and valley plains. This soil is deep and when irrigated, makes prime farmland. The Carrizo soil is nearly level and gently sloping, occasionally flooded, and very gravelly or sandy. This soil is evident on flood plains. The Carrizo has a depth of over 60 inches, and has a high permeability. This soil is used mostly for rangeland, but when irrigated, can be prime farmland (FCDMC, 2001b).

The materials in the streambed of the Agua Fria River between New River and the confluence with the Gila River are predominantly loose to medium-dense, non-cohesive sands and gravelly sands with less than 15 percent cobbles to 10 inches in diameter at the upstream end of the reach, gradually becoming finer downstream until silts and sands with less than 5 percent cobbles to 6 inches in diameter predominate below Buckeye Road. Materials are relatively free of cobbles and boulders to about eight feet.

The overbank materials along the Agua Fria River in the study reach are predominantly medium-dense sands, silty sands and moderately cohesive sandy silts with scattered layers of gravelly sand and generally less than 5 percent cobbles to 10 inches in diameter. In the vicinity of the west levee downstream from Buckeye Road, the foundation materials are relatively loose. These materials were removed or compacted before placement of levee fill materials. The foundation materials at the location of the east levee at Lower Buckeye Road are moderately dense. Surface soils are relatively pervious. The duration of the SPF and lesser floods would indicate that water does not remain long enough after floods to saturate soils.

Test holes and test trenches from explorations performed in June and July 1984 (USACE, 1986) indicated that materials from zero to as deep as 16 feet are predominantly sands. Just upstream of I-10 surface materials from zero to ten feet are generally classified as sand, sandy silt, sandy gravel, gravelly sand or silty sand and in most cases damp, moist or wet soils were found from two to six feet of the surface. Most of these test trenches were located near the bank or within the channel. From I-10 down to Lower Buckeye Road finer materials were found in the surface one to two feet and classified as sandy silt, silty sand or sandy clay. Below that depth coarser materials again predominated. Again, moist or damp soils were found within two and one half feet from the surface. From Lower Buckeye Road to the Gila River material was similar.

Soil Samples

Soil Fertility Tests

In April 2002, soil samples were taken at seven locations throughout the project area at approximately two feet depth. Two locations each were sampled near the I-10 discharge, Durango Regional Outfall Channel at Buckeye Road and in the channel at the AWWTP outfall, and one samples was taken at the Chicken Ranch mitigation site (Table 3.4-1 and Figure 4). The subsurface samples were analyzed for standard fertility characteristics and one of the samples at the I-10 discharge was subjected to a metals scan. Wallace Laboratories, in El Segundo, California, performed the soil tests.

Table 3.4-1 Soil Sample Locations

Soil Site Number	Location	Depth of Sample
1	North of I-10, on the east side of the channel, near the outflow channel.	2 feet
2	South of I-10, east side of the channel	2 feet
3	North of Buckeye Road, east side of channel, near Durango outflow	2 feet
4	South of Buckeye Road, east side of channel	2 feet
5	Avondale Wastewater Treatment Plant Site, near southern end of surface water flow	2 feet
6	Avondale Wastewater Treatment Plant Site, south of the southern end of surface water flow	2 feet
7	Chicken Ranch site, south of Avondale Wastewater Treatment Plan site	2 feet

The soils sampled had a moderately high alkalinity, with pH values range from 8.08 to 8.70. Limestone was present in nearly half of the samples. Salinity levels were low to moderate. Most of the samples were low in phosphorus and nitrogen. Boron was low in most of the samples, while zinc low only in two of the samples. The metal scans did not reveal abnormal conditions. See Appendix F for the complete results of the soil tests, along with recommendations for soil additions at specific sites to improve fertility and plant success.

Pesticide Presence/Absence Soil Tests

Soil samples were taken to test the presence/absence of pesticides near the I-10 outflow channel because of concerns that agricultural runoff would contaminate river sediments. Results indicated that pesticide levels were negligible in the samples. For the complete soil sample report see Appendix F.

3.5 AIR QUALITY AND CLIMATE

3.5.1 Regulatory Setting

Federal Regulations

Clean Air Act of 1970. The Clean Air Act (CAA) directs the attainment and maintenance of National Ambient Air Quality Standards (AAQS) for six "criteria" pollutants [ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), respirable particulate matter (PM_{10}), sulfur dioxide (SO_2), and lead (Pb)]. Under the CAA, when air quality of a geographical area contains enough impurities to be deemed polluted, the U.S. Environmental Protection Agency (EPA) classifies it as being in "non-attainment." The EPA then must approve a State Implementation Plan (SIP) that defines the actions to be taken and the time schedule for air quality to be improved and attainment achieved. The EPA implements the New Source Review (NSR) and Prevention of Significant Deterioration (PSD) regulations in areas of "attainment." Additional Federal laws related to air quality control are:

- The **1977 Clean Air Act** enacted legislation to control seven air toxic pollutants. EPA adopted the National Emission Standards for Hazardous Air Pollutants (NESHAP), which was designed to control Hazardous Air Pollutants (HAP) emissions to prevent adverse health effects in humans.
- The **1990 Amendments to the Clean Air Act** determine attainment and maintenance of NAAQS (Title I), motor vehicles and reformulation (Title II), hazardous air pollutant (Title III), acid deposition (Title IV), operating permits (Titles V), stratospheric ozone protection (Title VI), and enforcement (Title VII).

General Conformity. Under Section 176(c) of the Clean Air Act Amendments (CAAA) of 1990, the Lead Agency is required to make a determination of whether the Proposed Action "conforms" with the State Implementation Plan (SIP). Conformity is defined in Section 176(c) of the CAAA as compliance with the SIP's purpose of eliminating or reducing the severity and number of violations of the National Ambient Air Quality Standards (NAAQS) and achieving expeditious attainment of such standards. However, if the total direct and indirect emissions from the Proposed Action are below the General Conformity Rule *de minimis* emission thresholds, the Proposed Action would be exempt from performing a comprehensive Air Quality Conformity Analysis, and would be considered to be in conformity with the SIP.

State and Local Laws and Regulations

The Arizona Department of Environmental Quality (ADEQ), Air Quality Division has compliance and enforcement responsibility for all portable sources in the project area. Stationary and construction dust sources in the project area are regulated by the Maricopa County Environmental Services Department (MESD). The ADEQ and MESD adopt rules designed to fulfill the State's responsibilities under the Federal Clear Air and its amendments to provide a legally enforceable SIP for the attainment and maintenance of the NAAQS.

The State Implementation Plan (SIP). The SIP is the cumulative record of all air pollution strategies, non-attainment area plans (NAPs), statutes, rules, and ordinances implemented under Title I of the Clean Air Act by governmental agencies within Arizona, such as ADEQ and MESD. Revisions to Arizona's SIP must be submitted to the EPA by the director of the ADEQ on behalf of the governor. Once approved by EPA as published in the Federal Register, the provisions contained in the SIP revision become enforceable by the Federal government as well as by the appropriate governmental entities of Arizona. The following rules that have been adopted by ADEQ or the MESD that may be applicable to the restoration project are:

- **Arizona Administrative Code Rule Title 18, Chapter 2, Title 606 (R18-2-606), Material Handling.** No person shall cause, suffer, allow or permit crushing, screening, handling, transporting or conveying of materials or other operations likely to result in significant amounts of airborne dust without taking reasonable precautions, such as the use of spray bars, wetting agents, dust suppressants, covering the load, and hoods to prevent excessive amounts of particulate matter from becoming airborne.
- **R18-2-607, Storage Piles.** (A) No person shall cause, suffer, allow, or permit organic or inorganic dust producing material to be stacked, piled, or otherwise stored without taking reasonable precautions such as chemical stabilization, wetting, or covering to prevent excessive amounts of particulate matter from becoming airborne. (B) Stacking and reclaiming machinery utilized at storage piles shall be operated at all times with a minimum fall of material and in such manner, or with the use of spray bars and wetting agents, as to prevent excessive amounts of particulate matter from becoming airborne.

- **R18-2-802, Off-road Machinery.** (A) No person shall cause, allow or permit to be emitted into the atmosphere from any off-road machinery, smoke for any period greater than 10 consecutive seconds, the opacity of which exceeds 40 percent. Visible emissions when starting cold equipment shall be exempt from this requirement for the 1st 10 minutes. (B) Off-road machinery shall include trucks, graders, scrapers, rollers, locomotives and other construction and mining machinery not normally driven on a completed public roadway.
- **House Bill (HB) 2538 Section 1.** By July 1, 2002, Maricopa County must adopt an ordinance that limits the idling time of heavy-duty diesel vehicles (gross weight over 14,000 pounds).
- **House Bill (HB) 2538 Section 10.** The ADEQ will encourage the voluntary replacement of old diesel equipment with less polluting newer equipment, as well as the voluntary usage of ultra-low sulfur diesel fuel, on an accelerated basis to achieve higher Federal standards.
- **Maricopa County Air Pollution Control Rule 310.** Rule 310 applies to sources of fugitive dust within Maricopa County, including construction sites. The PM_{10} SIP for Maricopa County relies upon Rule 310 for its demonstration of attainment. It establishes limits for the emissions of particulate matter into the ambient air from any property, operation, or activity that may serve as an open fugitive dust source. Construction projects that disturb a total surface area of 0.1 acre or more require a permit from the MESD. These projects are required to have a valid permit before the soil is disturbed. If the project continues for more than 1 year, the permit must be renewed.
- **Maricopa County Air Pollution Control Rule 314.** Rule 314 requires a project proponent to obtain a Burn Permit from the County Control Officer before igniting, causing or permitting to be ignited, allowing, or maintaining an open outdoor fire. The Control Officer may impose any permit conditions that are necessary to ensure compliance with all Federal Laws, State laws, or local rules. Burn Permit conditions(s) may include, but are not limited to, burning hours, notification of intent to burn, and Burn Permit posting.

3.5.2 Climate

The study area is located in southwestern Arizona. It is characterized as semiarid with long, hot summers and short, mild winters. Most of the annual rainfall in the study area occurs in a bimodal pattern. Winter precipitation from December to March is generally associated with mid-latitude cyclonic disturbances from the Pacific Ocean, while summer precipitation during July and August is associated with tropical warm, moist air masses from the Gulf of Mexico. Minor or no precipitation occurs between April and June, the driest months.

Monthly temperature and precipitation data for Litchfield Park, which is located in the northern portion of the study area, is available from the Western Regional Climate Center. As described in Table 3.5-1, average summer (July) high and low temperatures in Litchfield Park are 106.9°F (41.6°C) and 75.4°F (24.1°C). The hottest months are June through August. Average winter (January) high and low temperatures in the study area are 66.9°F (19.4°C) and 36.0°F (2.2°C). Rainfall averages approximately 8.2 inches (20.9 cm) per year in the study area. Winds are from the east and southeast throughout the year, switching to westerly from May to July. Average monthly wind speeds range from 6 to 8 mph.

Table 3.5-1 Average Monthly Temperatures and Precipitation in the Project Area

Month	Temperature				Precipitation	
	Maximum		Minimum			
	°F	°C	°F	°C	Inches	Centimeters
January	66.9	19.4	36.0	2.2	0.89	2.26

February	71.8	22.1	39.7	4.3	0.96	2.44
March	77.4	25.2	43.7	6.5	0.84	2.13
April	86.2	30.1	49.7	9.8	0.33	0.84
May	95.2	35.1	57.7	14.3	0.13	0.33
June	104.2	40.1	66.3	19.1	0.08	0.20
July	106.9	41.6	75.4	24.1	0.73	1.85
August	104.7	40.4	74.0	23.3	1.21	3.07
September	100.4	38.0	66.7	19.3	0.87	2.21
October	89.7	32.1	53.7	12.1	0.48	1.22
November	76.6	24.8	42.0	5.6	0.64	1.63
December	67.9	19.9	36.7	2.6	1.06	2.69
Annual Average/Total	87.3	30.7	53.5	11.9	8.21	20.85

Note: Period of Record is from August 1, 1917 to February 29, 2000.
Source: WRCC, 2001.

3.5.3 Air Quality Setting

Criteria Pollutants. The quality of surface air (air quality) is evaluated by measuring ambient concentrations of pollutants that are known to have deleterious effects. The degree of air quality degradation is then compared to the ambient air quality standards established by Federal and State agencies. The air pollutants that are regulated by these standards are called "criteria pollutants." The current National and State Ambient Air Quality Standards are the same in the project area and are listed in Table 3.5-2. Healthy adults can tolerate occasional exposure to air pollutant concentrations above the standards listed in Table 3.5-2 before adverse effects are observed.

Air quality standards are designed to protect those people most susceptible to further respiratory distress, such as asthmatics, the elderly, very young children, people already weakened by other disease or illness, and people engaged in strenuous work or exercise.

Air Quality Attainment Status. Indications of criteria pollutant levels in the project area can be obtained by reviewing recent data collected by the Arizona Department of Environmental Quality (ADEQ) at nearby monitoring stations. The nearest monitoring station to the Study Area is located in West Phoenix at 6180 W. Encanto about 10 miles (16 km) east of the project area. The West Phoenix monitoring station monitors ozone, nitrogen dioxide, suspended particulate matter (PM_{10}), and carbon monoxide. Table 3.5-3 provides the monitoring data collected by the subject monitoring station from 1997 to 1999. Nitrogen dioxide and carbon monoxide standards were not exceeded during the three-year study period. However, the monitoring station recorded values above both the ozone 8-hour standard and the PM_{10} 24-hour standard during this period.

Table 3.5-2 National and State Ambient Air Quality Standards[a]

Pollutant	Averaging Time	National and State Standards	
		Primary[b]	Secondary[c]
Ozone (O_3)	8-hour 1-hour	0.08 (160 $\mu g/m^3$) 0.12ppm (235 $\mu g/m^3$)	NS 0.12 ppm (235 $\mu g/m^3$)
Carbon Monoxide (CO)	8-hour 1-hour	9.0 ppm (10 mg/m^3) 35 ppm (40 mg/m^3)	NS NS
Nitrogen Dioxide (NO_2)	Annual Avg. 1-hour	0.053 ppm (100 $\mu g/m^3$) NS	0.053 ppm (100 $\mu g/m^3$) NS
Sulfur Dioxide (SO_2)	Annual Avg. 24-hour 3-hour 1-hour	80 $\mu g/m^3$ (0.03 ppm) 365 $\mu g/m^3$ (0.14 ppm) NS NS	NS NS 1300 $\mu g/m^3$ (0.5 ppm) NS
Suspended Particulate Matter (PM_{10})	Ann.Geo.Mean Ann.Arith.Mean 24-hour	NS 50 $\mu g/m^3$ 150 $\mu g/m^3$	NS 50 $\mu g/m^3$ 150 $\mu g/m^3$
Suspended Particulate Matter ($PM_{2.5}$)	24-hour Annual	65 $\mu g/m^3$ 15 $\mu g/m^3$	NS NS
Sulfates (SO_4)	24-hour	NS	NS
Lead (Pb)	30-day Avg. Calendar Qtr.	NS 1.5 $\mu g/m^3$	NS 1.5 $\mu g/m^3$

Notes: NS = no standard; ppm = parts per million; $\mu g/m^3$ = microgram per cubic meter; mg/m^3 = milligrams per cubic meter

[a] Standards are not to be exceeded more than once per year with two exceptions. In the case of ozone and PM_{10}, compliance is determined by the number of days on which the ozone or PM_{10} standard is exceeded. The number of exceedance days per year, based on a 3-year running average, is not to exceed 1.0.

[b] Primary Standards are designed to protect public health, allowing for an adequate margin of safety.

[c] Secondary Standards are designed to protect human welfare from any known or anticipated adverse effects of the criteria on the soils, water, crops, animals, structures, or other property.

Source: ADEQ, 1998a.

Table 3.5-3 Air Quality Summary for the Project Area

Standard	1997	1998	1999
OZONE (8-Hour) STANDARD Fourth-Highest 8-Hour Average (ppm) 3-Year Average (Standard met if < 0.084 ppm)	0.078 –	0.086 –	0.091 0.085
NO_2 (Annual Average) STANDARD[a] Annual Average (ppm) (Standard met if < 0.053 ppm)	NA	0.028	0.031
PM_{10} (24-Hour) STANDARD[b] Maximum Concentration (ug/m^3) Days > NAAQS (150 ug/m^3)	345 2/61	107 0/57	111 0/57
CO (8-Hour) STANDARD Maximum Concentration (ppm) Days > NAAQS (9.0 ppm)	6.6 0	7.7 0	7.7 0

Sources: ADEQ, 1998a, 2000, and 2002a.

Notes: ppm=parts per million; ug/m^3=micrograms per cubic meter; NA = Not Available.

[a] No Federal or State (1-hour) NO_2 standard.

[b] "Days" for PM_{10} are given as exceedances/number of annual measurements.

The ozone 8-hour standard is not met when the average of the annual fourth-highest daily maximum 8-hour average ozone concentrations is equal to or greater than 0.085 ppm. An average of the most recent three calendar years is used to assess compliance with this standard. For the years of 1997 through 1999, the fourth-highest 8-hour average is 0.085 ppm. Therefore, the 8-hour ozone standard has not been met during the three-year study period.

With regard to PM_{10}, a maximum 24-hour concentration of 345 Φg/m^3 was recorded in 1997. One other value over the 24-hour standard occurred that year for a total of two violations during 1997. No other violations of the PM_{10} 24-hour standard were recorded during the three-year study period.

Non-attainment is a term used to indicate violations of the standard. As shown in Table 3.5-4, air quality in the study area is designated as serious non-attainment for the National Ambient Air Quality Standards (NAAQS) and the Arizona Ambient Air Quality Standards (AAAQS) for all pollutants, with the exception of nitrogen dioxide, which is classified as attainment.

Table 3.5-4 Attainment Status of the Study Area

Area	O_3	CO	NO_2	PM_{10}
Phoenix Area	Serious NA	Serious NA	Attainment	Serious NA

Notes: A= Attainment of Standards; NA= Non-Attainment of Standards; U/A= Unclassifiable/Attainment
Source: EPA, 2001.

3.6 SOCIOECONOMICS

3.6.1 Regulatory Setting

Executive Order 12898 – Executive Order 12898 directs Federal agencies to assess the effects of their actions on minority and/or low-income populations within their region of influence. Agencies are encouraged to include demographic information related to race and income in their analysis of the environmental and economic effects associated with their actions.

3.6.2 Demographic Characteristics

Table 3.6-1 describes the demographic data for Maricopa County and the City of Avondale, using U.S. Census Bureau data from the 1990 and 2000 censuses. As depicted in the table, total population has increased in the County by 950,048 people and in the City by 19,714 between 1990 and 2000. Minority populations increased in the County of Maricopa between 1990 and 2000, but decreased in the City of Avondale. However, in neither the City nor the County was the low-income population or the minority population greater than 50 percent of the total population.

Table 3.6-1 Demographic Profile Maricopa County and the City of Avondale

	Maricopa County 1990	City of Avondale 1990	Maricopa County, 2000	City of Avondale 2000
Total Population	2,122,101	16,169	3,072,149	35,883
Total Minority Pop.	322,681	6641	695,890	13,179
Minority percent	15.2 %	41.1 %	22.6 %	36.7 %
Total Low-Income Population**	257,359	4493	N/A	N/A
Low-Income percent*	12.1 %	27.8 %	N/A	N/A

Source: US Census 1990 and 2000. http://factfinder.census.gov/servlet/BasicFactsServlet
* Indicates all residents of legal working age
Note: Low income information is not yet available for the Year 2000 Census

3.6.3 Economic Characteristics

Maricopa County

Based on the 1990 Census data (year 2000 census employment data are not yet available), Maricopa County's civilian labor force was 1,070,667 in 1990. Of the civilian labor force, 64,742 were unemployed (U.S. Census 2002). Table 3.6-2 shows the number of people working in specific industries within Maricopa County in 1990. As noted, the majority of people work in retail, manufacturing, construction, transportation, health services, educational services, finance/insurance/ real estate, business/repair, or public administration.

Table 3.6-2 1990 Employment Profile of Maricopa County

Industry	Number of People
Agriculture, forestry, and fisheries	20,147
Mining	1,359
Construction	64,475
Manufacturing, nondurable goods	36,130
Manufacturing, durable goods	115,295
Transportation	46,246
Communications and other public utilities	32,252
Wholesale trade	43,945
Retail trade	177,656
Finance, insurance, and real estate	90,255
Business and repair services	61,954
Personal services	15,850
Industry	**Number of People**
Entertainment and recreation services	76,977
Health services	69,440
Educational services	67,341
Other professional and related services	44,966
Public administration	36,637
Total	**1,000,925**

Source: U.S. Census Bureau, 1990 Census; Note: Year 2000 data on employment are not yet available.

City of Avondale

The City of Avondale ranks as one of the fastest growing residential areas of Maricopa County. Shifting from its historical agricultural base, the City of Avondale has an economy based around commercial enterprise and light industry. Between 1990 and 2000, Avondale's population grew at a rate of over 121 percent (PGEC 2002). Table 3.6-3 lists general economics of the City of Avondale.

Table 3.6-3 General Economic Characteristics of Avondale

Population, 2000	35,883
Growth, 1990-2000	121.90%
Total Civilian Labor Force, 2000	8,912
Employed, 2000	8,457
Unemployed, 2000	456
Median Age, 2000	
0 - 17 years	34%
18 - 34 years	27%
35 - 54 years	28%
55+ years	11%
Education, 1990	

High school graduate	57.10%
Some college	18.20%
Bachelors degree	9.40%
Graduate or professional degree	3.20%
Median Household Income, 2000	$55,157
Real Estate, 2000	
Median home price, new	$124,900
Median home price, resale	$130,000
New building permits	1,327

Source: Phoenix Greater Economic Council

3.7 CULTURAL RESOURCES

3.7.1 Regulatory Setting

National Historic Preservation Act (NHPA) – The National Historic Preservation Act provides leadership in preserving and maintaining the historic and cultural environment of the project location. Under Section 110 of the Act, Federal agencies are required to identify and evaluate the significance of the historic properties that are located on Federal lands. Section 106 (36 CFR 800) requires Federal agencies to take into account the effects of their undertaking on historic properties; and to protect significant historic properties that are located on Federal lands and/or which would be affected by Federal actions.

Based on investigations conducted by Los Angeles District archeological staff, the USACE has determined that no historic properties are present in the project area, therefore pursuant to 36 CFR § 800.4(d)(1), and 36 CFR § 800.3 (f)(2), the USACE is in compliance with Section 106.

Coordination with the Arizona State Historic Preservation Officer is required. A letter was sent to the Arizona State Historic Preservation Officer requesting his concurrence with this determination. The response is provided in Appendix C.

Pursuant to 36 CFR § 800.3 (f)(2) the Corps of Engineers sent a project description along with a request for comments to the Ak-Chin Indian Community, Hopi, Pasqua Yaqui Tribe, Salt River Pima-Maricopa Indian Community, Gila River Indian Community, Tohono O'odham Nation and the Zuni. To date, there has been no response.

If historic properties are discovered during construction activities, work will stop while the property is evaluated under Section 106.

3.7.2 Description of Cultural and Archaeological Resources

The following information is based on data from several sources: Gilpin and Phillips (1999); Gumerman (1991); Gumerman and Haury (1979); Haury (1976, 1945); Mabry (1998); McGuire and Schiffer (1982); Rogers (1998, 1991, 1985).

The lower Agua Fria River valley was extensively utilized during the prehistoric past, and its cultural record may someday prove to have begun more than 11,500 years ago. However, there are currently

no recorded Paleo-Indian or later Archaic sites from this particular portion of the northern Gila River and adjacent Salt River Valley.

The best-known post-Archaic culture interpreted for south-central Arizona was the Hohokam, and unquestionably constitutes the apogee of prehistoric culture of not only south central, but all southern Arizona. Characteristically, the Hohokam were agriculturalists who employed intricate systems of local canal irrigation and both local floodwater and sheetwash farming. They supplemented their cultivated foods with those obtained by hunting, gathering and collecting a wide variety of indigenous plants and animals. Hohokam habitations varied greatly through time and included subsurface pithouses, semi subterranean, masonry-footed, and adobe-walled structures, and large compounds built of adobe and rock.

The Hohokam cultural sequence may have lasted more than 1700 years. Traditionally it has been divided into four periods: Pioneer, Colonial, Sedentary, and Classic; and a series of nine corresponding phases. The earliest period is somewhat controversial, but may have included the Vahki (A.D. 300-500), Estrella (A.D. 500-600), Sweetwater (A.D. 600-700), and Snaketown (A.D. 700-800) phases. The Colonial period is much better known and includes the Gila Butte (A.D. 800-900) and Santa Cruz (A.D. 900-1000). The Sedentary period coincides with the Sacaton phase of A.D. 1000-1200. The final Classic period, at least in the northern Salt-Gilla River Valley, consists of only the Soho (A.D. 1200-1300) and Civano (A.D. 1300-1450) phases.

Due to its location between the plentiful resources along the Salt and Gila Rivers and those in the uplands of the Bradshaw Mountains, the more arid project area was not utilized for habitation by historic Native Americans. The waters of the Agua Fria were not as reliable as those found elsewhere, therefore not sufficient to support farming or permanent settlement.

After the end of the Mexican War and the subsequent Gadsen Purchase in 1854, anticipation of a transcontinental railroad led to explorations throughout the central part of the Arizona Territory. In the mid to late 1800, the Agua Fria River Valley continued to be an area that people passed through on their way to settle elsewhere. After discovery of gold near present-day Wickenburg in 1863, and settlement increasing east of the Agua Fria, additional wagon roads crossed the river in various locations.

Investigations were conducted over the last two years for a watercourse master plan for cultural resources along the Agua Fria River, between the Waddell Dam and the Gila River, for the Flood Control District of Mariposa County. The proposed restoration project area is within the boundary of the above investigations. Although there are recorded historic and prehistoric resources on terraces adjacent to the river, there are no recorded sites within the Area of Potential Effects (APE) of the proposed project.

3.8 HAZARDOUS AND TOXIC MATERIALS

3.8.1 Regulatory Setting

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) – Congress passed CERCLA, also known as "Superfund", in response to a growing national concern about the release of hazardous substances from abandoned waste sites. CERCLA gives the Federal government broad authority to regulate hazardous substances, to respond to hazardous substance emergencies, and to develop long-term solutions for the nation's most serious hazardous waste problems. CERCLA also created a Hazardous Substance Response Trust Fund. This fund, supported by an excise tax on feedstock chemicals and petroleum, is used to pay for cleanup activities at abandoned waste sites.

CERCLA requires the parties responsible for the contamination to conduct or pay for the cleanup. If the Environmental Protection Agency's (EPA's) efforts to take an enforcement action for the cleanup are not successful, the Federal government can clean up a site using the CERCLA Trust Fund. If the Superfund program conducts the cleanup, the government can take court action against responsible parties to recover up to three times the cleanup costs.

In 1986, CERCLA was reauthorized and amended by the Superfund Amendments and Reauthorization Act (SARA). SARA expanded the Federal government's response authorities and clarified that Federal facilities are subject to the same CERCLA requirements as private industry. Under Section 120 of CERCLA, each department, agency, and instrumentality of the United States is subject to, and must comply with, CERCLA in the same manner as any nongovernmental entity. However, funds from the Superfund do not generally go towards paying for the cleanup of releases from Federally owned facilities [Section 111(e)(3)]. Executive Order 12580, signed in January of 1987 and modified in August 1996 by Executive Order 13016, further clarified that Federal agencies and departments are responsible for sites within their jurisdiction.

Arizona Administration Code, Title 18, Chapter 9. The Arizona Administration Code, Title 18, Chapter 9 regulates hazardous waste generation, handling and transport in Arizona.

3.8.2 Initial Assessment

The initial hazardous materials assessment of the subject site is based upon information obtained from historical aerial photographs, the Arizona Department of Environmental Quality (ADEQ), the Maricopa County Health Department, Environmental Services Division (MCHD), the City of Avondale Fire Department (AFD), and a FirstSearch environmental database report.

3.8.2.1 *Hazardous Material Spills and Incidents*

According to the ADEQ and the AFD, there have been no recorded hazardous waste spills or hazardous waste dumping in the Agua Fria River. However, ADEQ information indicates there was a confirmed incident of medical waste dumping at approximately 127th Avenue and Missouri Street, which appears to be located within the floodplain easement and approximately 0.25 mile east of the Durango Regional

Outfall Channel Restoration Site. The FirstSearch database report indicated there was a spill of 508 gallons of an unknown media at the Calmat Companies location at Litchfield and Broadway Roads in 1989. This spill appeared to occur adjacent to the river, but not directly within the riverbed boundary. Furthermore, incidents of gasoline and waste oil spills were reported within one mile of the subject site (ADEQ, 2001).

The remainder of the FirstSearch database report did not indicate areas of concern located within the riverbed or easements.

3.8.2.2 *Underground Storage Tanks and Leaking Underground Storage Tanks*

Underground storage tanks (USTs) and leaking underground storage tanks (LUSTs), which usually contain fuels and oils, are a common hazardous materials issue. Based on ADEQ information and the FirstSearch report, there are no registered USTs or LUSTs within the project area; however, USTs are registered for properties adjacent to the project area.

3.8.2.3 *Sand and Gravel Operations*

Based on historical aerial photographs obtained by Rupp Aerial Photography (Rupp), Phoenix, Arizona, it appears that historically much of the project area was used for sand and gravel operations and subsequently filled (Figures 5 to 7). Historic sand and gravel operations existed in the Agua Fria near McDowell Road, within the 1-10 Restoration Site, just north of Buckeye Road, within the Durango Regional Outfall Channel Restoration Site, possibly along the eastern easement south of Lower Buckeye Road, and possibly along the western portion of the levee area south of Lower Buckeye Road. Historic sand and gravel operations in the project area date back to at least 1949. Historic aerial photographs were not available from Rupp south of Broadway Road prior to 2000; however, a 1956 aerial photograph was reviewed at the Flood Control District, which indicated a sand and gravel operation located along the western portion of the study area, south of Broadway Road. Current sand and gravel operations are located on the eastern and western portion of the site area just south of Broadway Road (Figure 8).

3.8.2.4 *Solid Waste Landfills*

The former Avondale Landfill, a portion of which extended into the river, was located north of Buckeye Road on the western portion of the river. The landfill was relocated as part of the levee project and the area outside the channel was converted to Coldwater Park. Based on the as-built plans, a portion of the landfill appeared to extend into the river area. Reportedly, the landfill, including the portion located within the study area, was relocated.

3.8.2.5 *State Sites*

In July 2000, the ADEQ replaced its *Arizona CERCLIS Information Data System (ACIDS)* with the Superfund Program List (SPL). The SPL is more representative of the sites and potential sites within the jurisdiction of the Superfund Programs Section, which was created in April 1997, the date of the latest Water Quality Assurance Revolving Fund (WQARF) statute (ADEQ, 2001). The WQARF is

defined in statute as the "geographical area extent of contamination (Arizona Revised Statutes Section 49-281.14). Potential WQARF sites are those cases that are awaiting or undergoing WQARF preliminary investigation. The SPL is comprised of the following elements:

1. WQARF Registry sites
2. Potential WQARF Registry sites
3. National Priorities List sites
4. Department of Defense (DOD) sites requiring oversight.

The restoration project has one SPL Registry in the area, the Western Avenue Tetrachloroethylene Plume Project, which is 0.75 mile east of the project area, near Buckeye Road. The groundwater in the vicinity is impacted by tetrachloroethene, also known as perchloroethylene (PCE), which is a common solvent used in dry cleaning. In June 1993, PCE contamination was detected above the water quality standard of 5 micrograms per liter in nearby groundwater monitoring wells (ADEQ, 2001). The impacted area is along Western Avenue in the cities of Avondale and Goodyear, with the east-west extent apparently running from 2nd Street and Western Avenue in Avondale to just east of Litchfield Road and Western Avenue in Goodyear, which is approximately 0.75 mile east of the project area, near Buckeye Road. The impacted area appears to be limited to the upper groundwater aquifer, which is approximately 60 to 110 feet below ground surface (bgs). The groundwater flow direction is generally to the west, turning southwest near Litchfield Road and Western Avenue.

The site was placed on the WQARF Registry for consideration in December 1998. ADEQ has installed seven groundwater monitoring wells north and east of the PCE plume to define the lateral and vertical extent of impact, to attempt to determine a source, and to determine the mass of the PCE within the plume (ADEQ, 2002b). A soil gas survey was recently conducted at an upgradient dry cleaning facility to attempt to define a source for the contamination. The analytical data indicated PCE levels were minor or below the laboratory detection levels. According to the ADEQ a remedial investigation is planned as funds become available.

The Western Avenue PCE plume is currently under investigation and until the source and extent of the PCE groundwater contamination is determined, environmental impacts cannot be assessed. Currently it appears that groundwater in the area is used for irrigation purposes.

3.8.2.6 *Environmental Protection Agency Comprehensive Environmental Response, Compensation, and Liability Information System and National Priorities List*

The EPA maintains a database of designated Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) sites, which consists of current and potential Superfund sites currently or previously under investigation, and National Priorities List (NPL) sites, which recognizes sites that require long-term remedial response actions that would permanently and significantly reduce the dangers associated with releases or threats of releases of hazardous substances, yet have risks that are serious, but not immediately life threatening (EPA, 2002). A query of the EPA Hazardous Waste Sites list for Maricopa County, Arizona, revealed four Superfund sites (one of which

was on the NPL) within the general vicinity of the project area, as presented in Table 3.8-1. It should be noted that the Goodyear Dry Cleaners site is located slightly less than a mile to the west, and the Phoenix-Goodyear Municipal Airport is located approximately 1.5 miles to the west. The remaining two facilities, the Liberty Substation and Faith Cooperage, are approximately 12 miles to the west and downgradient from the site.

Based on the distance and groundwater flow direction with respect to the project area, there is a low likelihood that the project area has been impacted by these off-site facilities.

Table 3.8-1 Superfund Sites in the Project Area

Name	Location/City	Distance to Project Area	Groundwater Gradient	NPL Status	Non-NPL Status
Goodyear Dry Cleaners	142 N. Litchfield Rd, Goodyear	1 mile (west)	Downgradient	No	PA Start Needed
Phoenix–Goodyear Airport Area	Phoenix-Goodyear Airport Area, between Lower Buckeye Road and Van Buren, Goodyear	1.5 miles (west)	Downgradient	On Final NPL	Not Applicable
Liberty Substation	Tuthill Road and Broadway, Buckeye	12 miles (west)	Downgradient	No	PA Start Needed
Faith Cooperage	801 Irwin Road, Buckeye	12 miles (west)	Downgradient	No	PA Start Needed

Notes: PA = Preliminary Assessment; Source = EPA 2002.

3.8.2.7 *Pesticide Contamination*

Based on historical agricultural and urban land use activities, impact to soil sediments in the study area is possible by DDT by-products, such as DDE and/or other pesticides, such as toxaphene. DDT by-product contamination has been identified in Gila River sediments; however, it does not appear to be as notorious a problem in the Agua Fria River (Turek, pers. comm., 2002). Sediment samples taken at two locations where the I-10 drainage empties into the Agua Fria River channel were analyzed for the presence of pesticides. The results of the analysis were negative; however, the timing and design of the sampling effort were intended only to provide a general indication of conditions and should not be considered conclusive. The I-10 drainage channel was chosen as the sampling location because this channel drains agricultural lands. If pesticides in sediments are a problem, they are most likely to show up at this location. Appendix F provides the laboratory results of the analysis.

3.8.2.8 *Recommendations*

The hazardous waste review indicated areas of potential concern for future phases of the project. In terms of earth moving activities, potential impact to soil, from the previously mentioned medical waste spill, prior sand and gravels operations, the unknown source of sand and gravel operation fill material, possible pesticides such as DDT, DDT by-products, and toxaphene are a concern. Recommendations for assessing these potential impacts prior to conducting earth moving activities would include conducting test pits and/or a geophysical survey to determine the location, extent, and type of fill material used following the sand and gravel operations. Soil sampling for pesticides is recommended where earth moving is proposed to support negative results from the feasibility phase (preliminary) sampling summarized in Appendix F. Additional research should be conducted to determine the extent and type of the medical waste that was spilled, in order to ascertain the sampling methodology needed to assess the spill.

3.9 NOISE

3.9.1 Regulatory Setting

Acoustical Fundamentals

A brief background in acoustics is helpful in understanding how humans perceive various sound levels. Some common acoustical definitions are:

- *Acoustics* refers to the study of sound wave generation and transmission, both audible and inaudible.
- *Sound* is the physical oscillation or vibration of a medium, such as air, that can be perceived by an instrument, such as the human ear or a microphone.
- *Noise*, on the other hand, has commonly been categorized as loud, disruptive sounds that can annoy or cause harm to people.
- *Background noise* is the aggregation of all perceptible, but not necessarily identifiable, sound sources (such as traffic, airplanes, and environmental sounds) that create a static ambient noise baseline.

Although extremely loud noises can cause temporary or permanent damage, the primary environmental impact of noise is annoyance. The objectionable characteristic of noise often refers to its *loudness*. Loudness represents the intensity of the sound wave, or the amplitude of the sound wave height (measured in decibels (dB)). Decibels are calculated on a logarithmic scale, thus a 10 dB increase represents a tenfold increase in intensity, while a 20 dB represents a hundredfold increase in intensity. Decibels are the preferred measurement of environmental sound because of the direct relationship between a sound's intensity and the subjective "noisiness" of it. The A-weighted decibel system (dBA) is a convenient sound measurement technique that weights selected frequencies based on how well humans can perceive them. The range of human hearing spans from the threshold of hearing (~3 dBA) to past the threshold of pain (120 dBA). In general, humans will notice a change of sound greater than 3 dBA. Noise levels are generally considered low when they are below 45 dBA, moderate in the 45 to 60 dBA range, and high above 60 dBA. Noise levels greater than 85 dBA can cause temporary or permanent hearing loss if exposure is sustained. Examples of low daytime levels are isolated natural settings, such as the Grand Canyon (20 dBA), and quiet suburban residential streets (43 dBA). Examples of moderate level noise environments are urban residential or semi-commercial areas (55 dBA) and commercial locations (60 dBA). Although people often accept the higher levels associated with very noisy urban residential and residential-commercial zones (63 dBA), as well as industrial areas (65 to 70 dBA), they nevertheless are considered adverse noise levels (EPA, 1974; Berenek, 1971). Further examples of noise and their associated A-weighted decibels are shown in Figure 18. Figure 19 gives examples of outdoor L_{dn} sound levels for various locations.

In general, human sound perception is such that a change in sound level of 3 dB is just noticeable, while a change of 5 dB is clearly noticeable. A change of 10 dB is perceived as doubling or halving of sound level. Ambient environmental noise levels can be characterized by several different descriptors.

- *Noise Equivalent Level* (L_{eq}) describes the average noise level over a specified period of time. L_{eq} provides a useful measure of the impact of fluctuating noise levels on sensitive receptors over time. Other descriptors of noise incorporate a weighting system that accounts for human's susceptibility to noise irritations at night.

- *Community Noise Equivalent Level* (CNEL) is a measure of cumulative noise exposure over a 24-hour period, with a 5 dB penalty added to evening hours (7:00 pm to 10:00 pm) and a 10 dB penalty added to night hours (10:00 pm to 7:00 am).
- *Day/Night Average Noise Levels* (L_{dn}) is essentially the same as CNEL, with the exception that the evening penalty is dropped. As a matter of practice, L_{dn} and CNEL values are considered to be equivalent and are treated as such in this assessment. L_{dn} and CNEL values rarely differ by more than 1 dB. Further, A-weighted noise levels that are exceeded a selected percentage of time can be classified as L_x, where x is the percentage of time that the noise level is exceeded during a given interval. Sound levels associated with L_{10} typically describe transient or short-term events (these noise levels occur about 10 percent of the time), while L_{90} levels generally describes background noise conditions.

Regulatory Setting

Federal and State Laws

There are no Federal or Arizona State noise standards that directly regulate environmental noise from construction. However, it should be noted that the EPA has developed guidelines on recommended maximum noise levels to protect public health and welfare (EPA, 1974). Table 3.9-1 provides examples of protective noise levels recommended by EPA. With regard to noise exposure and workers, the Occupational Safety and Health Administration (OSHA) regulations safeguard the hearing of workers exposed to occupational noise. Refer to 29 CFR Section 1910.95 (Code of Federal Regulations) for a list of permissible noise exposures.

Table 3.9-1 Summary of Noise Levels Identified as Requisite to Protect Public Health and Welfare With an Adequate Margin of Safety

Effect	Level	Area
Hearing Loss	Leq (24) < 70 dB	All areas
Outdoor Activity Interference and Annoyance	Ldn < 55 dB	Outdoors in residential areas and farms and other outdoor areas where people spend widely varying amounts of time and other places in which quiet is a basis for use.
	Leq (24) < 55 dB	Outdoor areas where people spend limited amounts of time, such as school yards, playgrounds, etc.
Indoor Activity Interference and Annoyance	Ldn < 45 dB	Indoor residential areas
	Leq (24) < 45 dB	Other indoor areas with human activities such as schools, etc.

Note: Leq (24) = Represents the sound energy averaged over a 24-hour period.
Ldn = Represents the Leq with a 10 dB nighttime weighting.
Source: USEPA, 1974

Local Laws

According to the Maricopa County Comprehensive Plan (Maricopa County, 1997), noise abatement occurs on three fronts: point source noise from major developments, area source noise from individual land uses in zoning districts, line source noise from vehicular traffic. The Maricopa County Comprehensive Plan proposes to protect, preserve, and promote the health, safety, and welfare of citizens through the reduction, control, and prevention of noise. Policy 2E2.2 Maricopa County Comprehensive Plan encourages "the consideration of noise impacts in site planning."

The City of Avondale's Safety Element of the General Plan has policies that require the City to identify and resolve potential noise problems when reviewing site and development plans, and prohibit residential development, daycare centers, and schools in areas where noise levels are 60 dBA or greater (Avondale, 2001a). The City of Avondale does not have codes or ordinances that regulate noise associated with construction projects. However, noise complaints are directed to the City of Avondale Police Department (Avondale, 2001b).

3.9.2 Existing Noise Environment

The ambient noise conditions in the project study area are described in terms of sources and levels of noise, and sensitive noise receptors (e.g., residences).

The dominant noise sources in the project area are associated with the operations of transportation facilities. These facilities include the Southern Pacific Railway that crosses the project area along the north side of Buckeye Road, the Phoenix Goodyear Airport with a runway approximately 1.5 miles (2.4 kilometers) northwest of a portion of the project area, the east-west trending Interstate 10 (I-10) that crosses the northern portion of the project area, and local roadways that cross (e.g., W. McDowell Road, West Van Burton Street, and W. Buckeye Road) or parallel (e.g., S. El Mirage Road and N. Litchfield Road) the Agua Fria River in the project area.

Noise measurements were recorded at six locations (see Figures 5 through 8) surrounding the project site. Noise monitoring was conducted in the project area in January 2002 to quantify existing conditions using an impulse integrating sound level meter (Quest Technologies - Model 2800). Table 3.9-2 provides the recorded morning ambient noise conditions in the study area. Noise conditions are described in terms of: Equivalent Sound Level (L_{eq}), a measurement that accounts for the moment-to-moment fluctuations due to all sound sources during the measurement period (in this case 15 minutes) combined; the maximum sound level (L_{max}) reached during a sampling period; and the minimum sound level (L_{mix}) reached during a sampling period. The existing ambient L_{eq} noise levels ranged between 45.9 dBA to 67.7 dBA, with the loudest noise levels associated with trains passing by along the Union Pacific Railway, traffic (particularly on the I-10), or planes taking off at the airport.

Table 3.9-2 Ambient Measured Noise Levels of the Project Area

Location		Survey Period (minutes)	L_{eq}	L_{min}	L_{max}	Notes
No.	Description					
1	Under I-10 bridge overpass	11:20 – 11:35 am	67.7	55.1	76.1	Dominated by I-10 traffic.
2	Apartment complex at Dysart and McDowell Road, approximately 2 miles from site on the West Bank	12:25 – 12:40 pm	56.9	51.2	72.9	Overhead planes were loudest noise source.
3	Apartment complex at Lower Buckeye Road, on west bank.	4:00 – 4:15 pm	46.5	36.2	60.9	Fairly quiet. Several dogs were barking during recordings.
4	East bank, near Van Buren Street, on wall between apartments.	12:15 – 12:30 pm	49.8	39.2	65.4	Three planes flew overhead during recordings. 150 feet from levee.

Location		Survey Period (minutes)	L_{eq}	L_{min}	L_{max}	Notes
No.	Description					
5	Southwest corner of residential area near Lower Buckeye Road, east bank.	10:00 – 10:15 am	45.9	36.1	63.4	Local traffic was the loudest noise source.
6	Marsh at Avondale Waste Water Treatment Plant.	9:30 – 9:45 am	48.7	37.4	56.1	Fairly quiet. Loudest noise source was distant machinery from sand and gravel mining operations.

All measurements are in dBA; Measurements taken in January 2002 between 10:00 a.m. to 4:15 p.m.

L_{eq} = Equivalent Sound Level, a measurement (in this case 15 minutes) that accounts for the moment-to-moment fluctuations due to all sound sources during the measurement period, combined.

L_{max} = The maximum sound level reached during a sampling period.

L_{min} = The minimum sound level reached during a sampling period.

Sensitive Receptors

Noise-sensitive receptors are facilities or areas (residential areas, hospitals, schools, offices, parks, etc.) where excessive noise may cause annoyance or loss of business. Sensitive noise receptors in the vicinity of the study area are generally limited to residences approximately 50 to 100 feet east and west of the river channel.

3.10 Land Use and Recreation

3.10.1 Regulatory Setting

The Flood Control District of Maricopa County (FCDMC) manages the easement rights for the floodway limits of the Agua Fria River within the study area of the restoration project. FCDMC is supporting the West Valley Multi-Modal Transportation Corridor Master Plan with the Maricopa Association of Governments (MAG, 2001). This plan demonstrates FCDMC and the County of Maricopa's support of multi-use recreation and restoration projects in the lower Agua Fria River.

The study area is owned by a combination of private and public owners. Although private ownership extends into the river within the study area, the FCDMC controls the area contained within the 100-year flood zone. FCDMC owns some of this property, but has flood control easements throughout this area. It also controls most of the maintenance roads and flood control features as part of its flood control mandate. The City of Avondale and the County of Maricopa own pockets of land in the study area, and the City of Phoenix controls the Casey Abbott Recreation Area, located near the confluence of the Agua Fria and Gila Rivers. The Arizona Department of Transportation has easement and ownership rights of the Interstate 10 corridor Maricopa County Route 85 (MC 85) at Buckeye Road (MAG, 2001). There are also privately held and/or managed sand-and-gravel mining operations at two locations within the study area and utility easements throughout.

The City of Avondale surrounds nearly the entire project. The primary long range planning tool and land use descriptor for the City of Avondale is its General Plan, which is described below.

City of Avondale General Plan

The City of Avondale 2001 General Plan (General Plan) represents the comprehensive, long-range growth and development goals of the City. To this end, Avondale divided the General Plan into five themes, each of which were broken up by 1 to 6 Elements. Table 3.10-1 illustrates the organization of the General Plan.

Table 3.10-1 City of Avondale General Plan

Theme	Element	Focus of Element
Land Use	Land Use	Designates the general distribution and location and extent of land uses.
Economic Development	Economic	
	Cost of Development	Policies and strategies to require development to pay its fair share.
	Growth Area	Identification of areas appropriate for intense activity.
Neighborhoods	Housing	Standards and programs for improving the quality, variety and affordability of housing.
	Conservation, Redevelopment and Rehabilitation	Programs for the elimination of slums and blighted areas.
Open Space	Open Space	Comprehensive inventory of open space, analysis of forecasted needs, and policies for the enhancement of open space and recreation activities.
	Recreation	Comprehensive inventory of existing and planned recreation.
	Environmental and Conservation	Protection of air and water quality and natural resources.
Communities	Circulation	Map of the transportation system including transit.
	Bicycling	Proposed bicycle facilities
	Water Resources	Currently available surface water, groundwater, and effluent supplies, projections of future growth and need.
	Public Services	
	Public Buildings and Facilities	Locations of civic and community centers, public schools, libraries, etc
	Safety	Protection of the community from natural and man-made disasters.

Source: City of Avondale Draft General Plan (Revised 11/8/01)

The following describes General Plan policies that are relevant to the restoration project.

Open Space Element

- Participate in the implementation of the West Valley Non-Motorized Transportation Corridor Plan, the Agua Fria Watercourse Master Plan, the Maricopa Count Trails planning project and other regional projects designed to protect and conserve the Agua Fria, Salt and Gila Rivers as an open space resource.
- Require new development adjacent to the Agua Fria, Salt, and Gila Rivers and Estrella Mountains to provide recreation access to these areas
- Revegetate and restore to their natural appearance, where practical, feasible and appropriate, disturbed areas of the Agua Fria, Salt and Gila Rivers
- Develop public active and passive recreation amenities in conjunction with Tres Rios Greenway, Agua Fria, Salt and Gila corridors and mountain open space
- Participate in the development of public passive recreation such as trials, recharge areas, trailheads and pocket parks adjacent to the Agua Fria, Gila and Salt Rivers and Estrella Mountains
- Prohibit development of the 100-year floodplain of the Agua Fria, Salt and Gila Rivers
- Coordinate with Federal, State and other entities and private landholders to provide public access trails to recreation resources
- Support the acquisition of land for public river access areas adjacent to the Agua Fria and Gila Rivers, and the Estrella Mountains.

Environmental Planning and Conservation Element

- Protect Federal and State listed wildlife species
- When possible and practical, encourage the use of non-structural flood control techniques to protect the health and safety of the public
- Prohibit activities that would erode the Agua Fria, Salt and Gila River floodplains or wetlands associated with them
- Minimize the environmental impact of future mining operations
- Prepare and adopt a Native Plant Ordinance relative to the protection, enhancement and relocation of indigenous plants within the Planning Area
- Require new development to receive a written response from Arizona Game and Fish regarding the effects of urbanization on special status flora and fauna species and threatened and endangered species.

Recreation Element

- Work with other City departments to encourage multiple use of City facilities for recreation
- Provide for equestrian use of some trails
- Develop and adapt a citywide trails plan
- Monitor and support private and residential recreation.

3.10.2 Existing Land Ownership and Use

Land ownership patterns within and surrounding the study area are illustrated in Appendix G. The land ownership maps in this appendix were originally completed for the West Valley Multi-Modal Transportation Corridor Master Plan, a multi-agency project that analyzed a regional 42-mile trail network along the New River and Lower Agua Fria River (see Section 3.10.3, Recreation below). The trail corridor plan was organized by the Maricopa Association of Governments and funded by the Arizona Department of Transportation. The City of Avondale participated in the preparation of the plan and stated in its General Plan that it should make every effort to follow the goals outlined in it. These maps were later supplemented with parcel maps provided by the FCDMC that were utilized for the real estate report and land appraisal (Appendix H). See Section 4.4.2 for a list of the property owners of the portions of the river channel where restoration would occur under the various alternatives.

The City of Avondale surrounds the Agua Fria River within the study area, both to the west and the east. Near the confluence of the Agua Fria and Gila Rivers, the study area adjoins the eastern edge of the City of Goodyear. Since the majority of the project area is surrounded by the City of Avondale (Avondale), the majority of the land use discussion will focus on land uses within Avondale. The General Plan outlines the land use designations for Avondale, including the study area for the restoration project, as illustrated by Figure 20. As shown, the land use designators adjoining the Agua Fria River between the Interstate 10 Bridge and the Gila River are primarily residential (medium-high, medium, and low density) and Employment (business park and industrial). The project length along the Agua Fria River is approximately 5.5 miles. Currently the study area is bordered on the east bank by

approximately 0.4 mile of park/undeveloped space, 0.2 mile of commercial/industrial, 2.6 miles of agricultural, 2.0 miles of residential, and 0.2 mile of sand and gravel land use. The west bank is bordered by approximately 1.5 miles of park/undeveloped space, 1.5 miles of commercial/industrial, 0.4 mile of agricultural, 1.8 miles of residential and 0.3 mile of sand and gravel land use. Along the southern half of the west bank however, beyond the commercial/industrial use, sand and gravel operations and undeveloped land, the land use is predominantly agricultural.

Residential land uses adjoin areas along the western bank from McDowell Road to just south of Buckeye Road. On the eastern bank, residential land uses run from McDowell Road to Lower Buckeye Road. The Buckeye Canal has extensions on the east and west sides of the project area near the Gila River confluence. The eastern branch empties into the Gila River south of the AWWTP.

Although agricultural land uses are prevalent in the southern part of the study area, it is expected that within the next 10 to 20 years, residential, commercial, and industrial development will dominate the surrounding areas.

The lower reaches of the Agua Fria River are heavily mined. The active sand and gravel operation that extends from Indian School Road to Camelback Road on the west side of the river is outside of the 100-year floodplain (FCDMC, 2001b). There are mining pits extending from Indian School Road to Camelback Road that are within the regulatory floodway. These pits appear to be inactive but may now be part of the operation to the west. Additionally, there is a mining pit on the east side of the river just north of Indian School Road, which is outside of the 100-year floodplain. There are three active sand and gravel operations at the confluence of the Agua Fria River and New River. These operations extend from Camelback Road to Bethany Home Road on the west side of the river and are within the floodway fringe (FCDMC, 2001a). Within the project area there is sand and gravel mining on the east side south of the AWWTP, an on the west side further inland near Broadway Road.

Urban and agricultural land uses along the Agua Fria dominate the stretch between McDowell Road and the Gila River. Two high-powered electrical transmission lines run in the channel south to Buckeye Road, with circular flood-control structures protecting the western transmission line. Two more high-powered electrical transmission lines cross the channel at Broadway Road, just north of the Avondale Wastewater Treatment Plant. Levees run along both sides of the channel between McDowell Road and Buckeye Road, and along the western levee south of Buckeye Road to past Lower Buckeye Road. Two smaller levees are located on the east side of the river south of Buckeye Road, one near Lower Buckeye Road and one north of Broadway Road.

Table 3.10-2 describes the general features of current land uses in different stretches of the river.

Table 3.10-2 Land Use Characteristics and Features along the Agua Fria River

Features on West Side	Features On East Side
McDowell Road to I-10	
Multi-family housing near river and an open field. Behind the residential development are some large department stores and a shopping center. Further west is the Litchfield Park and Palm Valley detention basin.	Friendship Park and open space, along with the ADOT inflow channel on the north side of I-10.

Features on West Side	Features On East Side
I-10 to Van Buren Road	
The river is bordered by open, vegetated fields. Commercial and residential development occurs farther to the west.	Agricultural development borders the river.
Van Buren Road to Buckeye Road	
Open, non-agricultural fields border the river, south to Coldwater Park, which borders Buckeye Road. Single-family homes are located west of the open fields.	A pump station is located just south of Van Buren Road. Farther south are single-family homes and a golf course, which borders the Durango Regional Outfall Channel outflow, along Buckeye Road.
Buckeye Road to Lower Buckeye Road	
Open fields vegetated with native species borders the river. A small development of multi-family homes is located in the open field. More multi-family homes are located west of the open field.	A tank and steel company is located just south of Buckeye Road, along the unleveed river. Southward are agricultural uses and multi-family homes bordering Lower Buckeye Road. Agricultural uses dominate eastward.
Lower Buckeye Road to Broadway Road	
River is leveed four approximately 5000 feet. Agricultural fields and some sparsely agricultural housing units are located north of Broadway Road.	Natural vegetation lines the unleeved portion, south to a cattle company site, which is protected by a levee. Agricultural fields dominate south of the cattle company site.
Broadway Road to Gila River Confluence	
Agricultural fields line the river south to near the Gila River confluence, where native vegetation predominates.	Agricultural fields line the river south of this to near the Gila River confluence, where native vegetation predominates.

3.10.3 Recreational Facilities and Opportunities

The General Plan outlines the recreation goals of Avondale. In the future, Avondale plans to provide parks based on a service radius calculation to ensure parks and recreation facilities are equitably distributed throughout the community. The service radius calculations will be based on the National Recreation and Parks Association Standards, described as follows:

- *Neighborhood Parks* – These parks served a one to several neighborhoods and have a service radius of 0.25 to 0.5 mile. They are usually developed to encourage semi-active to passive activities. Minimal parking may be provided. Oftentimes these parks will be located near schools.
- *District Parks* – These parks service certain sections of population centers of the City. District parks also provide a variety of activity centers on a smaller scale and are located such that they encourage motorized and non-motorized transportation. A District park area ranges from 0.5 to 3 miles and size, and has 2.5 acres per 1,000 population.
- *City-Wide Parks* – These parks are larger park areas with the capacity to service a variety of activities. Facilities may include a community center, swimming pool, ball fields, picnic and parking facilities. City-wide parks are most often located centrally and are accessible by main transportation routes. These parks generally should be provided at a ratio of 2.5 acres per 1,000 population.
- *Open Space Areas* – These areas include a variety of open space, including vest-pocket parks, common areas, easements, right-of-ways, greenbelts, and private recreation areas. These areas are generally passive areas in a landscaped or natural state. They may be planned for conversion to more intensive recreation when needed. These spaces may provide interpretive nodes and act as buffers between lands uses or provide habitat or land banking. These spaces should be provided at a ration of 0.5 acre per 1,000 population.

Currently, Avondale meets the services ratio for open space and greenways established in the 2001 General Plan. While Avondale provides Community and Neighborhood parks, it does not meet its projected service area ratios for Neighborhood, Community, or District parks.

Two small community parks are located near the project area. Friendship park is located about 0.25 mile from the east side of the river at McDowell Road, and the City of Avondale has plans to extend the park westward to the river. Coldwater Park is located at Buckeye Road, adjacent to the west bank of the river. The Estrella Mountain Regional Park, south of the Gila River, offers regional recreational opportunities, including extensive hiking and riding trails through the foothills.

Final West Valley Multi-modal Transportation Corridor Master Plan

The West Valley Multi-Modal Transportation Corridor Master Plan is a part of a multiphase undertaking conducted through the efforts of Maricopa Association of Governments, in association with the Maricopa Flood Control District (MAG, 2001). The corridor for the study is located along the New River and Lower Agua Fria River and the will serve not only as a recreational and alternative transportation plan but an assessment of alternative non-structural flood control systems. The primary purpose of this Master Plan is to create a regional planning framework for a 42-mile trail network for pedestrians, equestrians, bicyclists and other non-motorized trail users. Appendix G describes the segment within the project area and its major constructed elements. The primary concepts of the study include:

- Create a regional planning framework for a 42-mile trail network for pedestrians, equestrians, bicyclists and other non-motorized trail users
- Establish a universally accessible trail for a variety of users of different abilities and ages
- Expand on existing and planned river trail systems
- Establish a mechanism for the conservation of natural river resources
- Encourage an awareness for livable community design
- Identify a variety of funding mechanisms to implement the project for communities along the river corridor
- Ensure consistent and uniform design for the development of the trails.

The southern reach of the West Valley Multi-Modal Transportation Corridor Master Plan trail corridor includes the City of Avondale along the Lower Agua Fria River. The plan cites the relatively undeveloped nature of this part of the corridor as providing greater opportunities for parks and other recreational amenities as well as trails with less restricted use. The restoration project area that falls within the southern reach of the corridor is classified as approximately one-half passive landscape management zone intended to provide for low and moderate intensity uses; one-fourth conservation zone (near the confluence of the Gila River) where the natural landscape character is protected and trails are well-defined with limited access; and one-fourth active zone (further south of I-10 around SR MC-85 at Buckeye Road) where higher intensity use is expected with linkages to urban and commercial areas. In this area trail options include underpass or overpass facilities at I-10, SR MC-85 and the Union Pacific Railroad. In passive and active areas introduced and ornamental vegetation may be used.

Existing access roads may also be taken advantage of, if possible. According to proposed plans, trails may extend throughout the entire river cross-section. Excerpts from this plan are provided in Appendix G and are also referred to in Section 2.10.

Within the regional context of this plan, the City of Avondale would like to extend Friendship Park (east of the river on McDowell Road) towards with open space to the west between the I-10 channel and McDowell Road. A multi-use trail would connect this park west and south along the western-eastern levee of the Agua Fria River and then crossing the channel west down to Coldwater Park at Van Buren Road. This local project has funding and would likely be implemented in the next five years (Figure 21).

The City of Avondale's General Plan supports the development of the West Valley Multi-Modal Transportation Corridor Master Plan. As shown in Appendix G, the southern segment of the West Valley Multi-Modal Transportation Corridor Master Plan within the study area of the restoration project, proposes two primary trails that would run north-south along the western and eastern levees of the Agua Fria River (MAG, 2001). Primary gateway access areas would be located on the western side of Van Buren Road, Buckeye Road, Lower Buckeye Road, and Southern Avenue. Two secondary trails were proposed to run east-west along portions of Broadway Road and Southern Avenue, with secondary access gates at Southern Avenue. Neighborhood connector trails were proposed to run east-west on Van Buren Road, east west on Buckeye Road and east of Lower Buckeye Road (from the Agua Fria). Also, equestrian trails are proposed within the channel.

The West Valley Multi-Modal Transportation Corridor Master Plan (MAG, 2001) recognized the two following potential recreational use conflicts associated with the planned trails.

- *Interstate 10, Union Pacific Railroad and State Route 85* – The heavy traffic and high traffic speeds at I-10, the Union Pacific Railroad, and SR-85 offer challenges to the planned urban trial system.
- *Confluence of the Agua Fria River and Gila River* – The confluence of the Agua Fria and Gila Rivers represents the terminus to the Lower Agua Fria River trail, and providing the need trail linkages that would cross both the Lower Agua Fria River and the Gila River would present a challenge. The spans of the river channels are lengthy and exiting roadway arterial bridges are either non-existent or do not safely accommodate bicyclists and pedestrians.

Specific Plans

Avondale has designed two specific plans to meet the needs of key areas within Avondale. The Freeway Corridor Specific plan was adopted in June 1991 to address development north and south of the Interstate 10 Freeway, which is viewed as a key transportation corridor. The North Avondale Specific Plan was adopted in June 1992, which covers the areas north of Encanto Boulevard.

In the immediate vicinity of the project area, the Western Avenue Revitalization Plan has been adopted for the area adjoining Western Avenue, to the west of the Agua Fria River.

3.11 SAFETY AND PUBLIC HEALTH

3.11.1 Regulatory Setting

National Flood Insurance Program. The National Flood Insurance Program (NFIP) is administered by FEMA's Federal Insurance Administration. The program makes flood insurance available to residents of communities that have adopted flood plain management ordinances, which regulate development in designated flood hazard areas and require flood-proofing of new construction in such areas. Federal flood insurance is needed because homeowners' policies do not provide coverage for flood damage. Approval and implementation of the Operation and Maintenance Plan will provide relief from flood insurance to residents that are currently within the 100-year flood plain.

3.11.2 Flood Hazards

Four floods in the last 25 years had the most impact on southern Arizona, as described briefly below.

October 1977. The storm of October 6-10, 1977 in southern Arizona resulted from a collision between Tropical Storm Heather, which came off the Pacific Ocean, and a cold front that was moving northwest to southeast.

October 1983. From September 29 to October 2, 1983, the combination of a cold front to the north of Arizona and the dissipation of Tropical Storm Octave over the southwestern United States brought record amounts of precipitation to much of Arizona, on top of an unusually wet August and September.

July 1990. On July 24, 1990, an intense thunderstorm developed in the Phoenix area in the early morning hours and moved southeast toward the Tucson area bringing intense rainfall between 3 and 11 am. The storm was considered atypical since most monsoons are fed by moisture from the Gulf of California or the Gulf of Mexico, and travel southeast to northwest.

January 1993. From late December 1992 through February 1993, a series of winter storms produced record-breaking amounts of precipitation and severe weather across Arizona. The rainfall in January, in particular, was 520 percent above normal statewide averages, which, combined with rapid snow-pack melting in higher elevations, caused intense runoff and flooding.

3.12 PUBLIC SERVICES AND UTILITIES

3.12.1 Regulatory Setting

The City of Avondale Utilities Department is responsible for the organization, planning, direction and management of activities its five divisions, which are:

- Utilities Administration
- Water Resources
- Water and Wastewater Distribution and Collection
- Wastewater Treatment Facility

- Water and Wastewater Maintenance.

City of Avondale Utilities Administration provides direction, coordination and support for the activities in the Utilities Department. This includes planning (short and long range) for the utility needs of the community. Another major function of this division is to provide the City of Avondale Engineering Division with technical support on water, wastewater and environmental programs. The Utilities Administration's goal is to organize the various divisions of the department into an efficient and effective team that provides a safe and uninterrupted supply of water and to ensure the wastewater treatment facility produces a water-discharge quality that meets or exceeds all regulatory requirements.

3.12.2 Public Services and Utilities Relevant to the Project

Wastewater Treatment. The existing plant capacity at the Avondale Wastewater Treatment Plant (located at 4200 S. Dysart Road) is 3.5 million gallons per day (MGD). Currently the plant processes approximately 3.5 MGD, but an expansion is underway to increase the output to 6.4 MGD with the potential for further expansion in the next five years. On a monthly basis, over 150,000 pounds of solids are removed from 101 million gallons of wastewater. The treated water must comply with strict State and Federal environmental regulation governing on how clean the water must be before it can be released to the dry Agua Fria riverbed (Avondale, 2002a).

Wastewater Collection. Sanitary waste material transported to the AWWTP. Most waste streams flow by gravity but, due to unfavorable elevation differences, these streams must occasionally be pumped. These pumping stations are referred to as lift stations. Gravity flows within the collection system are maintained near 2 feet per second. This velocity maintains solids in suspension so they do not become deposited on the bottom and sides of the piping system. Cleaning of the collection system piping network is scheduled and performed regularly (Avondale, 2002a).

Electrical. Arizona Public Services (APS) provides electrical service to the area surrounding the Agua Fria River.

Gas. Southwest Gas Corporation - Southwest Gas provides gas service to most area residences and businesses.

Street Maintenance. The City of Avondale is responsible for maintaining City of Avondale streets, street signs, traffic signals, and street lighting. Maricopa County's Department of Transportation maintains Maricopa County streets and roads. The State Department of Transportation maintains the region's designated State routes, including Interstate 10.

Solid Waste/Landfill. The City of Avondale Field Operations provides residential and commercial refuse collection for City of Avondale residents and businesses. The solid waste is taken by Field Operations to the Glendale Landfill, approximately 5-7 miles from the City of Avondale (Avondale, 2002b).

Recycling. The City of Avondale Field Operations provides residential collection of recyclable materials.

3.12.3 Utilities Located within the Project Area

Water utility facilities and wastewater utility facilities in the project area are shown in Figures 22 to Figure 24, respectively. Several water lines cross the Agua Fria River within the project area (Figure 22). A twenty-inch-diameter line crosses at McDowell Road and a 16-inch-diameter line crosses the river at Van Buren Street. Several wastewater lines cross the Agua Fria River within the project area, namely one at Van Buren Street and one south of Lower Buckeye Road (Figure 23).

An electrical transmission easement extends north-south along the majority of the project reach. Electrical and natural gas lines extend east-west across the channel just north of MC 85. There are numerous other utilities crossing the project area.

Figure 24 illustrates existing and planned utilities along the eastern side of the Agua Fria; the east-west lines would ostensibly continue to the western side of the river. Some of the utilities that cross the Agua Fria are Kinder-Morgan Energy Partners (petroleum lines), APS electric transmission lines, El Paso Natural Gas lines, Burlington-Northern RR may have some utilities in their Right of Way, ATT Communications lines, Sprint Communications lines, Qwest Communications lines and possibly, Cox Communications.

Section 4.4.2 (Real Estate) of this document summarizes the utility easements in the area affected by the restoration alternatives.

3.13 AESTHETIC RESOURCES

3.13.1 Regulatory Setting

Aesthetic resources are regulated by local land use plans and policies.

3.13.2 Existing Environment

The character and condition of a landscape can be defined with a series of factors, including topography, climate, soils, vegetative cover and landscape. Landscape character gives a geographic area its visual and cultural image and consists of the combination of physical, biological and cultural attributes that make each landscape identifiable and unique. The existing landscape character along the project area ranges from predominantly natural landscapes to those that are heavily culturally influenced. Landscape character studies in the Agua Fria River Corridor identified seven distinct landscape character types defined as zones recognizable in aerial photos (adapted from FCDMC, 2001b) (Figures 4 through 8).

- Hydric – Riparian Zone: Found in areas of open water and perennial flow. Found only within project area at the AWWTP site.
- Mesic/Xeric – Riparian Zone: Intermittent flows and shallow ground water. Found at I-10 and Durango Regional Outfall Channel discharges.

- Upland Scrub Zone: Open areas along foothills, supporting Sonoran desert vegetation. Not found within the project area (has been largely replaced by development.
- Ephemeral Channel Zone: Found within the channel in areas without perennial or intermittent flow and deeper ground water levels (e.g., > 10 feet). Also includes unleveed portions of the project area where floodplain characteristics are still evident. Supports sparse ground cover of grasses and shrubs, some sectors include dispersed small trees.
- Urban Development: Found primarily in the northern half of the project area and marked by single family and low to medium density residential and commercial.
- Agriculture and Open Space: Found primarily in the southern half of the project area and marked by field agriculture, farms, ruderal open space.
- Sand and Gravel Mines: Primarily north of the project area, but two small operations at the elevation of the AWWTP.

Within the project area natural features include:

- Park Sites – There are two City parks/open space near or adjacent to the project area: Friendship Park located approximately 0.25 miles east on McDowell Road and Coldwater Park located immediately adjacent to the west side of the levees at Buckeye road.
- AWWTP Effluent Pond – A wetland fed by water discharged from the plant. These manmade wetlands by aguatic wildlife, birds and small mammals.
- Chicken Ranch – Located immediately north of the confluence of the Agua Fria River and the Gila River. It was created as a mitigation site that was only partially successful due to the loss of many of the plantings; however it is still a habitat area for birds and small mammals.
- Gila River Confluence – Agricultural fields and rural residences occupy the confluence of Agua Fria River and the Gila River. Thick mesquite bosques inhabit the river edge. Within the river channels certain sections are being used for water retention creating rich riparian habitats with lush vegetation and abundant wildlife.

3.14 TRANSPORTATION

3.14.1 Regulatory Setting

The City of Avondale requires applicants of a proposed project that would involve work in a public road right of way to obtain a Right of Way Permit from the City's Engineering Division. In addition, applicants for projects that require hauling materials (e.g., sediment and plant debris) on public roads need to submit the proposed haul route(s) to the City of Avondale Engineering Division for approval and issuance of a permit (Avondale, 2001a).

3.14.2 Road Network

Within the project area, bridges cross the river at McDowell Road, Interstate 10, Buckeye Road, Lower Buckeye Road and the Union Pacific Railroad. The Union Pacific Railroad bridge crosses the Agua Fria River slightly north of and parallel to Buckeye Road.

Interstate 10 (I-10) acts as the major thruway for east/west traffic for both cars and trucks in the area. I-10 crosses the Agua Fria River in the northern portion of the project. This highway experiences relatively heavy traffic levels primarily associated with daily commuters in and out of downtown

Phoenix, which is approximately 10 miles (16 kilometers) east of the study area. I-10 is under the jurisdiction of the Arizona Department of Transportation (ADOT) and has an average daily trip (ADT) rate of approximately 89,000 in the vicinity of the study area (see Table 3.14-1). Maricopa County Highway 85 (MC 85) extends east-west across the channel. In addition to I-10 and MC 85, there are several arterial, collector, and local roadways that either cross or run parallel to the study area. These roadways are maintained by the City of Avondale or Maricopa County. Refer to Figure 24 for an illustration of the roadway network in the study area.

The Maricopa Association of Governments collects weekday ADT data for major roadways within Maricopa County. Table 3.14-1 provides the names and ADT information for the majority of the roadways that either cross, run parallel, or run perpendicular to the proposed Study Area (Figure 25).

Table 3.14-1 Average Daily Trip Information for Project Area Roads

Name	Relation to Project	Location of Count Segment	ADT
W. McDowell Rd	Defines north end of the Study Area.	S. 115th Avenue – Dysart Rd	6,000
Interstate 10	Crosses the northern portion of the Study Area.	S. 91st – S. 99th St	89,000
W. Van Buren St	Crosses Study Area approximately 1/3 mile south of I-10.	S. 115th Ave – Dysart Rd	2,000
Dysart Rd	Runs parallel to the west side of the Study Area.	W. Thomas Rd – W. McDowell Rd	16,000
115th Ave	Runs parallel to the east side of the Study Area.	I-10 - W. Van Buren St	3,000
		W. Van Buren St – W. Yuma Rd	4,000
Buckeye Rd	Crosses project area with the Union Pacific Railroad (UPRR) approximately 1 mile south of W. Van Buren St.	S. El Mirage – N. Dysart Rd	11,000
El Mirage Rd	Runs parallel to the east side of the Study Area.	Buckeye Rd - Lower Buckeye Rd	2,000
Lower Buckeye Rd	Crosses Study Area approximately 1 mile south of Buckeye Rd.	N. Dysart - N. Litchfield Road	3,000
W. Broadway Ave	Perpendicular to east side of river, but does not cross the river. Approximately 1 mile south of Lower Buckeye Rd.	115 Ave – S. El Mirage	1,000

Source: MAG, 1999.

3.14.3 Other Transportation Facilities

The Phoenix West Line portion of the Union Pacific Railroad (UPRR) crosses the study area approximately 2 miles (3.2 km) south of the northern boundary of the study area. The Phoenix West Line is the former railroad link between Phoenix, Yuma, and Los Angeles. In 1996, Union Pacific Railroad (the owner of the railroad at the time) downgraded this line from an Amtrak passenger main train to a "storage" train in order to save on maintenance cost. Currently, the West Line experiences only a few local freight trains daily between downtown Phoenix and Buckeye (ARPA, 2000).

The Phoenix Goodyear Airport, located approximately 1.5 miles northwest of the central portion of the study area, has an 8,500 foot by 150 foot runway that experiences approximately 120 arrivals/ departures a day. The airport tower operates from 6:00 a.m. to 9:00 p.m., seven days a week (Phoenix, 2001). Aviation safety is a major public concern. FAA regulations discourage the creation of wildlife attractants within 10,000 feet of an operational taxiway.

Buses

In 1985, the Arizona Legislature passed a law enabling the citizens of Maricopa County to vote on sales tax increase to fund regional freeway improvements and provide for the creation of the Regional Public Transportation Authority (RPTA). In 1993, the RPTA Board adopted Valley Metro as the identity for the regional transit system. The Valley Metro provides regional bus coverage for the Greater Phoenix Metropolitan Area, including the City of Avondale (County of Maricopa, 2002).

Bicycles

The Maricopa County region has an estimated 1000 to 1200 miles of bicycle paths. The majority of these miles are located within cities and towns, with approximately 100-150 miles found in unincorporated Maricopa County. Maricopa County Department of Transportation is responsible for 2,829 miles of roadway in unincorporated County areas, and nearly 2,000 of these miles are paved and potential routes for bicyclists (MCDOT, 2002). Bicycle travel is affected by a wide range of plans, programs and polices in Maricopa County, including transportation plans, land use plans, area studies, corridor studies, Maricopa County Board of Supervisor adopted policies, and internal programs and initiatives (MCDOT, 2002).

4. ALTERNATIVES

Section 4 describes the development of alternative plans that address the planning objectives; it provides a comparison of those plans; and it describes the selection of a recommended plan. Section 4.1 outlines the plan formulation rationale of the alternatives. Section 4.2 summarizes the management measures and preliminary plans that formed the basis of the final alternatives array. Section 4.3 describes the eight final alternatives. Section 4.4 provides a comparison of the alternatives. Sections 4.5 through 4.8 outline key features of the recommended plan and its implementation requirements relative to the other plans.

4.1 PLAN FORMULATION RATIONALE

Management measures that make up the restoration plan were initially selected based on descriptions from the Preliminary Restoration Plan (PRP) (USACE, 2001) and the opportunities and constraints identified in Section 2. The management measures were then evaluated individually and collectively to form the preliminary alternatives. As additional information about the site was gathered and input was received from the local sponsors and technical experts, the preliminary management measures and alternatives were formulated into a set of preliminary alternatives. The preliminary alternatives were reviewed by the various stakeholders and a final set of alternatives was then carried forward for analysis.

4.2 PRELIMINARY MANAGEMENT MEASURES AND CONSIDERATIONS

This section provides a brief description of the management measures and other considerations formed of the final alternatives. A description of the final alternatives is presented in Section 4.3.

4.2.1 Initial Management Measures

The following are initial management measures that were defined in the Baseline Conditions Report.

Revegetation. The goal of this management measure is to reestablish and maintain native vegetation. The focus is on three areas where vegetation currently exists and receives some surface water: the I-10 drainage outfall (Papago Diversion Channel), the Durango Regional Outfall Channel at Buckeye Road, and the Avondale Wastewater Treatment Plant (AWWTP). Options under this management measure include:

- Revegetation with native species. In those areas where surface and groundwater are most available, vegetation would consist of either riparian woodland/scrub dominated vegetation with a high hydrologic component (see definition in following text) or herbaceous dominated vegetation with a low hydrologic component (see definition in following text). In areas where there is limited water availability, drought tolerant Sonoran desert species typically found in the older, more remote flood plains would be used.
- Invasive species control program. This would consist of a combination of mechanical removal and herbicide to primarily control large stands of tamarisk, tobacco tree, buffel grass, and Russian thistle.
- Other wildlife habitat resources. This includes additional materials that would enhance the benefit of vegetation such as nesting boxes, artificial burrows, woody debris piles, etc.

The plant palette would be based on surface water availability, depth to ground water and hydraulic impacts. Some restored areas would emphasize riparian woodland and scrubland where tree and shrub

species would depend on surface and ground water availability and external water inputs. The choice of species would also be based on whether the species has a high or low ("flood friendly") hydrologic component (Appendix B). The phrase "hydrologic component" distinguishes the degree to which plants can resist flow, which in turn affects the roughness coefficient used in the hydraulic analysis. As flow resistance increases the roughness coefficient increases and the potential for loss of flood capacity increases. Woody species are generally inflexible and result in a higher roughness coefficient in the hydraulic analysis. However, infrequent large flood events would presumably wash out some of this vegetation. In other areas where flood capacity is limited, the planting would emphasize herbaceous species that are identified as having a low hydrologic component, typically species associated with seasonal wetlands or marshes. In both cases whether species have a high or low hydrologic component there would be a gradient from hydric/mesic areas where water availability is greatest to more xeric/upland conditions with increasing distance from the water source. This general pattern would be applied throughout the project area.

Hydrologic Enhancement. This management measure considers methods for improving and increasing water availability. Some of these measures were originally proposed in the PRP (USACE, 2001).

Additional sources of water or improving the retention of water in the soil from existing sources would increase the opportunity to use a wider range of plant species and extend the area of vegetation. Options considered under this management measure include:

- Move water from the AWWTP to upstream locations. This could be done in conjunction with future recharge projects and can be phased into the project even after construction and implementation have been completed.
- Divert water from irrigation channels. This would require cooperation from the irrigation districts.
- Use local groundwater pumping with surface distribution to riparian areas. This could be incorporated into a recharge project. The City would likely own and operate the wells.
- Add clay liners or soil amendments to retain soil moisture and reduce infiltration. This can improve water delivery to downstream areas, but should not be so impermeable as to entirely prevent horizontal and vertical water movement.
- Place impermeable materials overlain by coarse material to encourage subsurface flow and limit surface evaporation (potentially in conjunction with the next item), if scouring occurs.
- Construct small dams, groins or other surface and subsurface barriers to retain surface flow. The benefit can be seen in the existing grade control structure located just downstream of I-10. Upstream there is more vegetation, and soil moisture from the seasonal discharges from the I-10 outfall is retained longer in the surface.
- Use small check dams created from stabilized coarse materials and some woody debris in the side channel to create microvariation in bed conditions. These are very small scale structures that may be constructed to resist frequent flow events (10-15 year events).
- Construct depressions or swales to trap and concentrate surface water. These may be constructed at the terminus of channels or riparian strips and may also serve the dual purpose of recharge zones.
- Add sand bars or coarse materials and woody debris used to trap surface moisture after flood events and create microvariation in soil conditions and soil moisture.

- Use seasonal irrigation, open patches and importation and placement of fine sand and silt sized material upstream to be redistributed by natural flood events and replenish scoured or degraded zones and facilitate regeneration of riparian species. Most of the elements that facilitate natural regeneration have been lost in the Agua Fria. Therefore, these events can be simulated on a small scale. Fine material may come from neighboring sand and gravel mines or the I-10 outfall maintenance.
- Use rocks, cobbles, soil cement and vegetative material to protect and stabilize the side channel and sand bar areas for vegetation growth.

Hardscape Levee Modifications. This management measure would include hardscaping or modifications to the slope and microtopography of the levees. This concept was originally defined in the PRP (USACE, 2001) and includes two options:

- Gently vegetated slopes on the inside and/or outside of the levee
- Vegetated, terraced slopes on the inside and/or outside of the levee.

The objective of this management measure is to use imported fill or material from the excavated side channel or other places within the channel to place along the inner and/or outer slope of the levee. Because bed materials are generally coarse and permeable and because these areas are elevated from surface or ground water, vegetation in these areas would likely be limited to Sonoran desert vegetation normally found in the older floodplain surfaces, marked by low density shrubs, annual grasses or herbs, and cacti. A permanent irrigation source and delivery system can be designed along the levee to increase the density and variety of species. Additional fine and cohesive materials may need to be added to ensure stability, and this may have the added effect of improving water-holding capacity. Terracing would also reduce these two problems. The topography of the slopes may be varied to have undulating features and sand bars that extend into the channel. Where fill for planting is placed along the levees, new slopes would be increased from 1:1 to a slope of 4:1. Hardscaping is not necessarily an all or nothing measure insofar as it can be implemented along segments. However, there is a clear advantage to creating a corridor for birds and mammals to migrate along the levees along the full length of the project site. Where trail landscaping coincides with this measure, 4:1 slopes may unfortunately make it easier for pedestrians to enter into the restoration areas. In such cases a suitable vegetation buffer or other barrier should be considered.

Other Restoration Opportunities. These management measures consider the potential for using other areas that may be incorporated into the restoration effort. Constraints at the current site may limit the acreage available for restoration or the opportunity to achieve the project goals, and additional sites may need to be evaluated for the project. The areas described below were evaluated as potential additions to the existing plan. Considering these sites would provide the obvious benefit of strengthening habitat linkages within the Agua Fria and Gila rivers, and the lower watershed as a whole. They would also provide the opportunity to restore areas not subject to the same constraints as the sites within the channel and potentially emphasize different vegetation communities. Ultimately these sites were dropped from further consideration for the reasons described below.

- *Off-Channel Overflow Space Near McDowell Road* - This site is approximately 20 acres located on the east side of the river, north of McDowell Road. It would ostensibly be incorporated into the City's plans to extend Friendship Park, but may potentially be designed as a habitat restoration/limited recreational component. Use

of this area would require coordination with the City of Avondale. Measures might be considered to divert flood flows into this area and amendment of soils with finer materials could help to retain soil moisture that would support riparian or scrub species. This site was dropped because it had been committed entirely for recreational use.

- *Chicken Ranch Failed Mitigation Site* – This site is approximately 27 acres located south of the AWWTP. It was originally planted as mitigation for District activities, but most of the plantings failed because irrigation was turned off before plant roots had a chance to reach ground water. Also, moderate salt content of groundwater may have contributed to the lack of success. Use of this site would necessitate releasing the site from its current mitigation status. The site would ostensibly be developed as hydric/mesic riparian with species similar to those already planted (i.e., cottonwood and sycamore). Additional investigation of the reasons for poor performance of the original mitigation plan might suggest appropriate corrective measures so that the AWWTP restoration site could be extended to this area, providing an almost complete link to the confluence with the Gila River. This site was dropped because restoration projects under the 1135 program cannot be used to satisfy mitigation requirements, and it would be difficult to change the mitigation status of the site.
- *I-10 Outfall (Papago Diversion Channel)* - The lower segment of the outfall that is unlined could serve as an important extension to the channel. It retains water for longer periods of time than the zone where water is discharged to the Agua Fria. The outfall is subject to NPDES requirements, and so these responsibilities would have to be maintained by the Arizona Department of Transportation (ADOT). Incorporating management measures into the maintenance plan for this outfall that would be compatible with the restoration effort would require an agreement with this agency. This site was dropped because in operating the restoration project along this discharge, the local sponsors might incur responsibilities under the NPDES permit; achieving a suitable agreement with ADOT would at best, be difficult.

4.2.2 Revised Management Measures and Considerations

The management measures identified in Section 4.2.1 were presented at a May 6, 2002 technical workshop attended by representatives of the USACE, City of Avondale, FCDMC, Arizona Department of Game and Fish, and local experts. Based on consensus developed at the workshop, four management considerations were emphasized that became the basis for defining additional management measures and formulating the final alternatives. These four considerations and the conclusion that was reached for each of them are described below.

Consideration 1: Effects on flood capacity is one of two primary constraints (in addition to an outside water source) in developing alternatives. Even though the FCDMC focuses on complying with flood insurance requirements for the 100-year discharge, the project must also maintain the SPF capacity with a minimum of three feet of freeboard per USACE requirements.

Outcome: If restoration is carried out in a flood control project, it needs to have sufficient capacity to accommodate revegetation. This is not the case for the entire length of the project area; portions of the reach do not have extra flood-control capacity. This factor limits the location, area and type of vegetation that can be maintained in the channel. The SPF conditions are currently not met in some areas along the channel because of existing bed elevations and biomass. The design of alternatives, as well as maintenance measures during implementation, must demonstrate that the restoration project itself does not contribute to impacts to the SPF condition.

Consideration 2: Water is the second primary constraint to the success of the restoration project. Without additional sources, the alternatives for restoration and the potential environmental benefits would be very limited. Current surface water sources are ephemeral and unreliable.

Outcome: The alternatives were redefined to present a range of water needs proportional to the area that is restored and the acreage of each vegetation type (i.e., vegetation dominated by hydric or mesic riparian species versus vegetation dominated by xeroriparian species). The feasibility of obtaining water from different sources was considered in the technical workshop and subsequent meetings between the Corps and the local sponsors.

Diverting water from nearby irrigation canals would likely be difficult to achieve with the water districts within the necessary timeframe and given their commitments to current users.

Groundwater, either from existing or new wells operated by the City of Avondale, was considered the most viable short-term water source for the I-10 restoration site.

Recharge is not an acceptable project goal under the 1135 program unless it is incidental to the primary objective of increasing habitat benefits. However, the City is independently developing a project to use the AWWTP effluent for recharge just north of the I-10 site. If the recharge project is online when the restoration project is constructed, it is likely that some of this effluent will be diverted to the I-10 restoration site to replace the option for supplying water to the site from groundwater wells. Under such circumstances any recharge associated with the water supplied to the restoration site might be considered incidental. Also a portion of the existing 3.5 mgpd of effluent will be committed to the southern AWWTP restoration site.

Although each alternative differs in the restored acreage and water needs they all consider the same vegetation/habitat types. This approach was taken so that the restoration project, regardless of the alternative that was chosen, would establish the full range of native riparian vegetation that could be supported within the channel (i.e., from hydric to xeric riparian vegetation with increasing distance from the water source).

Consideration 3: Restoration along the entire Agua Fria River is a long-term goal of local governments and resource agencies, and many view early projects, such as this one, as important models to motivate future restoration efforts. In this same context, local sponsors are very eager to have the restoration project developed in a manner that could enhance local efforts to establish parks and trails along the river corridor.

Outcome: The concept developed in the PRP and the preliminary array of alternatives was to focus restoration efforts at three areas along the 5.5-mile project reach (I-10 outfall, Durango Regional Outfall Channel at Buckeye Road, and the Avondale Wastewater Treatment Plant). Because of the local sponsors' interests in establishing recreational amenities along the river, the configuration of the restoration area was elongated to cover a greater length of the project reach that could be appreciated along more of the river and adjacent to planned trails and parks. However, those alternatives that

covered the greatest length of the river also required large amounts of fill that significantly increased construction costs and require significantly more water.

Consideration 4: Permanent changes in the watershed have significantly reduced low-flows and peak discharges for more frequent flood events, but less frequent events greater than 10 or 15 years would still result in changes to the channel and losses of vegetation. Therefore, unprotected structural changes in the river for the purpose of restoration would be sacrificial.

Outcome: The alternatives were redesigned to include riparian strips located along the sides of the channel that would be protected by berms that could withstand a 10 to 15 year flood event. Protection from less frequent events would require berms greater than four feet that would be costly, create unnatural barriers to wildlife movement and be difficult to maintain. Restoration in the interior of the channel, outside of the protected riparian strips, would be limited to invasive species control to allow native vegetation to reestablish on its own and limited planting. This area would be subject to disturbance from frequent discharges and it would not be cost-effective to implement extensive revegetation in this area. The riparian strips would be protected with terrace bank armor to resist relatively frequent flood events but all or part of the protection could wash out during a very large infrequent event (e.g., 100-year or SPF). Within these areas, additional measures such as sediment replenishment could be implemented to mimic processes that have been significantly reduced by dams, diversions and other controls.

The final alternatives were based on these most important issues discussed at the workshop, as well as subsequent discussions with the local sponsors. The final alternatives use many of the originally proposed management measures, but were reorganized and improved as more information was obtained during the course of the feasibility phase. The following is a description of habitats that were used to design the final alternatives, which are described in detail in Section 4.3.

4.2.3 Preliminary Habitat Considerations and Descriptions

Plant communities (or vegetation types) and hydrologic conditions determine the type of habitat that can be restored. Notwithstanding, plant and wildlife habitat is comprised of many other biological, chemical and physical elements and processes. Section 3.2.2.2 describes plant communities present in the project area and Section 3.2.2.3 provides a general classification of native plant communities as described in Brown (1994) that could be established in the project area. Table 4.2-1 summarizes the description of these plant communities and their application to alternatives development.

4.3 FINAL ARRAY OF ALTERNATIVES

The following is a description of the final alternatives, which includes the No Action Alternative and seven action alternatives. The No Action Alternative describes baseline conditions that would continue in the future without the project. Alternatives 2, 3, and 4 are based on low, moderate, and high water availability, respectively. Alternatives 5, 6, and 7 are the counterparts of 2, 3, and 4, respectively, but

Table 4.2-1 Considerations for Applying Habitat Types to the Alternatives

Plant Community/Habitat Type	Summary Description	Considerations for Applying Habitat Types
Upper Sonoran Desert Scrub	This plant community includes a mixture of growth forms and while adapted to arid conditions, is not limited by the same extremes as desert vegetation. The same species identified in the interfluves of ephemeral drainages may also be found in upland areas, but physiognomy may be different. Soil conditions may be variable but include sand and gravel alluvium such as that found in the Agua Fria channel or clay lenses. Plant species associated with this community are adapted to extended periods of drought and have developed strategies to take advantage of limited water availability. Appendix B identifies species typical of this community "upland shrub" and "ephemeral flow" vegetation that includes species that persist along dry channels that receive ephemeral flows and along upper slopes.	Species common to this plant community may be established in the driest parts of the restoration area and may be subject only to periodic flooding: (1) along the levees; (2) along the upper floodplains of the project area in portions of the restoration sites that are without levees; and (3) at the fringes of restoration areas where the benefits of surface water inputs are minor or nonexistent and groundwater is > 30 feet.
Sonoran Riparian Woodlands – Mesic/Xeric	This plant community is located more distant from flowing water or may develop in areas where flows are intermittent. Plants may also be dependent on groundwater that generally occurs at < 30 feet. The most typical of mesic riparian woodlands is the mesquite bosque, but the same species present in a mesquite bosque may also persist under more arid conditions with lower densities or with smaller growth forms. Within the restoration project area, mesquite are scattered throughout the upper portion near the I-10 overpass. Mesquite and associated species are identified in Tables 4.3-2a and 4.3-2b.	Species with these habitat characteristics may be planted in the restoration areas with slightly deeper groundwater (i.e., nearer the northern end of the project area), but still adjacent to the intermittent and ephemeral drainages.
Sonoran Riparian Woodlands and Wetlands – Hydric	These plant communities are generally dependent on a combination of perennial surface water and shallow groundwater. The most well known of these is the cottonwood gallery riparian woodland. The AWWTP effluent sustains a small marsh, but under without project conditions (see Alternative 1) this would likely be eliminated when water is diverted upgradient to the City's recharge ponds in approximately 2004 or 2005 or designated for other uses. Emergent vegetation varies from sparse stands of such short stature and alkali resistant species as salt grass, alkali bulrush (*Scirpus maritimus* var. *paludosus*) and three-square (*Scirpus americanus*) to dense, impenetrable communities of reed (*Phragmites australis*) and giant bulrush (*Scirpus californicus*). Often the most prevalent species is the cattail, represented by *Typha domingensis*. At the edge of the marsh there is typically much intermingling with adjacent scrublands of salt cedar, arrow-weed, quailbush (*Atriplex lentiformis*), and mesquite. Table 4.3-2c provides a draft plant palette for this vegetation community.	This vegetation community would be preserved as much as possible at the AWWTP site with a portion of effluent and shallow ground water. Along the edges of the side channel areas and areas where there is insufficient freeboard (e.g., near Buckeye Road), wetland or at least facultative wetland species may be preferred over woody species because of their effect on flood capacity within the channel.

do not include restoration along the western levee. Alternative 8, the Recommended Plan, is a combination of characteristics from Alternatives 2 and 4.

4.3.1 Final Alternative 1: No Action

The No Action Alternative presumes that no restoration project would be undertaken by the USACE or by local interests to achieve the planning objectives, and that the existing and future without project conditions would prevail.

The acreage of existing vegetation types that would persist under the No Action Alternative or that would be restored under each Action Alternative is summarized in Table 4.3-1.

Table 4.3-1 Summary Estimate of the Acreage of Each Major Vegetation/Habitat Type by Alternative

Alternative/Location	Riparian scrubland/ woodland (xeric)[1]	Riparian scrubland/woodland (mesic)	Riparian scrubland/woodland (hydric)[2]	Riparian wetland/herbaceous (hydric)[2]	TOTAL
Alternative 1 – No Action[3]					
TOTAL	95.8	137.9	59.5	10.7	303.9
Alternative 2 – Low water use					
Eastern riparian strip (6110' X 310')[4]	0	12.3	22.5	4.4[5]	39.2
Western riparian strip (8773' X 75')	15.8	0	0	0	15.8
Vegetation management areas	0	0	0	0	0
Construction Areas[6] (14,883' X 50')	17.1	0	0	0	17.1
Restored Subtotal	32.9	12.3	22.5	4.4	72.1
Unaffected	62.9	125.6	37.0	6.3	231.8
TOTAL	95.8	137.9	59.5	10.7	303.9
Alternative 3 – Moderate water use					
Eastern riparian strip (8820' X 310)	0	23.6	27.6	6.6	57.8
Western riparian strip (8773' X 75)	15.8	0	0	0	15.8
Vegetation management areas	0	0	0	0	0
Construction Areas (17,594' X 50')	20.2	0	0	0	20.2
Restored Subtotal	36.0	23.6	27.6	6.6	93.8
Unaffected	59.8	114.3	31.7	4.1	210.1
TOTAL	95.8	137.9	59.5	10.7	303.9
Alternative 4 – High water use w / Vegetation Management Areas					
Eastern riparian strip (18,690' X 310')	0	89.4	57.5	8.8	155.7
Western riparian strip (8773' X 75')	15.8	0	0	0	15.8
Vegetation management areas[6]	48.5	48.5	2	1.9	100.9
Construction Areas (27,463' X 50')	31.5	0	0	0	31.5
Restored Subtotal	95.8	137.9	59.5	10.7	303.9
Unaffected	0	0	0	0	0
TOTAL	95.8	137.9	59.5	10.7	303.9
Alternative 5 – Low water use w/o western riparian strip					
Eastern riparian strip (6110' X 310')	0	12.3	22.5	4.4	39.2
Western riparian strip	0	0	0	0	0
Vegetation management areas	0	0	0	0	0
Construction Areas (6110' X 50')	7.0	0	0	0	7.0
Restored Subtotal	7.0	12.3	22.5	4.4	46.2
Unaffected	88.8	125.6	37	6.3	257.7

Alternative/Location	Riparian scrubland/ woodland (xeric)[1]	Riparian scrubland/woodland (mesic)	Riparian scrubland/woodland (hydric)[2]	Riparian wetland/herbaceous (hydric)[2]	TOTAL
TOTAL	95.8	137.9	59.5	10.7	303.9
Alternative 6 – Moderate water use w/o western riparian strip					
Eastern riparian strip (8820' X 310')	0	23.6	27.6	6.6	57.8
Western riparian strip	0	0	0	0	0
Vegetation management areas	0	0	0	0	0
Construction Areas (8820' X 50')	10.1	0	0	0	10.1
Restored Subtotal	10.1	23.6	27.6	6.6	67.9
Unaffected	85.7	114.3	31.9	4.1	236.0
TOTAL	95.8	137.9	59.5	10.7	303.9
Alternative 7 – High water use, w / Vegetation Management Areas, w/o western riparian strip					
Eastern riparian strip (18,690' X 310')	0	89.4	57.5	8.8	155.7
Western riparian strip	0	0	0	0	0
Vegetation management areas	48.5	48.5	2	1.9	100.9
Construction Areas (18,690' X 50')	21.4	0	0	0	21.4
Restored Subtotal	69.9	137.9	59.5	10.7	278
Unaffected	25.9	0	0	0	25.9
TOTAL	95.8	137.9	59.5	10.7	303.9
Alternative 8 – Moderate water use, w / reduced Vegetation Management Areas, w / reduced western riparian strip					
Eastern riparian strip (3130' X 310')	0	6	11	2.2	19.2
Western riparian strip (3885' X 75')	6.5	0	0	0	6.5
Vegetation management areas	38.8	38.8	2	1.4	81
Construction Areas (7015' X 50')	8.0	0	0	0	8.0
Restored Subtotal	53.3	44.8	13	3.6	114.7
Unaffected	42.5	93.1	46.5	7.1	189.2
TOTAL	95.8	137.9	59.5	10.7	303.9

1 Includes species common to upper Sonoran desert scrub and species found under xeric conditions typical of upper flood plains or, as in the present case, alluvial systems deprived of water because of hydrological controls. The total acreage for this habitat type is based on the western levee restoration area.

2 Woodland/scrubland hydric: dominated by woody species with a high hydrologic component (inflexible species); wetland/herbaceous hydric: dominated by herbaceous species with a low hydrologic component (flexible species).

3 The total acreage for this alternative corresponds to the maximum restoration acreage under Alternative 4. For the other alternatives, the restored acreage would be less.

4 Maximum dimensions for each strip. The restored acreage, i.e., revegetated area along the levees may be slightly more or less, depending on the alternative.

5 Approximates the acreage occupied by two low flow channels that would deliver water along the extent of the eastern riparian strip; it would support wetland or facultative wetland species (i.e., there would not be permanent surface water to support an aquatic environment.)

6 Located along the riparian strips towards the interior of the channel. These are sparsely or unvegetated areas within the channel that are dominated by nonnative vegetation. Affected areas that are vegetated at the construction phase will be reseeded with native species. It is assumed the area will have greater habitat value than the existing condition. The construction area is approximately 50 feet wide along the length of the terrace bank armor (i.e., eastern and western riparian strips).

7 Vegetation management areas around I-10, Durango Regional Outfall Channel and the AWWTP support predominantly mesic to xeric riparian conditions, depending on the time of year. The marsh and adjacent areas at the AWWTP discharge are the exception.

The acreage affected by the without project alternative, 303.9 acres, is based on Alternative 4, which covers the greatest area via establishment of riparian strips, establishment of native cover in areas affected by construction, and incorporation of vegetation management areas (see Section 4.3.4). The affected area does not include all the acreage in the channel along the 5.5-mile reach. Although the same vegetation types are used in Table 4.3-1 to describe the No Action condition as those used to

describe the restoration Alternatives 2 through 8, species diversity under the No Action condition is low and dominated in many cases by invasive, exotic species that provide limited habitat resources.

In the future, the environment within and adjacent to the Agua Fria River will be influenced by several factors, including planned land-use and resource-use policies, projects or activities that would directly affect the proposed project area, recreational development, and watershed-level activities that would indirectly effect the restoration area. These are generally the same anthropogenic and natural factors that are influencing existing conditions within the project area. While they are applicable to both the without and with project condition, their negative impact on the channel is potentially greater under the former. The following is a brief description of these major factors, and their present and likely future effects on the project area.

Recreational Development

Habitat value along the study area may be adversely affected by human disturbance associated with recreational activities and plans described in Section 3.10.3. Recreational development in the project area is focused primarily on a trail system within and adjacent to the river. Conservation areas would be subject to disturbance associated with the recreation plans, and the trail system would fragment habitat resulting in a very high edge to interior ratio. The use of non-native vegetation in those areas classified as active and passive recreation zones would potentially limit efforts in conservation zones and habitat restoration projects adjacent to the trail system. Construction of trails, over- or underpasses and amenities would potentially occupy existing open space and disturb adjacent habitat. The completed trail network would potentially replace or limit opportunities for habitat restoration or enhancement for native flora and fauna. Under the without project condition trails may occupy more of the channel bottom and there may be greater use of nonnative (landscape) species in the channel.

Water Resources Planning and Use

Water demand over the next two decades is likely to shift from agricultural to residential in the immediate project vicinity, as described in Section 3.3 (Water Resources). In addition, the Phoenix Active Management Area and specifically, the City of Avondale are committed to ensuring a balance between water use and recharge. Although historic groundwater levels have dropped within the project area, this trend has slowed and may even reverse itself because of significant recharge efforts in the area (Mario Lluria, 2002; Frank Turek, 2002).

Surface drainage to the restoration sites would change. Under the without project condition, it is assumed that eventually all effluent from the AWWTP would be diverted to other uses that may be more profitable. This would significantly reduce or eliminate the existing marsh and riparian vegetation near the outfall for the plant, requiring vegetation to depend predominantly on groundwater.

Changes in land use from agricultural to residential may result in localized areas of increased runoff from impervious surfaces. However, the net effect of this conversion under the without project condition would be a reduction in seasonal and intermittent flows to the Durango Regional Outfall Channel and possibly, the I-10 Channel, with an overall reduction in vegetation cover in the channel.

Among other things, the Watercourse Master Plan and other water resource plans described in Section 3.3 help to establish policy towards land development in the flood plain. The restoration alternatives work mostly within the levee system and the channel invert precisely because there is no publicly owned land available for restoration within the remaining floodplain (unleveed portions). Some of the alternatives incorporate flood plain lands near the AWWTP. Under the without project condition even some of these areas could be developed with appropriate flood protection measures. Yet, these are also the areas that are most critical to riparian restoration.

Conversion of Agricultural and Open Space to Urban Land Use

From the beginning of the last century there was a general conversion of riparian areas to agricultural use and a loss of wildlife habitat within the floodplains; but now the trend is toward replacing agricultural land use with urban uses. With the exception of lands on the eastern side of the lower portion of the project area (in the vicinity of the AWWTP) near the Gila River confluence, lands adjacent to the project area would likely be converted to residential and commercial use in the future. This conversion would likely have indirect effects to the project area through: (1) changes in the quality surface drainage and reduction in flows; (2) placement of levees or dikes between new residential areas and the channel (e.g., planned development on the west side of the Agua Fria near Buckeye Road); (3) increased trash from surface runoff; (4) introduction of dog and cat predators; (5) increased pedestrian and off-road vehicle use; (6) increased sources of exotic species propagules; and (7) direct disturbance or loss of habitat from new utility easements.

The river channel within the project area experiences minor use by pedestrians and off-road vehicles. Major access for vehicles exists downstream of MC 85 along the unleveed portion of the floodplain. Most of the trash seems to enter through existing discharges at I-10 and the Durango Regional Outfall Channel.

Under the without project condition there would be no basis or motivation for controlling these urban impacts. Even though the restoration project covers a relatively small area along the lower 5.5 miles of the Agua Fria, it would serve as a starting point for further habitat protection and restoration efforts.

Channel Operation and Maintenance

There are periodic disturbances within segments of the Agua Fria River for maintenance of urban drainages, the I-10 channel, Durango Regional Outfall Channel and redistribution of sediment. These activities generally coincide with areas where vegetation develops or where sediments accumulate after significant flood events. These disturbances tend to be infrequent and localized. Maintenance in the I-10 channel near its confluence with the Agua Fria occurs approximately every two years and consists of vegetation and sediment removal in one of the two halves of the split channel and grading of the earthen berms (McNeary, pers. com., 2002). Under the without project condition, these actions would continue uncontrolled whereas the action alternatives recommend an agreement to minimize the disturbance in the Agua Fria.

The three overpasses in the project area (McDowell Road, I-10 and MC 85) undergo periodic inspections and maintenance to ensure that the structures are not affected by scouring and flood damage. The MC 85 bridge recently underwent temporary retrofit for scour protection and is scheduled for additional improvements in 2004-2005 (Wojakewicz, pers. comm., 2002). There is no significant difference between the effects of these actions under the with and without project conditions.

Sand and Gravel Mining

Sand and gravel mining has contributed significantly to the instability of the Agua Fria River Corridor. Historical records indicate that prior to the 1950s the Agua Fria River was relatively stable. However, active sand and gravel mining has been taking place since then, causing a significant volume of sediment to be extracted from the river. This is further compounded by the New Waddell Dam, which traps upper watershed sediment and eliminates periodic downstream flows. These two factors result in an increased potential for significant degradation, or lowering, of the bed of the Agua Fria River. Headcutting has been noted in several locations along the river (Fuller, 2001).

Sand and gravel mining occurs in the southern portion of the project area near the AWWTP and within 0.5 mile upstream of the northern project limit. These activities may cause localized alteration of groundwater and sediment patterns and create barriers to wildlife movement. The effect on riparian vegetation in the lower part of the project reach may be compounded when the plant effluent is diverted to recharge ponds to the north.

Watershed Level Changes

Dam construction, channelization and other controls within the Agua Fria watershed have affected 83 percent of the drainage area, reducing low-flows, peak discharges and sediment input to the project area. Large flood events may still cause changes in the riverbed and especially areas where there is less encroachment upon the floodplain, but changes caused by more frequent floods have been significantly reduced. In the future, discharges, volumes and frequencies may slightly increase from local inputs, diversions into the river or changes in reservoir operation, but this would probably be counteracted by demands by users and there is unlikely to be any significant benefit to the project reach. The project reach would continue to be impacted from a net loss of bed material and lack of streambed deposition of fine sediments, creation of open patches through partial washout of vegetation, seasonal moisture and perennial flows that are some of the critical functional characteristics of riparian ecosystems.

Other Habitat Restoration Projects

Section 3.2.5 summarizes several local restoration projects that would occur near the same time as the Agua Fria restoration project. In addition, several regional parks or preserved areas along the Gila River all serve to reverse the serious habitat fragmentation, degradation and loss of riparian, wetland and aquatic habitat that has occurred within Arizona. Under the with project condition these other projects may have a greater overall habitat benefit in the Agua Fria River.

Summary of No Action Alternative

Arizona is continuing to experience a significant loss of riparian habitat. The Agua Fria River is one of three primary river corridors in the Phoenix area. Within the channel of the Agua Fria River, existing riparian habitat is limited to a few isolated areas. The overall habitats are of low value and are declining in extent and quality. The projected future without-project condition would continue to follow this trend of decline.

The control of water resources on a watershed level, as well as localized changes to the groundwater and surface water drainage and surrounding land development, have already had a significant irreversible effect on the site. Some of the negative factors described above perpetuate and accelerate this trend (e.g., full development of adjacent areas, diversion and channelization of runoff, floodplain encroachments). Others would tend to have low-grade chronic or local effects, such as increased recreational development that would encourage more pedestrian and off-road use of the channel. The sum of these factors would result in continued habitat degradation and little opportunity for the growth of vegetation or increase in wildlife habitat.

The abovementioned factors would not result in a complete loss of existing vegetated areas within the channel. The only exception would be diversion of the AWWTP effluent that currently supports wetland and aquatic habitat. Some encroachments may occur in the remaining unleveed portions where levees, dikes or buildings are elevated to allow for some development. Maintenance at the I-10 channel repeatedly disturbs vegetation and favors establishment of non-natives. In addition there would be continued degradation of the channel bed resulting in coarser substrate than already exists. Some species like Fremont cottonwood depend on finer materials for germination and establishment of seedlings. Burrowing mammals prefer sandy substrate to coarse sand and gravel. Under these conditions it would become more difficult for vegetation and wildlife to reestablish after significant flood events.

Low magnitude, chronic disturbances have subtle and long-lasting effects. Natural recovery is a long process, especially in arid ecosystems. An ecosystem restoration project would help to restore some of the habitat quality and quantity, along with habitat functions, that have been lost from the current system.

4.3.2 Final Alternative 2: Low[1] Water Use[2]

Basic Concept

Alternative 2 would extend over the smallest area in comparison to the other alternatives: approximately 55 acres through establishment of riparian strips; and 17.1 acres through establishment of native cover in areas affected by construction that are currently sparsely vegetated and dominated by

[1] The use of "Low", "Moderate" and "High" is meant to describe water use for each alternative relative to one another rather than in an absolute context. The difference in water use correlates directly with the acreage of the restoration area for each alternative and is unrelated to the proposed habitat types.

[2] Because Alternative 4 is the most extensive of the restoration alternatives, it is described in Section 4.3.4 in the greatest detail. All other alternatives are described in relation to Alternative 4. The reader may wish to read Section 4.3.4 first.

invasive exotic species (Table 4.3-1 and Figure 26). It would require a relatively low input of water (1.1 mGPD), which would come from two new wells and some irrigation from the existing City water supply[3]. Water use for this alternative, as well as the others, would be proportional to the acreage of the restored area and the water needs of the vegetation.

The configuration of Alternative 2 would consist of a riparian strip along the western levee from McDowell Road to Coldwater Park (near the second grade control structure below I-10), and along the eastern levee from the I-10 outfall (Papago Diversion Channel) to the second grade control structure. The vegetation type along the western levee would be entirely xeric riparian vegetation and/or vegetation typical of the upper Sonoran desert scrub; vegetation along the eastern levee would consist of a gradient of hydric, mesic and xeric vegetation with increasing distance from side channels constructed within the riparian strip to convey water.

Major Structural and Other Physical Elements

The construction of the western and eastern riparian strips and the terrace bank armor to protect the riparian strips are the same as that described for Alternative 4 near the I-10 site (see text under this heading in Section 4.3.4 below).

Eastern Levee Riparian Strip. The riparian strip on the eastern side would be constructed with one or two slightly meandering side channels that would conduct pumped groundwater. Each well would have its own pump, reservoir tank and distribution system. The configuration consists of a restoration strip along various segments of the eastern side of the channel: approximately 130 feet north of I-10; 3000 feet south of I-10 to Van Buren Street; and 2980 feet starting 300 feet south of Van Buren (total length on eastern side ~ 6110 feet). The riparian strip averages 310 feet wide. The elevation of the riparian strip would be approximately two feet above the existing channel bed. The side channels would be approximately 10 feet wide by 1 foot deep, and would be somewhat shaded by canopy to minimize evaporative losses. They would also be lined with 8 inches of fine agricultural grade soil to moderate infiltration losses at the upper end and ensure that sufficient water is carried to vegetation downstream. The side channels would be filled with rocks and gravel to allow for water conveyance but minimize surface water area.

Western Levee Fill. The western levee would be filled on the interior to create a 4:1 slope with imported fine material and some material from the riverbed. Restoration would extend along segments of the western side of the channel: approximately 2043 feet north of the I-10; and 6730 feet south of the I-10 (total length on western side ~ 8773 feet). The restoration area would be approximately 75 feet wide.

[3] As long as the local sponsors can assure that the water needs for an alternative will be met, they can provide water from any other source at the time of construction or any time during the life of the project. However, for the purposes of feasibility design and cost estimating it is assumed that for this alternative the water will come from new wells and from existing supplies.

Hydraulic and Hydrologic Considerations

The hydraulic and hydrologic characteristics of this alternative are the same as those considered for Alternative 4 in this segment of the river (i.e., between McDowell Road and Buckeye Road) (see Section 4.3.4 and Appendix I).

Vegetation and Planting

The vegetation and planting scheme is similar to that described for Alternative 4 (Section 4.3.4).

Other Ecosystem Management Measures

The same management measures recommended for Alternative 4 would also be applicable to this alternative (see text under this heading in Section 4.3.4).

Primary Construction and Implementation Considerations

The construction activities of Alternative 2 would be less in magnitude and duration than Alternative 4. Most of the construction requiring heavy equipment for grading and earth movement, which causes the most disturbance, would take place over 30 to 45 days; however, this schedule must be timed with the invasive, exotics control, revegetation and seeding, and nesting periods for any sensitive species that may occur in the area.

Sensitive Species Clearance. Although no Federal or State listed threatened or endangered species are known to presently occupy the site, this does not preclude that sensitive species (especially birds) may occasionally use the project site and may be present during construction. Therefore, within approximately 30 days prior to mobilization for construction, a qualified biologist shall survey the area for the presence of any active nests, burrows, etc. of sensitive species.

Vegetation Clearing and Invasive, Exotics Control. Because there is relatively less restored area in this alternative, invasive exotic species control may be completed intensively in one season with less effort in the second season. There are no vegetation management areas in this alternative and so invasive, exotic species removal is restricted to the riparian strips along the eastern levee and the area at the toe of the western levee. This would be carried out as part of clearing and grubbing for site preparation, but may also include spraying and cutting with approved aquatic herbicides. The estimated duration is approximately two weeks in late summer/autumn. The effort would require a bull dozer and two haul trucks with 10 cy capacity for removal of vegetation debris. During vegetation clearing some of the surface soil/alluvium would be removed with vegetation in highly infested areas to ensure that seeds or rhizomes of invasive, exotic species are removed. In areas where the cover is dominated by native species, clearing may be done by hand methods, which are more selective. Approximately 30 truckloads of vegetation debris would be disposed of within five miles of the project area.

Grading and Fill. These actions are implemented within the riparian strips along the eastern and western levees. Approximately 280,020 cy consisting of approximately 112,004 cy of fine materials defined as silt or silty sand and approximately 168,012 cy of coarse material defined as gravel and sand with fines would be required as imported fill (see also Appendix F and Appendix I). The estimated

duration of this effort is three months along two fronts in late summer, early autumn. Approximately 52,915 cy of material consisting of soil cement, gunnite and/or planted gabions will be used to construct the bank armor protection along the riparian strips. An additional amount of agricultural grade soil is used to line the side channels and rock to fill them and minimize surface water area. This effort would require approximately ten laborers on 40-hour workweeks, two bulldozers, and several haul trucks. The finish grading for the eastern and western riparian strips is similar to that described for Alternative 4.

Placement of Microhabitat Features. This includes placement of cobbles, a small amount of woody debris, nesting boxes, nesting or perching platforms, artificial burrows, etc. Depending on the feature it may be completed after grading and fill, coincident with revegetation or immediately thereafter. Since it overlaps with other phases of construction it does not have its own timeline. This generally requires manual labor of two to three people.

Revegetation. This consists of a combination of poles, containers, and seed mix and should occur approximately from November to April, depending on the species. It is assumed that clearing and grubbing or backpack spraying and cutting within the riparian strips will be effective in removing the majority of invasive, exotic propagules on site and there will be no need for follow-up revegetation in a second season. This does not preclude the need for revegetation in areas where the initial effort has failed. Revegetation will require a backhoe for digging holes, equipment for placing trees, augers for pole plantings, mechanical seeding equipment, and manual labor. The duration of the revegetation effort would be approximately one month and require approximately five laborers.

Well Construction. This consists of well construction and testing that would be undertaken prior to and during initial vegetation removal. It takes approximately one week for construction and testing of two wells, using approximately four laborers working 40 hours/week.

Water Delivery and Irrigation System. The estimated duration of this effort is one month scheduled to be in place prior to the first germination/growing season in the late winter/early spring. This effort would require approximately 8 laborers on 40-hour workweeks; one grader and dozer for two days for placement of the reservoir for pumped water; and one concrete truck for construction of the reservoir.

Other issues that should be resolved during the design and construction phases are similar to those described in Alternative 4 (see Section 4.3.4), with the exception that:

- Acquisition of lands or conservation easements for any restoration near the AWWTP is not required
- Agreement for minimum effluent releases from the AWWTP is not required
- Coordination of approval of restoration project with Goodyear Airport exclusion zone is not required.

Primary Operation and Maintenance Measures

Major elements of the operation and maintenance phase of this alternative are similar to those described in Alternative 4 (see Section 4.3.4), except that most of the effort and cost are reduced because of the reduced restoration area.

4.3.3 Final Alternative 3: Moderate Water Use

Basic Concept

Alternative 3 would extend over a slightly greater area than Alternative 2: approximately 73.6 acres through establishment of riparian strips; and 20.2 acres through establishment of native cover in areas affected by construction that are currently sparsely vegetated and dominated by invasive exotic species (Table 4.3-1 and Figure 27). It also would require a slightly greater input of water (1.5 mGPD), which would come from approximately two new wells and some irrigation from existing City supplies. The configuration would consist of a riparian strip along the western levee from McDowell Road to Coldwater Park (also near the second grade control structure), and along the eastern levee from the I-10 outfall (Papago Diversion Channel) to the second grade control structure. Relative to Alternative 2, there would be an additional area of restoration south of Lower Buckeye in an unleveed portion of the river.

Major Structural and Other Physical Elements

The dimensions and construction of the western and eastern riparian strips and the terrace bank armor that would protect the riparian strips is the same as that described for Alternative 4 (see text under this heading in Section 4.3.4 below).

Eastern Levee Riparian Strip. The riparian strip on the eastern side would be constructed with one or two slightly meandering side channels that would conduct pumped groundwater. The configuration consists of a restoration strip along various segments of the eastern side of the channel: approximately 130 feet north of I-10; 3000 feet south of I-10 to Van Buren Street; 2980 feet starting 300 feet south of Van Buren; and 2710 feet south of Lower Buckeye Road (total on eastern side ~ 8820 feet). The elevation of the riparian strip would be approximately two feet above the existing channel bed. The side channels would be approximately 10 feet wide by 1 foot deep, and would be somewhat shaded by canopy to minimize evaporative losses. The restoration area averages 310 feet wide.

Western Levee Fill. The western levee would be filled on the interior to create a 4:1 slope with imported fine material. Material may be obtained from the riverbed, but quantity estimates assume that is all imported. The configuration consists of a restoration strip along segments of the western side of the channel: approximately 2043 feet above the I-10; and 6730 feet below the I-10 (total on western side ~ 8773 feet). The restoration strip would be approximately 75 feet wide.

Hydraulic and Hydrologic Considerations

The hydraulic and hydrologic characteristics of this alternative are the same as those considered for Alternative 4 in this segment of the river (i.e., between McDowell Road and Buckeye Road) (see Section 4.3.4 and Appendix I).

Vegetation and Planting

The vegetation and planting scheme would be similar to that described for Alternative 4 (see Section 4.3.4).

Other Ecosystem Management Measures

The same management measures recommended for Alternative 4 would also be applicable to this alternative (see text under this heading in Section 4.3.4 below).

Primary Construction and Implementation Considerations

The construction activities of Alternative 3 would be similar in magnitude and duration to Alternative 2 (see Section 4.3.2). A total of 314,260 cy of imported material would be required consisting of approximately 125,704 cy of fine materials defined as silt or silty sand and approximately 188,556 cy of coarser material defined as gravel and sand with fines would be required as imported fill (see also Appendix F and Appendix I). Approximately 62,585 cy of material consisting of soil cement, gunnite and/or planted gabions will be used to construct the bank armor protection along the riparian strips. Most of the construction requiring heavy equipment would take place over three months; however, this schedule must be timed with the invasive, exotic species control, revegetation and seeding, and nesting periods for any sensitive species that may occur in the area.

Primary Operation and Maintenance Measures

Major elements of the operation and maintenance phase of this alternative are similar to those described in Alternative 4 (see Section 4.3.4), except that most of the effort and cost are reduced proportionally because of the reduced restoration area.

4.3.4 Final Alternative 4: High Water Use

Basic Concept

Of the eight alternatives, Alternative 4 would extend along the greatest length of the 5.5-mile project reach and would occupy the greatest total area: approximately 171.5 acres of riparian strips; 100.9 acres managed to facilitate growth of native vegetation (i.e., vegetation management areas); and 31.5 acres of native cover established in areas affected by construction that are currently sparsely vegetated and dominated by invasive exotic species (Table 4.3-1 and Figure 28). Alternative 4 would require the greatest amount of water (5.2 mGPD), which would come from up to five new wells located throughout the project reach and some irrigation from existing City supplies. The eastern riparian strip would extend below the Durango Regional Outfall Channel at Buckeye Road. Within the riparian strip, there would be one or two meandering side channels. A constructed berm would partially exclude frequent flows (up to 15-year events) from the riparian strip to reduce the chances of significant losses; however, the terrace bank armor may not entirely exclude less frequent flows (greater than 15 years). Alternative 4 would not adversely affect the existing SPF condition.

Along the west side of the channel from approximately McDowell Road to the second grade control structure between Van Buren and Buckeye Roads, the interior slope of the levee would be filled to a slope of 4:1 and vegetated with species associated with xeric riparian and upper Sonoran desert scrub habitats. Terrace bank armor would protect the riparian strip from frequent flood events.

Some areas in the interior of the channel, outside of the protected strips, have been designated as Vegetation Management Areas to indicate that while no structural changes would occur in these areas, restoration actions would be taken. In Vegetation Management Areas, exotic species would be removed and/or controlled to allow native species to reestablish on their own, but the total biomass would remain approximately the same as existing conditions. There would be some planting or seeding of native species to in areas where exotics removal removes all the vegetation ground cover. The existing flood control capacity of the channel is maintained. The Vegetation Management Areas identified near the I-10 outfall (Papago Diversion Channel), the Durango Regional Outfall Channel at Buckeye Road and the AWWTP cover approximately 100.9 acres. The same external source of water used for the eastern riparian strip would be directed to these areas on a seasonal basis to mimic historical, natural discharges.

In the area around the AWWTP effluent discharge, the combination of the perennial source of surface water and relatively shallow groundwater currently sustains a small marsh and a vegetated strip. Under Alternative 4, it is assumed that there would be no change in the current 3.5 mGPD of effluent from the AWWTP and that this effluent would continue to sustain existing vegetation within that area. For that reason, the protected riparian strip along the east side is not extended to this area. Although complete removal of non-natives might be a prohibitive task, some of the large athel tamarisk trees, which consume disproportionately more water than cottonwood or willow, would be removed and replaced with native plantings[4]. Irrigation of plantings would be needed to encourage and facilitate growth of roots to groundwater. This could be done with trucks every two weeks for three months, then monthly or seasonally for the next two seasons, depending on the condition of the plantings.

Alternative 4 would require approximately 5.2 mGPD for irrigation (see Table 4.4-67. Water needs vary spatially and temporally throughout the year for different vegetation types. For instance, cottonwood and willow are dependent on higher seasonal flows from December through February and groundwater within three meters of the surface, whereas more xeric vegetation found in the upper flood plains would require periodic irrigation for a few hours once per week to once per month, depending on drought conditions. Flows should not be extended beyond the normal seasonality of events, because this might encourage establishment of tamarisk. Cottonwood and willow release seeds only through April and June, respectively, whereas tamarisk seeds are released through October and therefore, take advantage of delayed releases often associated with reservoirs (Tellman, 2002). A program defining delivery rates, frequency, and hydroperiods should be completed in the next phase of the project.

Major Structural and Other Physical Elements

Riparian Protection. In order to protect the riparian strips along the eastern and western levees from frequent and moderately frequent flood events up to 10-15 years, a protective berm would be constructed to armor the terrace bank. The terrace bank armor would separate the riparian strips from

[4] Athel tamarisk is not as invasive as other tamarisk species; it propagates from root stumps and adventitious roots rather than from seed. However, because it doesn't provide as many habitat resources and uses disproportionately more water when compared to native riparian species there is a benefit to removing some of the trees and replacing them with native species. The best method of control is to cut the trees and treat the stumps and roots with herbicide. The wood from athel tamarisk may be recycled and may be used for making furniture and fence posts.

the remainder of the channel. Without this protection, the project would require more maintenance and would be vulnerable to disturbance or loss from frequent flows. By design the protection is not complete; partial or complete overtopping and loss would occur during larger, less frequent events.

The dimensions and composition of the terrace bank armor would balance long term stability with the need to maintain connectivity between the restoration areas and the rest of the river, allow wildlife movement, or make sure that plant roots can reach groundwater. The berm could be constructed in overlapping segments along the length of the restored area to allow the inflow and outflow of water and provide protection from frequent flood events.

The protective berm would be armored approximately two feet high with coarse, earth-toned soil cement. On the eastern side only, an additional two feet of slope would be armored by earth-toned gunnite. The outer slope of the berm (towards the interior of the channel) would be approximately 4:1, and the inner slope (towards the levees) would be no steeper than approximately 5:1. The inner slope would not be protected by gunnite or soil cement. The toe of the terrace bank armor would extend to 10 feet below the existing surface. Drought tolerant annuals and shrubs with fibrous root systems would be planted at the toe on the outer slope of the terrace bank armor to protect against erosion. However, the outer slope of the berm cannot be planted. The top and inner slope of the berm can also be planted with drought tolerant species. The soil cement may be used in combination with or replaced with: (1) planted riprap or gabions; (2) stabilization fences that would accumulate vegetation and sediment to create a natural barrier; or (3) dense plantings that would naturally deflect flows (Briggs, 1996; USACE, 1997). However, for the purpose of cost estimation, it is assumed that the riparian strips are protected entirely with soil cement. In order to construct the berm and toedown the construction footprint would extend 50 feet beyond the toe of the terrace bank armor towards the interior of the channel. This area is included in the restoration effort; most of this affected area is currently sparsely vegetated and dominated by nonnative species. Revegetated areas would be seeded with drought tolerant native ground cover and irrigated for one to three years so that the ground cover would provide better quality habitat resources than what currently exists.

During construction, measures should be implemented to prevent erosion. It is anticipated that the bulk of rough grading will occur during the dry season. Erosion control will be especially important along the western riparian strip before vegetation becomes established. Methods and materials that may be employed include:

- Straw Punching – weed-free sterile straw is spread over an area prior to plant installation. A straw puncher is used to push the straw into the soil surface. The straw stalks aid in reducing the downslope movement of water and soil and increase water penetration into the surrounding soil.
- Straw Wattling – straw wattles, made from rice straw wrapped in black tubular netting are laid horizontally across slopes or small drainages and are anchored to the ground with metal or wooden stakes.
- Jute Matting – a loose weave mat of jute is placed over slopes and anchored in place by wooden stakes or rebar.

In areas where there is the potential for significant erosion and sediment, there may be the need to use straw bales. This type of bale would be placed in chevron patterns and anchored to the ground with

rebar or large wooden stakes on the slope contour to help direct water and sediment to a natural drainage.

Eastern Levee Riparian Strip. The riparian strip on the eastern side would be constructed with one or two slightly meandering side channels. The riparian strip extends along various segments of the eastern side of the channel: approximately 130 feet north of I-10; 3000 feet south of I-10 to Van Buren Street; 2980 feet starting 300 feet south of Van Buren; 3360 feet above Lower Buckeye Road and 9220 feet below Lower Buckeye Road (total length on east side ~ 18,690 feet). The restoration area averages about 310 feet wide plus an additional 50 feet construction zone towards the interior of the channel. The elevation of the riparian strip would be approximately one foot above the existing channel bed. Several factors must be considered in the final design of water delivery through the length of these strips: (1) evaporative losses, (2) high infiltration and plant uptake rates, and (3) low gradient. The side channels would be approximately 10 feet wide by 1 foot deep and would be somewhat shaded by canopy to minimize evaporative losses. Microvariation in the channels would be added by introducing rocks and cobbles to reduce the surface water area and also produce riffles that oxygenate water and by grading swales lined with fine, less permeable material to retain water after storm events. Water may also be piped further downstream to ensure that infiltration losses do not prevent water from flowing downstream. Alternatively, the side channels may be constructed with a subsurface layer of approximately 8 inches of less permeable material such as agricultural soil, fines from neighboring sand, and gravel mines or sediment excavated from the I-10 outfall (Wass, pers. com., 2002).

Western Levee Fill. The western levee would be filled to create a 4:1 slope with imported fine material, although riverbed material may be used. The restoration strip extends along the western side of the channel approximately 2043 feet above the I-10 and 6730 feet below the I-10 (total length on west side ~ 8773 feet. The restored width is approximately 75 feet wide plus an additional 50 foot construction zone. The fill would be contoured and terraced to provide some microsite variation for wildlife and plants that are primarily low water tolerant species and maximize water harvesting from direct precipitation.

Hydraulic and Hydrologic Considerations

The hydraulic analysis considers the impact of vegetation on flood conditions. A conservative hydraulic analysis approach was taken that presumed there would be no vegetation washout. The area occupied by the riparian strips was removed from the channel cross-section, i.e., it was conservatively assumed that there would be no flow conveyance in these areas. The water-surface profile model used in this study was based upon the model developed by Kimley-Horn and Associates (KHA) for the Agua Fria River Watercourse Master Plan. KHA and their associates converted the effective FIS HEC-2 model to HEC-RAS. This model was used to analyze the effect that each alternative would have on the SPF. More frequent events were evaluated using post-New Waddell Dam discharges. The results of this analysis are presented in greater detail in Section 4.4.6 and the entire analysis is presented in Appendix I.

Vegetation and Planting

General Description and Distribution. Tables 4.3-2a, 4.3-2b and 4.3-2c provide a list of plant species, densities and general habitat benefits for plantings in hydric, mesic and xeric water conditions that were selected from lists developed by Kimley-Horn (FCDMC, 2001a). Accordingly, the species in these tables require a range of water needs. Hydric species generally depend on a perennial source of surface water and/or groundwater within 3 m of the surface (phreatophytes fall into the hydric category and are particularly dependent on shallow groundwater). Mesic species can take advantage of groundwater at greater depths (generally up to 10 m) and can withstand periods of drought. Xeric species are particularly adapted to extended periods of drought. Within each group, the use of plants with a high hydrologic component (generally woody species with low flexibility that do not bend), moderate hydrologic component and low hydrologic component (generally herbaceous species with high flexibility) are determined by flood capacity limitations within the channel. Appendix B provides the complete list of these species (FCDMC, 2001a).

The plant species in Tables 4.3-2a, 4.3-2b and 4.3-2c would be used to revegetate the site in addition to the native species already present (Table 4.3-3). The Vegetation Management Areas would include some replacement planting of native species to encourage the success of native species relative to non-native species especially in areas where the removal of invasives would leave large areas without ground cover; however, self-establishment of native species would be the primary goal. The selection of species in the Vegetation Management Areas would also be based on existing groundwater conditions and ephemeral flows, from xeric species in the northern segment to mesic or hydric species in the southern segment. Table 4.3-1 describes the approximate acreage of vegetation types that would be restored, by location.

Planting Plan. The planting plan will delineate where native vegetation should be planted. The planting plan should identify where existing native vegetation such as specimen mesquite and cottonwoods are located. Prior to planting plan development, the landscape architect should review all previous vegetation reports, review the preservation plan prepared by the horticultural consultant, and conduct their own on-site review to verify plant locations and species. The landscape architect will consult with a soil scientist and fluvial geomorphologist with regard to the habitat restoration within the riparian strips. Light quality under large specimen trees should be noted before removal, because substantial changes in light intensity from opening the canopy will affect plant growth conditions.

Large native trees may be sensitive to new planting and irrigation under their canopy. In general no new planting or irrigation should be applied to within 10 feet of the trunk of any established willow, mesquite, cottonwood, or sycamore.

Revegetation Methodology. Native plant communities would be established in the habitat areas by a variety of methods, including container stock planting, cutting planting, seeding, pole planting, and wattle planting. In areas where saplings (but not trees) may have difficulty reaching groundwater at greater than 1 m, poles can be planted in 1.5 m holes dug with motorized augers. Plant materials would be acquired through nurseries, contract growers, site salvage operations, and harvesting from existing

riparian areas in the vicinity. A combination of the above planting methods would provide a cost-effective method for ensuring the initial success and sustainability of the vegetation. The success of these efforts is highly, if not entirely, dependent on the availability of water.

During the design and specifications phase, a site reconnaissance will be completed to identify those species for which viable propagules can be obtained from in situ plants, and these sources will be identified and located geographically. Nursery stock should be cultivated under edaphic conditions that mimic the site, including the use of site-specific soil inoculum to ensure establishment of mycorrhizae and other soil microbes. Watering rates for nursery stock should be reduced prior to planting to promote development of taproots or vertical growth of the roots system to most rapidly reach saturated soils.

In addition, part of this methodology would include a survey prior to development of a planting plan and construction to evaluate the health and potential for salvage and preservation of native species at the site to conform to Arizona's native plant laws. Native vegetation, especially trees, is highly susceptible to damage caused by construction activity. The survey would be completed by a qualified horticultural consultant, with expertise in restoration ecology, shall identify all native trees and vegetative stands suitable for preservation. Native vegetation designated for preservation should be located and recorded on a scale site plan. Specifications should be drafted to ensure the protection of native species. In general, to protect native stands or specimen vegetation, yellow caution tape should be placed around their perimeters, generally placing the tape at the drip lines of the trees and 5 feet beyond shrub foliage. All heavy equipment and grading operations would be prohibited from entering these areas. All other work within these areas shall be limited to manual labor under direct supervision of the horticulturist. Prior to any work, the horticulturist should identify to the restoration workers how existing native vegetation should be protected.

Table 4.3-2a Plant Species in Different Water Conditions

	Xeric Riparian (Intermittent Flow Vegetation) Mesic/Xeric early-level successional community		Evapotranspiration = 1.7 ac ft/year					
Spacing / Area coverage	Common Name	Botanical Name	Hydrologic Component [1]	Water Quality [2]	Moisture Regime [3]	Wildlife Value		General Comment
						Species	Type [5]	
10%	Alkali sacaton	*Sporobolus airoides*	Low	Low	Upland	Songbirds Small Mammals	Cover, Forage	Bunchgrass up to 1 meter tall. Withstands alkali soils.
10%	Big galleta	*Hilaria rigida*	Low	Moderate	Upland	Songbirds Small Mammals	Cover, Forage	Bunchgrass up to 1 meter tall. Withstands high temperatures w/o dormancy.
10%	Brittlebush	*Encilia farinose*	Low	Low	Upland	Songbirds Small Mammals	Cover, Forage	
25%	Bursage	*Ambrosia* spp.	Low	Low	Upland	Songbirds Small Mammals	Cover, Forage	Low-growth shrub. Several species
10%	Bush mulhy	*Muhlenbergia porteri*	Low	Low	Upland	Songbirds Small Mammals	Cover, Forage	Bunchgrass up tp 1 meter tall. Tends to form large singular bunches.
5%	Cereus	*Peniocereus greggii*	Low	Low	Upland	Songbirds Small Mammals	Cover, Forage	
40' o.c.	Creosotebush	*Larrea tridentate*	Moderate	Low	Upland	Songbirds Small Mammals	Cover	Medium growth shrub w/ open structure
40' o.c.	Paloverde	*Parkinsonia* spp.	High	Low	Upland	Songbirds Raptors Small Mammals	Cover, Forage, Nesting	Moderate height tree w/ branches to surface
5%	Sideoats gramma Blue gramma	*Bouteloua curtipendula* *Bouteloua gracilis*	Low Low	Moderate Moderate	Upland	Songbirds Small Mammals	Cover, Forage	Bunchgrass up to 1 meter tall. Bunchgrass no higher than 0.5 meters
10%	Snakeweed	*Gutierrezia sarothrae*	Low	Low	Upland	Songbirds Small Mammals	Cover, Forage	Small bushy herbaceous plant
15%	Spike dropseed	*Sporobolus contractus*	Low	Low	Upland	Songbirds Small Mammals	Cover, Forage	Bunchgrass grows to 1.5 meters

Source: Adapted from Kimley-Horn, 2001b.

1 Hydrologic Component is a measure of the vegetations contribution to resistance to channel flows. It is a combination of the N-Value (a friction coefficient) and the species flexibility and propensity for creating channel clogging snag material

2 Water quality is a measure of the vegetations ability to retain sediment, stabilize shorelines or uptake constituents. See accompanying text.

3 **Aquatic** moisture regime areas are normally inundated. **Shoreline** moisture regime is normally saturated or barely inundated. **Low Upland** moisture regime is occasionally inundated but is mostly dry. **Upland** moisture regime is normally dry, with occasional short duration wet periods. The upland moisture regime includes the Xeric-riparian areas found along upper floodplains of desert washes.

4 **Waterfowl** are species that normally float or swim. **Shorebirds** are normally wading birds and do not swim. **Songbirds** are primarily passerine migratory species. **Raptors** are upland birds of prey that would utilize all of the vegetation communities for hunting. **Small Mammals** are normally upland species coyote sized or smaller.

5 Habitat Types include **Cover**, which supplies wildlife with hiding areas and protected travel corridors; **Forage,** which supplies wildlife with vegetative food (predation is not included in forage) and **Nesting,** which includes the location of the nest and material necessary to build the nest.

Table 4.3-2b Plant Species in Different Water Conditions

	Mesic Riparian (Bosque Vegetation) Mesic mid-level successional community		Evapotranspiration = 3.8 ac ft/year					
Spacing / Area coverage	Common Name	Botanical Name	Hydrologic Component [1]	Water Quality [2]	Moisture Regime [3]	Wildlife Value		General Comment
						Species [4]	Type	
40' o.c.	Acacia	*Acacia greggii*	High	Low	Upland	Songbirds Raptors; Small Mammals	Cover, Forage, Nesting	
25%	Big galleta	*Hilaria rigida*	Low	Moderate	Upland	Songbirds Raptors; Small Mammals	Cover, Forage	Bunchgrass up to 1 meter tall. Withstands high temperatures w/o dormancy.
30%	Curly mesquite	*Hilaria belangeri*	Low	Moderate	Upland	Songbirds Raptors; Small Mammals	Cover, Forage, Nesting	Sod forming grass.
40' o.c.	Desert Hackberry	*Celtis pallida*	High	Low	Upland	Songbirds Small Mammals	Cover, Forage, Nesting	Moderate sized trees. Dense growth pattern
40' o.c.	Jojoba	*Simmondsia chinensis*	Low	Low	Upland	Songbirds Small Mammals	Cover	
25%	Knotweed	*Polygonum* spp.	Low	Moderate	Low Upland	Small Mammals	Cover, Nesting	Emergent/wet soil. Forms large masses.
40' o.c.	Mesquite	*Prosopis* spp.	High	Moderate	Upland	Songbirds Raptors; Small Mammals	Cover, Forage, Nesting	Large shrub to tree. Can form tickets.
10%	Panic grass	*Dichanthelium oligosanthes*	Low	Moderate	Shoreline Low Upland	Songbirds Small Mammals	Cover, Forage, Nesting	Wet soils. Normally at elevations > 3000 feet.
10%	Sedge species	*Carex* spp. *Cyperus* spp.	Low	Moderate	Shoreline Low Upland	Songbirds Small Mammals	Cover, Forage	Hydric to mesic grass-like species

Source: Adapted from Kimley-Horn, 2001b.

1 Hydrologic Component is a measure of the vegetations contribution to resistance to channel flows. It is a combination of the N-Value (a friction coefficient) and the species flexibility and propensity for creating channel clogging snag material

2 Water quality is a measure of the vegetations ability to retain sediment, stabilize shorelines or uptake constituents. See accompanying text.

3 **Aquatic** moisture regime areas are normally inundated. **Shoreline** moisture regime is normally saturated or barely inundated. **Low Upland** moisture regime is occasionally inundated but is mostly dry. **Upland** moisture regime is normally dry, with occasional short duration wet periods. The upland moisture regime includes the Xeric-riparian areas found along upper floodplains of desert washes.

4 **Waterfowl** are species that normally float or swim. **Shorebirds** are normally wading birds and do not swim. **Songbirds** are primarily passerine migratory species. **Raptors** are upland birds of prey that would utilize all of the vegetation communities for hunting. **Small Mammals** are normally upland species coyote sized or smaller.

5 Habitat Types include **Cover**, which supplies wildlife with hiding areas and protected travel corridors; **Forage** which supplies wildlife with vegetative food (predation is not included in forage) and **Nesting** which includes the location of the nest and material necessary to build the nest.

Table 4.3-2c Plant Species in Different Water Conditions

	Hydric Riparian (Riparian Vegetation) Hydric/mesic mid-level successional to climax riparian community		Evapotranspiration = 6 ac ft/year					
Spacing / Area coverage	Common Name	Botanical Name	Hydrologic Component [1]	Water Quality [2]	Moisture Regime [3]	Wildlife Value		General Comment
						Species [4]	Type	
15%	Bulrush	*Scirpus acutus* Varied other species	Moderate	Excellent	Aquatic, Shoreline Low Upland	Waterfowl Songbirds Shorebirds Small Mammals	Cover, Nesting	Persistent emergent (2-4 meters tall). Dense monotypic stands. Rhizomes
25%	Button-bush	*Cephalanthus occidentalis*	Moderate	Good	Aquatic, Shoreline Low Upland	Songbirds Small Mammals	Cover, Forage, Nesting	Shrub (< 3 meters tall), Wet soils
30%	Sedge species	*Carex* spp. Cyperus spp.	Low	Moderate	Aquatic, Shoreline	Shorebirds Songbirds Small Mammals	Cover, Forage, Nesting	Hydric to mesic grass-like species
10' o.c.	Coyote willow Other willows	*Salix exigua*	High	Moderate	Shoreline Low Upland	Songbirds Ground Birds Small Mammals	Cover, Nesting	Shrub (can exceed 3 meters). Very pliable stems. Other species such as S. gooddingii are tree-sized
25' o.c.	Cottonwood	*Populus fermontii*	Extreme	Low, High Transpiration	Low Upland Upland	Songbirds Raptors Small Mammals	Cover, Forage, Nesting	Large tree. Potential for large snags
30%	Knotgrass	*Paspalum distichum*	Low	Low	Shoreline	Waterfowl Songbirds Shorebirds Small Mammals	Cover, Forage, Nesting	Low-growth grass along banks

Source: Adapted from Kimley-Horn, 2001b.

1 Hydrologic Component is a measure of the vegetations contribution to resistance to channel flows. It is a combination of the N-Value (a friction coefficient) and the species flexibility and propensity for creating channel clogging snag material

2 Water quality is a measure of the vegetations ability to retain sediment, stabilize shorelines or uptake constituents. See accompanying text.

3 **Aquatic** moisture regime areas are normally inundated. **Shoreline** moisture regime is normally saturated or barely inundated. **Low Upland** moisture regime is occasionally inundated but is mostly dry. **Upland** moisture regime is normally dry, with occasional short duration wet periods. The upland moisture regime includes the Xeric-riparian areas found along upper floodplains in desert washes.

4 **Waterfowl** are species that normally float or swim. **Shorebirds** are normally wading birds and do not swim. **Songbirds** are primarily passerine migratory species. **Raptors** are upland birds of prey that would utilize all of the vegetation communities for hunting. **Small Mammals** are normally upland species coyote sized or smaller.

5 Habitat Types include **Cover**, which supplies wildlife with hiding areas and protected travel corridors; **Forage,** which supplies wildlife with vegetative food (predation is not included in forage) and **Nesting,** which includes the location of the nest and material necessary to build the nest.

Table 4.3-3 Native Species Occurring or Likely to Occur within the Restoration Project Area

Common Name	Scientific Name	Comment
		Trees
Mesquite	*Prosopis* spp.	Scattered along margins of ephemeral wash tributaries
Blue palo verde Yellow, foothill or little-leaf palo verde	*Parkinsonia floridum, Parkinsonia microphyllm*	Dominant woody species, scattered throughout corridor, concentrated in wash areas.
Cottonwood	*Populus fremontii*	Native, at margins of mesic/hydric areas
Desert willow	*Chilopsis linearis*	Very limited, in margins of xeric and mesic riparian interface with Sonoran upland
Willow	*Salix gooddingii* (may be hybridized)	Other co-dominate species of historical riparian community
Seep willow	*Baccharis* sp.	Scattered at interface w/other community
Catclaw	*Acacia greggii*	Scattered along wash and channel banks
		Shrubs
Saltbush	*Atriplex* spp.	Throughout corridor (T/O)
Burrobush	*Hymenoclea monogyra*	Scattered T/O, primarily on interfluves
Desert broom	*Baccharis sarothroides*	Scattered T/O
Brittlebush	*Encelia farinose*	Scattered T/O, primarily on interfluves
Rabbitbrush	*Chrysothamnus nauseosus* or *C. viscidiflorus*	Native perennial, T/O
White and Triangle bursage	*Ambrosia dumosa* and *A. deltoidea*	Scattered T/O, but co-dominate in portions, transition species to Sonoran upland, associated with creosotebush
Pale-leaf golden weed	*Isocoma acradenia*	Shrub
Creosotebush	*Larrea tridentate*	Transitional species to Sonoran upland community, scattered occurrence
Apache plume	*Fallugia paradoxa*	Scattered T/O
Winter fat	*Eurotia lanata*	Scattered T/O
		Herbaceous
Pigweed, amaranth	*Amaranthus* sp.	Common, annual
Horseweed	*Conyza canadensis*	Common, annual
Tansy mustard	*Descurainia pinnata*	Extensive areas at the higher, drier parts of this site, annual
Spurge	*Euphorbia* sp.	Common, annual
Common sunflower	*Helianthus annuus*	Scattered individuals, annual
Peppergrass	*Lepidium* sp.	Common, annual
Pappus grass	*Pappophorum mucronulatum*	Not common, perennial bunch grass
Ground cherry	*Physalis sp.*	Not common, perennial
Cocklebur	*Xanthium strumarium*	Not common, perennial
Sedge	*Carex* sp.	Small clump in standing water, perennial
Cheeseweed.	*Chenopodium sp.*	Scattered, annual
Silverleaf nightshade	*Solanum eleagnifolium*	Scattered, annual
Cattail	*Typha latifolia*	Standing water, perennial
Tumble pigweed	*Amaranthus albus L.*	Annual, T/O
Annual bursage	*Ambrosia acanthicarpa*	Annual, T/O
Cudweed	*Gnaphalium palustre*	Annual, in moist areas
Pineapple-weed	*Matricaria matricariodes*	Scattered in isolated areas
Cocklebur	*Xanthium stumarium L.*	Annual, isolated T/O corridor
Creeping bellflower	*Campanula rapunculoides L.*	Perennial
Horsetail	*Equisetum arvense L.*	Perennial, in moist areas
Rush	*Juncus spp.*	Perennial in moist areas
Bulrush	*Scirpus* spp.	Scattered point discharge sites, obligate water species
Spike rush	*Eleocharis* spp.	Scattered point discharge sites, obligate water species
Brome grass	*Bromus* spp.	Perennial, scattered T/O
Saltgrass	*Distichlis spicata*	Perennial, at drainage outlets and grade control structures
Mexican sprangletop	*Leptochloa uninervia*	Annual, in wet areas.
Wooly plantain	*Plantago insularis*	Scattered T/O

Source: Kimley-Horn, 2001a.

Plant species botanical name, common name, size, and location should be determined and depicted on the final planting plans. In addition, these plans should be reviewed and used by the restoration experts or landscape architect to select and place the proposed vegetation.

Irrigation Needs. Three generally different watering regimes shall be required within revegetated areas:

1. A combination of seasonal flooding and perennial low-flows within the eastern protected riparian strip
2. Irrigation for establishment and maintenance of vegetation along the western levee, Vegetation Management Areas and seeded areas along the channel side (interior face) of the terrace bank armor
3. Seasonal releases of pumped groundwater in Vegetation Management Areas outside of the protected riparian strips.

Frequent irrigation would be needed until new plants become established, especially in upland areas where vegetation is established along the western levee. Irrigation frequency may be weekly and then lessened to monthly and then finally a few times during the drought seasons in areas planted with xeric or upland species. Harvested rainwater would help sustain and regenerate plant communities along the side channel. The water table underneath the channel is shallow at the southern end of the project area, estimated at less than 20 feet in the lower end, but significantly deeper at the upper end, within 80 feet. There would ostensibly be sufficient groundwater to sustain woody plantings throughout much of the southern area once the root systems are established. Although the quality of the groundwater near the surface is not prohibitive of plant growth, salt levels may be limiting for native vegetation to reach full productivity, and plants should be monitored for signs of salt stress. Pumped groundwater quality in the northern end of the project area is good and only presents the potential for occasionally elevated nitrates, which at low levels would tend to benefit plants (sustained excess nitrate in water can favor growth of invasive, exotic species). The water quality characteristics from ephemeral sources at the I-10 outfall and Durango Regional Outfall Channel at Buckeye Road present typical problems of urban/agricultural runoff, and the addition of other water sources should offer some dilution of constituents limiting to native plant growth.

Control of Invasive Species. Revegetation in the vegetation management areas would be preceded by chemical and mechanical control of non-natives as summarized by Kimley-Horn (FCDMC, 2001a). In the riparian strips the entire vegetation cover shall be removed during site preparation. Prior to any work, the horticulturist should identify to the restoration workers the areas where exotic species shall be removed.

- **Mechanical Control.** Mechanical control measures range from manual removal to mechanized equipment. Manual removal includes cutting, picking, or pulling of the targeted species. It is labor intensive but has the advantage of minimizing additional stress on the adjacent non-target vegetation species. Mechanized machinery can range from select removal with small ground equipment to complete removal of surface vegetation and root zone plowing. It is less labor intensive but causes more collateral damage to the system. Mowing and pruning can also be used to retard or eradicate species. Mechanized control normally requires multiple applications to assure success.
- **Chemical Control.** There are several methods of chemical control. Herbicides such as glyphosate (active ingredient in Roundup®) and imazapyr (active ingredient in Arsenal®) are normally used in chemical applications for control of herbaceous or woody vegetation. These systemic herbicides are absorbed into the

plant and distributed throughout its system. Herbicide control can be very effective and is normally relatively economical. Herbicide control normally results in the destruction of additional non-targeted vegetation when interspersed with target species and may affect water and air quality. Glyphosate is relatively stable, immobile, and does not form long-term residual concentrations, which is why it is approved for use in aquatic environments.

- **Controlled Burning.** Some invasive species do not tolerate periodic fire, while many native species have adapted to the regime. Controlled burns can help control invasive species and promote healthy native ecosystems. Tamarisk and some other invasive species appear to tolerate periodic fire, and their propagation is not markedly affected.
- **Combination of Measures.** In many cases, a combination of the above techniques is the most successful eradication/control method. The general control plan for tamarisk includes mechanical cutting and immediate application of glyphosate to the stump. This approach has the advantage of select, limited application of herbicide, and minimal collateral damage. Controlled burns have also been used in combination with chemical and mechanical removal.

The most pervasive non-natives in the project area include: athel tamarisk, saltcedar, buffel grass, Russian thistle, and Bermuda grass because they are also invasive. It is important to point out that given the dominance of non-native grasses, the most intense removal effort may be carried out over two seasons, and thereafter with annual maintenance. Removal of non-natives would require scraping of the channel bed, and additional soil or amendments may be required to reestablish suitable germination and growth conditions.

There is ample literature discussing the control of these species and invasive, exotic species in general (Tellman, 2002). The extent to which this is carried out at the Agua Fria site depends on the likelihood of long-term success (especially when the underlying factors contributing to this problem cannot be controlled) and cost (i.e., complete eradication of nonnatives is unlikely). Areas dominated by tamarisk, which create high salt concentrations in the soil surface, may no longer be suitable for native cottonwood or willow without changes in soil chemistry (Anderson, 1995). Control of Bermuda grass and buffel grass takes at least several seasons and may require teams of people to ensure coverage of the affected area (Tellman, 2002). However, the extent to which invasive exotic species diminish habitat value (Barrows, 1996) and would diminish the success of the restoration effort, makes their control indispensable for the project. An approach focused on eradication should be balanced with efforts to encourage the growth of native species, which would in turn naturally control exotics (Tellman, 2002). The objectives and methodology would differ for each species and should be defined in the form of an invasive exotic species control program based on more careful surveys of their abundance and distribution in the project area.

Other Wildlife Habitat Resources. Additional materials that would enhance the benefit of vegetation and create microhabitat features such as nesting boxes, artificial burrows, nesting or perching platforms, woody debris or rock piles, etc. would be placed within revegetated areas and areas where vegetation is managed.

Other Ecosystem Management Measures

Beyond the primary efforts of structural modifications, increased water supply, invasive exotic species control and revegetation, additional measures driven by monitoring and adaptive management response or development policies would also affect the success of the project. These are briefly described below.

Natural Regeneration Sites. Cottonwoods and willows depend on the introduction of fine moist sediments, coincident with seeding; mesquites are more tolerant of drier conditions and coarser sediment. Areas suitable for natural regeneration should be created for long-term success of riparian restoration. Under these circumstances it may only be necessary to remove exotic species, create suitable moisture conditions and open space. During design, small areas of 1000 to 2000 ft^2 would be identified among revegetated areas where only clearing would be carried out to create open spaces for regeneration. Fine material would be released with pulse flows along the side channel and in Vegetation Management Areas to mimic sediment deposition. Other measures have been mentioned in the preceding text that would also encourage the success of native species.

Flood Plain Encroachment and Channel Disturbance. Measures should be implemented on several fronts to ensure that human disturbance and access to the channel is controlled. It is recommended that the City of Avondale incorporate a cooperative maintenance agreement with the ADOT to ensure that maintenance in the I-10 drainage (Papago Diversion Channel) does not unnecessarily impact the restoration sites. Finally, recreational development should be restricted to the perimeter of the restoration areas (see below).

Controlled Access. The Friendship Park and Coldwater Park trail and park expansion could affect the restoration project. The following measures may be incorporated into the restoration project on the recreational projects to ensure that park and trail users can positively coexist with the restoration areas:

1. Plant a shrub barrier adjacent to the levee trail on the west side to discourage entry into the riparian area.
2. Place mock wood fences and/or shrub barriers along trail underpasses to prevent access into restored areas.
3. A fenced or shrub bordered gravel trail would be constructed into the I-10 protected riparian strip and management areas to direct access of park users.
4. Informative signs and a map of the restoration project would be placed at important intersecting points.

Primary Construction and Implementation Considerations

Project construction consists of activities that can occur sequentially or in parallel. The following is a brief description of the construction activities, their approximate timeframe and the major equipment or methods used. In general most of the construction requiring heavy equipment would take place over four to six months; however, this schedule must be times with the invasive, exotics control, revegetation and seeding, and any nesting period for any sensitive species that may occur in the area.

Vegetation Clearing and Invasive, Exotics Control. This task consists of mechanical removal, application of herbicide and hydroperiod or moisture control. Invasive, exotics control in the riparian strips is carried out mainly through grubbing and clearing. In the vegetation management areas it will

be accomplished through a combination of heavy equipment, cutting and spraying. The majority of the control effort would take place over two seasons. The estimated duration of removal or application of herbicides for trees and most woody vegetation is one month in late summer/early autumn. Removal of annuals would be undertaken in spring after initial germination and herbicide application and mechanical removal. This effort would require approximately ten to fifteen laborers on 40 hour work weeks over four weeks for manual removal and backpack spraying, as well as one spray truck, two bull dozers, and six haul trucks for removal of vegetation debris. During vegetation clearing, the uppermost portion of soil/alluvium would be scraped away. Approximately 150 truckloads of vegetation would be disposed of within five miles of the project area.

Grading and Fill. This is needed in areas where removal of large athel tamarisk or roots of other nonnatives requires fill; within riparian strips along the eastern and western levees; and in construction of terrace bank armor for riparian strips. The estimated duration of this effort is four to six months along two to four fronts in late summer, early autumn. This effort would require working on two fronts, using approximately 15 laborers on 40 hour work weeks, and several bulldozers and haul trucks.

In general, borrow for the project would be needed for the following purposes:

- Approximately 438,435 cy of material for fill along the eastern and western levees consisting of 175,374 cy of fine material defined as silts and silty sand and 263,061 cy of coarse material defined as gravel or sands
- Lining for the side channel and areas where water may be accumulated to reduce (but not eliminate) infiltration losses and prolong its availability for plant uptake, such materials should be less permeable, but not present a barrier to plant roots; approximately 11,130 cy of fine material are needed for this purpose
- Rocks and cobble will be needed to fill the side channels and prevent the formation of open water; approximately 13,841 cy of coarse material are needed for this purpose
- 97,645 cy of material consisting of soil cement, gunnite and/or planted gabions will be used to construct the bank armor protection along the riparian strips parallel to the eastern and western levees
- Areas where tamarisk removal requires replacement fill because salt damaged soils exceed the tolerance of native riparian species (Anderson, 1995) or loss of volume because of root mass, although the majority of athel tamarisk will be left in place.

Material that is excavated from the toedown along the riparian strips is included in the construction of terrace bank armor; it may be used as fill within the riparian strips, but ultimate disposal is the responsibility of the construction contractor.

Placement of Microhabitat Features. This includes placement of cobbles, a small amount of woody debris, nesting boxes, etc. Depending on the feature it may be completed after grading and fill, coincident with revegetation or after. Since it overlaps with other phases of construction, it does not have its own timeline. This generally requires manual labor.

Revegetation. Revegetation requires a combination of poles, containers, and seed mix and should occur approximately from November to April, depending on the species. The majority of revegetation within the riparian strips and Vegetation Management Areas would be completed in the first year. However, since most invasive, exotic control requires two seasons for initial implementation, a second season of

revegetation is likely. This generally requires small equipment for digging holes and placing trees, augers for pole plantings, mechanical seeding equipment and manual labor.

Well Construction. This consists of construction and testing of up to five new wells that would be undertaken prior to and during initial vegetation removal. It takes approximately one-half week for construction and testing of each well (i.e., a total of three weeks for this alternative). Construction requires the placement of a drilling platform and staging area of approximately 15 ft^2 and approximately 3 to 4 laborers working 40 hours/week.

Water Delivery and Irrigation System. Water would be delivered from the wells to the restoration site via pumps connected to the existing electrical system. Water would be directed via pipe to reservoirs at the upstream portion of each segment and then subject to timed releases and allowed to flow by gravity downstream. The estimated duration of this effort is one month scheduled to be in place prior to the first germination/growing season in the spring. This effort would require working on two fronts, using approximately 16 laborers on 40 hour work weeks. In addition, one bulldozer, one grader, and one concrete truck would be needed for seven days for construction of reservoirs for the pumped water.

In anticipation of completing the activities described above, the following issues should be resolved during the design and construction phases:

- Compliance with native plant laws with completion of native species salvage survey
- Development of a planting plan and native plant preservation map
- Development of exotic and invasive species control program
- Inform ADEQ of the potential use of herbicides in aquatic environments (permit may be required)
- Acquisition of lands or conservation easements for any restoration near the AWWTP
- Well development and operation of wells by City of Avondale, including permitting by ADWR
- Detailed water production and delivery program
- Agreement for minimum effluent releases from the AWWTP
- Identification of existing and planned utility easements
- Integration of controlled access features with City's recreation project
- Coordination of maintenance of I-10 drainage (Papago Diversion Channel) with restoration activities
- Coordinate approval of restoration project with Goodyear Airport
- Implement adaptive management plan for post-construction monitoring, operation, response, and maintenance.

Primary Operation and Maintenance Measures

The operation and maintenance phase of this alternative includes the following actions:

- Operation and maintenance of wells and water delivery system
- Invasive and exotic species control program requiring labor intensive efforts
- Repair of riparian strip protection after flood events

- Revegetation or reseeding after flood events that cause damage or loss of vegetation (greatest during first five years of operation)
- Controlled sediment releases in small patches along eastern riparian strip to create new germination sites
- Minimization of in-channel disturbance (e.g., operation and maintenance at I-10 outfall)
- Coordination with future recreation projects to control access into the channel
- Redistribution of woody and other plant debris (as opposed to removal)
- Thinning of inflexible trees (e.g., greater than 1.0 inch diameter) that establish in areas where flood capacity is limited.
- Control of foreign litter and debris
- Control of non-authorized use by pedestrians and off-road vehicles
- Public awareness (e.g., signage and education, community involvement)
- Additional funding sources
- Third-party mitigation for in-channel disturbance in restoration sites as a result of recreation, maintenance of in-channel structures, road improvements, etc.

Maintenance of structures constructed for restoration or maintenance of the levee system itself by the local sponsors, may result in disturbance or loss of restored habitat. Under such circumstances the local sponsors will replace and/or restore the habitat to the design condition. This approach does not apply to disturbances or loss caused by other parties for maintenance of utilities, etc. Mitigation will be addressed on an individual basis for those activities.

4.3.5 Final Alternatives 5, 6 and 7: Alternative 2, 3 and 4 without Western Riparian Strip

Alternatives 5, 6 and 7 are the same as their counterparts, Alternatives 2, 3 and 4, respectively, but do not include any restoration along the western levee. The approximate acreages of each habitat/ vegetation type are summarized in Table 4.3-1. The relative requirements for imported fill and water are:

- Alternative 5 (Alternative 2, without western levee riparian strip): 34,114 cy fine material, 45,826 cy coarse material, 21,725 cy for terrace bank armor and 0.8 mGPD of water
- Alternative 6 (Alternative 3, without western levee riparian strip): 44,959 cy fine material, 66,221 cy coarse material, 31,390 cy for terrace bank armor and 1.2 mGPD of water
- Alternative 7 (Alternative 4, without western levee riparian strip): 95,174 cy fine material, 140,181 cy coarse material, 66,455 cy for terrace bank armor and 4.8 mGPD of water.

4.3.6 Final Alternative 8 (Recommended Plan): Low Water Use, With Reduced Vegetation Management Areas and Reduced Western Riparian Strip

Basic Concept

Alternative 8 (Recommended Plan) is an adaptation of Alternatives 2, 4 and 5, based on management measures and considerations described in Section 4.2.2 (see Figures 29 to 31 and Table 4.3-1). Alternative 8 would occupy approximately: 25.7 acres of riparian strips; 81 acres managed to facilitate growth of native vegetation (i.e., vegetation management areas); and 8 acres of native cover established

in areas affected by construction that are currently sparsely vegetated and dominated by invasive exotic species. Alternative 8 requires a relatively low water use (1.9 mGPD) and focuses restoration at two locations: (1) the I-10 site near the Papago Diversion Channel; and (2) the AWWTP site. Restoration options near the Durango Regional Outfall Channel (Buckeye Road) site were not considered under Alternative 8 because of the 10,000-foot Goodyear Airport exclusion zone that prohibits land uses that may attract birds and wildlife that present a risk to air traffic (Figure 4). The airport exclusion zone also influenced the southern limit of the I-10 site and the northern limit of the AWWTP site.

Restoration at the two sites for Alternative 8 would primarily involve eight measures:

1. Removal and control of exotic, invasive species throughout the entire restoration site
2. Construction of riparian strips along the eastern and western levees with terrace bank armor protection
3. Establishment of Vegetation Management Areas between the riparian strips and at the AWWTP site
4. Introduction of water from an external source at the I-10 site
5. Retain 1 mGPD of effluent from the AWWTP as a source of water at the AWWTP restoration site
6. Installation of filtration galleries and a system of pumps to recirculate shallow groundwater and infiltrated effluent at the AWWTP site from the downstream to the upstream end to help support vegetation cover
7. Non-construction measures to enhance habitat resources (e.g., microtopographic variation, creation of plant regeneration areas, etc.)
8. Measures to eliminate or reduce impacts from adjacent park and trail users.

The following is a description of the restoration actions that would occur at the two sites.

I-10 Site. Restoration at the I-10 site would be similar to Alternatives 2 and 5 (see Sections 4.3.2 and 4.3.5); however, the riparian strips would be reduced in length.

The eastern riparian strip would start approximately 130 feet north of I-10 and run 3000 feet south of I-10 (Figure 29) (total on eastern side ~ 3130). The average width of the eastern riparian strip would be 310 feet. Two side channels would be constructed within the strip to convey surface water. The eastern riparian strip would be planted with mesic and hydric riparian vegetation and irrigation would come from an existing City of Avondale groundwater well in the short-term; however, it is possible that by the time the restoration project is ready for construction the effluent from the AWWTP will be available as part of a recharge project undertaken by the City just north of the I-10 site. Terrace bank armor would protect the riparian areas from frequent flows (up to 15-year events); however, the berm and riparian strips may not withstand larger flows that would probably erode part or all of the protection and vegetation.

The western levee restoration area would include added fill planted with xeric riparian plant species and species typical of upper Sonoran desert scrub. The inner slope of the western levee would be filled with imported material at a 4:1 slope. Material may be taken from within the channel, but the cost estimate assumes that all of it is imported. The levee fill would extend approximately 75 feet into the main channel and would run approximately 3085 feet south of I-10 to about 800 feet downstream of Van Buren Road (total on western side ~ 3885). Terrace bank armor would also protect the filled areas

along the western levee from frequent flood events; however, flood protection would not be to the same extent as the eastern protection since most the western levee plantings would be elevated above very frequent flood events.

A Vegetation Management Area covering 63 acres would be established in the in-channel area south of McDowell Road, extending to just south of I-10. The Vegetation Management Area would increase the percentage of native species without significantly increasing the overall amount of plant biomass. Invasive species would be removed and controlled to encourage establishment of existing and planted native species. No structural changes would occur in the Vegetation Management Area. Limited planting would be carried out in this area where the removal of exotic, invasive species leaves no vegetation cover. The water demands for the Vegetation Management Area are based on a per day calculation; however, the actual irrigation schedule would fluctuate. Input of water and sediment to create renewal sites would be planned to coincide with natural flows to create conditions in the Vegetation Management Area that are favorable for the regeneration and establishment of native species.

The City of Avondale has planned a multi-use trail that would connect Friendship Park to Coldwater Park at the second grade control structure at the southern limit of this site. Starting from Friendship Park, the trail would extend south along the eastern levee and cross over the river on the grade-control structure located south of I-10 and up onto the western levee before continuing south to Coldwater Park (see Figure 21).

An existing City of Avondale groundwater well would supply a perennial source of irrigation water for the eastern riparian strip, periodic irrigation for the western riparian strip, and seasonal irrigation of Vegetation Management Areas. A delivery system would be constructed from the nearest connector to the restoration areas. Cost estimates assume this will be the source of water; however, the City may substitute other sources as long as the estimated water needs of the project are met.

AWWTP Site Restoration Actions. Currently, a small pond, marsh and a vegetated strip exist at the AWWTP outflow pipe and downstream, which are supported by the perennial source of water from the treatment plant effluent (3.5 mGPD) and relatively shallow groundwater. Similar to Alternative 4, Alternative 8 considers an 18 acre Vegetation Management Area, which would include the existing pond, marsh and surrounding areas (Figure 29). In contrast to Alternative 4, there would be no riparian strip extending north of the effluent outfall. Under this Alternative approximately 1 mGPD of effluent from the AWWTP would be retained for the Vegetation Management Area. To sustain similar vegetation cover as what exists now at the AWWTP site, it will be necessary to ensure efficient use of the remaining effluent as well as shallow groundwater. In the final evaluation of this Alternative (Recommended Plan) it was deemed necessary to add a system of infiltration galleries and pumps to capture infiltrated effluent and shallow ground water (at < 20 feet) for recirculation back to the surface to increase water availability. Still, it is likely that the open surface water area at the pond located at the effluent discharge will be reduced from what exists now.

Major Structural Elements and Other Physical Elements

The following is a summary of the major structural elements considered under Alternative 8. These are the primary features of the plan that would have to be physically constructed, maintained, and/or operated on an on-going basis.

Restoration Protection. The riparian strips on the eastern and western sides of the I-10 site would be protected from frequent flood flows by terrace bank armor. The protection would be the same as that described for Alternative 4 (see Section 4.3.4). The terrace bank armor will be constructed with soil cement; however, on the eastern riparian strip gunnite on the upper two feet will be replaced with planted gabions. The armor extends four feet above grade on the eastern side and two feet above grade on the western site. The toedown extends 10 feet below grade on both sides. An additional 50 feet into the interior of the channel is needed on both sides to construct the terrace bank armor.

Eastern Levee Riparian Strip. The conceptual design for the eastern levee riparian strip would be the same as that described for Alternative 4 (see Section 4.3.4).

Western Levee Riparian Strip. The conceptual design for the western levee riparian strip would be the same as that described for Alternative 4 (see Section 4.3.4) except that there would be no riparian strip north of the I-10.

Water Recirculation System at the AWWTP Site. To compensate for the reduction of effluent at the site from 3.5 to 1 mGPD subsurface groundwater at <20 feet and infiltrated effluent will be captured by filtration galleries placed just outside the Vegetation Management Area (Figure 30c). Water will be collected, pumped to the surface and redistributed throughout the site. The goal is to maintain the existing vegetation cover; however, it is likely that the surface area of the marsh and pond right at the AWWTP outfall will be reduced. The system will be operated via a power line connection of approximately 1000 feet extending approximately 2900 feet to the existing grid at Southern Avenue.

Hydraulic and Hydrologic Considerations

The same methodology was applied to the hydraulic analysis of Alternative 8 as to the other alternatives (see 4.3.4 and Figures 34 to 36, as well as Appendix I for the complete analysis). Alternative 8 would not adversely impact the flood control capacity of the river channel, nor does it undermine the structural integrity of the levees or bridges, as described in Appendix I.

Vegetation and Planting

The vegetation and planting scheme for Alternative 8 would be similar to that described for Alternative 4 (see Section 4.3.4).

Other Ecosystem Management Measures

The same management measures recommended for Alternative 4 would also be applicable for Alternative 8 (see Section 4.3.4).

Primary Construction and Implementation Considerations

The construction activities for Alternative 8 would be slightly greater in magnitude and duration than Alternative 2 because of the additional Vegetation Management Areas at both restoration sites and the need to construct the infiltration galleries and water recirculation system at the AWWTP (see Section 4.3.2). The amount of fill needed for the riparian strips would be approximately 32,351 cy of finer cohesive materials and 47,649 cy of coarser sand and gravel. Approximately 24,940 cy of material will be needed to construct the terrace bank armor. Approximately 2,318 cy of coarse material will be needed to fill the side channels to prevent the formation of surface water and 1,864 cy of fine material would be needed to line the side channels to reduce infiltration. Material that is excavated from the toedown along the riparian strips is included in the construction of terrace bank armor; it may be used as fill within the riparian strips, but ultimate disposal is the responsibility of the construction contractor. The fill depth for the eastern and western riparian strips was reduced in this alternative to a minimum of one foot.

The same issues described in Section 4.3.4 are also applicable to Alternative 8. However, no work is proposed within the Goodyear Airport exclusion zone and no new wells are proposed, thereby reducing the coordination required with Goodyear Airport and the Arizona Department of Water Resources, respectively. It will be necessary to obtain an easement for construction of the power line to run the pump system at the AWWTP and coordination with the power utility.

Primary Operation and Maintenance Measures

Major elements of the operation and maintenance phase of this alternative are similar to those described for Alternative 4 (see Section 4.3.4), except that most of the effort and cost would be reduced proportionally because of the reduced restoration area.

4.4 COMPARISON OF ALTERNATIVES

This section compares the environmental, engineering and cost features of each alternative to evaluate how each alternative meets the goals and objectives of the project. The comparison section is organized as follows:

- Section 4.4.1 - design and cost features
- Section 4.4.2 - real estate and utilities
- Section 4.4.3 - habitat output
- Section 4.4.4 - water requirements
- Section 4.4.5 - overall effects on environmental quality
- Section 4.4.6 - conveyance capacity
- Section 4.4.7 - cost effectiveness
- Section 4.4.8 - formulation criteria (general project goals)
- Section 4.4.9 - environmental and cost trade-offs.

4.4.1 Overall Comparison of Design Features and Costs

Tables 4.4-1 and 4.4-2 compare the major construction and operation costs of the eight action alternatives (for a complete summary of costs, see Appendix J). As shown below, Alternative 4 is the most expensive overall, followed by Alternative 7. Alternative 5 is the least expensive overall, with Alternative 8 the second least expensive. The removal of the western levee riparian strip caused a 54 percent reduction in total project cost between Alternative 2 and Alternative 5, a 51 percent reduction between Alternative 3 and Alternative 6, and a 28 percent reduction between Alternative 4 and Alternative 7. Alternative 8 has 58 percent less restoration acreage than Alternative 4 and 105 percent more restoration acreage than the smallest alternative, Alternative 5.

4.4-1 Comparison of Alternative Costs

	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8 Recommended Plan
LERRDs	$868,000	$1,302,000	$3,328,000	$528,000	$962,000	$2,173,000	$1,115,000
Subtotal *	$ 10,394,986	$14,858,933	$22,777,643	$ 4,624,479	$ 7,115,503	$16,357,639	$5,589,000
P,E,&D (Plans, Specs, Etc.)	$ 300,000	$ 300,000	$ 300,000	$ 300,000	$ 300,000	$ 300,000	$ 446,200
S.I.O.H. (6.5%)	$ 695,174	$ 985,331	$ 1,500,047	$ 320,091	$ 482,008	$ 1,082,747	$ 290,000
TOTAL	$ 11,390,160	$16,144,264	$24,577,690	$5,244,570	$ 7,897,511	$17,740,386	$6,325,200

*Subtotal includes all construction costs + LERRDS + 10% contingency.

Table 4.4-2 Annual OMRR&R Costs

	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8 Recommended Plan
Annual Cost	$ 120,822	$ 144,857	$ 673,597	$ 78,932	$ 128,607	$ 318,992	$ 129,166
Annual Cost per Acre	$ 1,694	$ 1,590	$ 7,527	$ 1,683	$ 1,906	$ 1,415	$ 1,123

Table 4.4-3 compares key project features of the alternatives. For a more complete description of alternatives, refer to Section 4.3.

Table 4.4-3 Comparison of Alternative Features

Features	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8
Number of Irrigation Wells	2	3	5	2	3	5	1
Average Water Used (Million Gallons Per Day)	1.1	1.5	5.2	0.8	1.1	4.8	1.9
Water Needs	Low	Moderate	High	Low	Moderate	High	Low
Restoration Strip Along Western Levee (Acres)	Yes	Yes	Yes	No	No	No	Yes
Vegetation Management Areas (Acres)	0	0	100.9	0	0	100.9	81
Habitat Between McDowell Road and I-10	Yes	Yes	Yes	No	No	Yes	Yes
Habitat Between I-10 and Buckeye Road	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Habitat Between Buckeye Road and Lower Buckeye Road	No	No	Yes	No	No	Yes	No
Habitat Between Lower Buckeye Road and Wastewater Treatment Plant Site	No	Yes	Yes	No	Yes	Yes	No
Habitat Between the Wastewater Treatment Plant Site and the Gila River Confluence	No	No	Yes	No	No	Yes	No
Xeric Habitat (Acres)	32.9	36.0	95.8	7.0	10.1	69.9	53.3
Mesic Habitat (Acres)	12.3	23.6	137.9	12.3	23.6	137.9	44.8
Hydric Habitat (Acres)	22.5	30.9	59.5	22.5	27.6	59.5	13.0
Hydric Habitat in Channel (Acres)	4.4	6.6	10.7	4.4	6.6	10.7	3.6
Presence of Federally Protected Species	No	No	No	No	No	No	No
Number of Maintenance Laborers/Hours Per Week	2 Laborers @ 20 hrs/week	2 Laborers @ 20 hrs/week	4 Laborers @ 26 hrs/week	1 Laborer @ 20 hrs/week	2 Laborers @ 20 hrs/week	4 Laborers @ 26 hrs/week	1 Laborers @ 20 hrs/week
Maintenance Equipment Required	½ Maintenance Vehicle	½ Maintenance Vehicle	1 Maintenance Vehicle	¼ Maintenance Vehicle	½ Maintenance Vehicle	1 Maintenance Vehicle	¼ Maintenance Vehicle
Environmental Monitoring	1 Biologist @ 8 hrs/week	1 Biologist @ 8 hrs/week	1 Biologist @ 20 hrs/week	1 Biologist @ 8 hrs/week	1 Biologist @ 8 hrs/week	1 Biologist @ 20 hrs/week	1 Biologist @ 8 hrs/week
Terrace Bank Armor for Protection of Riparian Strips	Yes	Yes	Yes	Yes	Yes	Yes	Yes

4.4.2 Real Estate, Utilities and Affected Lands

Affected Lands

Access, Staging and Borrow Areas. There is no planned construction of additional access roads for any of the alternatives. Access to the I-10 site for construction and maintenance during the operational

phase for all alternatives is entirely along public roads and existing ramps into the channel. Access to the AWWTP site at the southern end of the project reach for Alternatives 4, 7 and 8 may occur via Southern Avenue and then within the channel itself at the southern end of the AWWTP site. At the northern end of the AWWTP site access would occur through the AWWTP and/or along an existing private road.

The majority of borrow or fill would come from commercial sites. A small amount of borrow may come from within the channel, but the location of these areas would depend on maintenance for flood control and the location of depositional areas at the time of construction and would be subject to approval by FCDMC and the USACE.

All areas affected by construction are within the channel. The construction zone for the terrace bank armor would extend approximately 50 feet beyond the toe of the bank. This zone is incorporated into the restoration acreage (operational areas), because it would be reseeded with native, drought tolerant species to attain a higher habitat value.

The staging area for the I-10 site would be on already disturbed or developed, publicly owned ADOT or City lands just north of the I-10 Channel, south of Friendship Park. Near the AWWTP, the staging area would be on privately owned unoccupied, disturbed land within the flood control easement.

Restoration Areas. Table 4.4-4 provides an approximate description of the parcels affected by each alternative. This evaluation was developed by overlaying Maricopa County ownership maps with the potential restoration areas associated with each alternative (see maps in Appendix H). The affected parcels were recorded, along with a description of approximately how much of each property was affected and the approximate location of the impact on the property. This general evaluation does not substitute for an assessor's appraisal.

Table 4.4-4 Description of Affected Parcels by Alternative

Restoration Area	Parcel #	Owner	% Impact	Approximate location of impact on Parcel
ALTERNATIVES 2, 3, 4 & 8 ONLY				
Western Levee	174	Flood Control District of Maricopa County	10	West
	183	Flood Control District of Maricopa County	30	Middle
	184	Arizona State Department of Transportation	10	north-west corner
	193	Arizona State Department of Transportation	20	Middle
	214	Arizona State Department of Transportation	20	West
	220	Flood Control District of Maricopa County	20	West
	222	Flood Control District of Maricopa County	30	West
	306	Flood Control District of Maricopa County	30	West
ALTERNATIVES 4, 7 & 8 ONLY				
I-10 Vegetation Management Area	174	Flood Control District of Maricopa County	90	all but E/W edges
	183	Flood Control District of Maricopa County	25	south-east corner
	184	Arizona State Department of Transportation	50	West
	193	Arizona State Department of Transportation	50	East
	196	State of Arizona	30	West
ALTERNATIVES 4 & 7 ONLY				
Durango Regional Outfall Channel/ Buckeye Road Vegetation Management Area	464	County of Maricopa	10	south-west
	465	State of Arizona	5	south-east corner
	471	Flood Control District of Maricopa County	50	north-east corner

Restoration Area	Parcel #	Owner	% Impact	Approximate location of Impact on Parcel
ALTERNATIVES 4, 7 & 8 ONLY				
AWWTP Vegetation Management Area	573	Lakin Cattle Company	15	south-west corner
	582	Buckeye Irrigation Co.	25	east/south
	584	Spend Rocks LLC	20	West
	606	Flood Control District of Maricopa County	30	Middle
ALTERNATIVES 4 & 7 ONLY				
Lower East Bank (Above Lower Buckeye)	464	County of Maricopa	20	south/middle
	476	City of Avondale	20	North
	477	City of Avondale	30	East
Lower East Bank (Below Lower Buckeye)	497	Allied Concrete INC	40	West
	496	Allied Concrete INC	25	south-east corner
	505	Allied Concrete INC	10	South
	515	Allied Concrete INC	30	West
	504	Allied Concrete INC	30	southeast corner
	518	Allied Concrete INC	100	All
	527	Laken Estrella Ranch Limited Partnership	20	Middle
(Below Broadway)	567	Allied Concrete INC	40	East
	568	Lakin Cattle Company	10	north-west corner
ALTERNATIVES 3 & 6 ONLY				
Lower East Bank (Finger Below Lower Buckeye)	496	Allied Concrete INC	30	East
	497	Allied Concrete INC	20	north-west
	505	Allied Concrete INC	5	north/north-east corner
	515	Allied Concrete INC	20	north/middle
	573	Lakin Cattle Company	20	north/middle
ALL ALTERNATIVES				
Upper East Bank (Above Van Buren)	196	State of Arizona	20	south-west corner
	1	N/A	N/A	under I-10
	193	Arizona State Department of Transportation	5	east edge
	204	Arizona State Department of Transportation	95	all but east edge
	214	Arizona State Department of Transportation	5	east edge
	221	Flood Control District of Maricopa County	90	All but south-west corner and eastern edge
ALTERNATIVES 2, 3, 4, 5, 6 & 7				
Upper East Bank (Below Van Buren)	224	Flood Control District of Maricopa County	30	south-east
	244	State of Arizona	50	East
	245	Flood Control District of Maricopa County	50	West
	309	State of Arizona	50	East
	315	First American Title INS	50	West

All affected lands for Alternatives 2 and 5 are public lands; Alternatives 3, 6 and 8 have a small portion of affected lands on private parcels; and Alternatives 4 and 7 have approximately 40 percent of the affected lands on private parcels. There are as many as six private landowners with parcels affected by the project alternatives. As many as five state and local agencies have ownership over the publicly owned lands, depending on the alternative: Arizona Department of Transportation, City of Avondale, FCDMC, Maricopa County and the State of Arizona.

For Alternative 8, the Recommended Plan, approximately 18 acres of privately owned land would be acquired by the City or the District at an estimated value of $20,000 per acre. Approximately 37 acres of land owned by the City or the District would be provided as in-kind contribution at an estimated value of $20,000 per acre. Easements, rights-of-way or use permits would be obtained for the remaining acreage of approximately acres owned by the Arizona Department of Transportation or the State of Arizona. An easement of approximately 2900 feet by 25-100 feet would be needed across private lands for the power line connect from the water recirculation system at the AWWTP site to the existing grid of Southern Avenue. There are no real estate needs for relocations or disposal areas. The lands, easements, rights-of-way, relocations and disposal areas (LERRDS) for the project are

summarized for each alternative in the cost estimate (Appendix J). The real estate plan is provided in Appendix H.

Agua Fria Utilities

Several utility lines are located in the vicinity of the two restoration sites considered in Alternative 8 near the I-10 and the Avondale Waste Water Treatment Plant. Utility crossings are also located at the Durango Regional Outfall Channel site, but this area has been excluded from the restoration effort, and further research was only pursued in the areas affected by Alternative 8 (Recommended Plan). These utility locations were identified based on communications with Blue Stakes of Arizona, which is an information system sponsored by underground facility owners to assist with the location of buried utility lines. According to Blue Stakes, an exact locating and mapping of the utility lines would require consultation with each specific utility. After this information is received for all the utilities in the affected area, a master map could be produced. Table 4.4-5 summarizes the utilities that have a potential to be affected by Alternative 8 (also see Figures 22 to 24).

The condition for project design for all alternatives assumes there will be no disturbance or relocation of utilities. Avoidance would be carried out by limiting restoration activities to ground depths above buried utilities, avoiding the area occupied by utilities at the surface and/or ensuring that the conditions for planting vegetation in the utility rights-of-way are observed.

For the Recommended Plan a low voltage power line will be needed to supply electricity to the water recirculation system at the AWWTP site.

Table 4.4-5 Utility Lines Potentially Affected by the Recommended Plan

Utility	Contact Number
I-10 Site	
US West	602-630-5884
SRP	602-236-8026
City of Avondale, Water and Sewer	623-932-1909
Southwest Gas	602-703-4000
Cox Cable	480-858-2650
APS Electric	602-493-4225
Arizona Department of Transportation	602-712-6665
AWWTP Site	
Sprint	800-521-0579
SRP	602-236-026
City of Avondale, Water and Sewer	623-932-1909
Southwest Gas	602-484-5345
Broadwing Communications	800-441-0223
APS Water	602-493-4225
City of Goodyear	623-932-1716
Source: Blue Stakes of Arizona, Contacted on August 14, 2002	

4.4.3 Habitat Value

Table 4.3-1 summarizes the estimated restoration acreage for each alternative.

Habitat Evaluation

The USACE's guidance for ecosystem restoration in the Civil Works Program is provided in Engineer Circular (EC) 1005-2-210. The purpose of this guidance is to ensure that civil work investments in ecosystem restoration have the intended beneficial effects, are consistent with administrative policy, and would be conducted in the most cost effective manner.

Sections 13.b(1) and (20) of EC 1005-2-210 require that the ecosystem outputs of proposed alternatives be subjected to detailed cost effectiveness and incremental cost analysis, allowing an explicit comparison of the additional costs and outputs associated with the alternatives. Consequently, it is necessary that the environmental outputs of the alternatives be based on some quantifiable unit, such as habitat units (HUs). Comparing the alternatives in this manner facilitates the determination of the most cost-effective restoration alternative that meets restoration goals. The Habitat Evaluation Procedure (HEP) is a method of quantifying ecological values in the form of HUs. See Appendix K for the full analysis.

Methodology - Habitat Evaluation Procedures Analysis

The USFWS originally developed the standard Habitat Evaluation Procedure (HEP) that documents the quality and quantity of available habitat for selected wildlife species and/or habitat elements. A traditional HEP assumes that there are known and quantifiable relationships between the reproductive success of a target species (i.e., population size) and a particular habitat characteristic. For example, there is a relationship between the level of dissolved oxygen in a freshwater stream and the abundance of trout.

The USACE has modified this standard HEP analysis to evaluate habitat conditions without emphasizing the habitat requirements of a single target species. The purpose of developing the modified approach was to minimize the time and cost inherent in developing detailed site-specific information about the habitat requirements of individual species and the relationship between species success, habitat requirements and measurable characteristics of the habitat. The modified HEP evaluates the community or ecosystem as a whole to calculate habitat value for each of the environmental restoration alternatives.

Because the modified HEP analysis is designed to look at the characteristics of a community type in meeting the requirements of guilds or groups of wildlife species, the evaluation process tends to be more qualitative than quantitative, and hence, difficult to document or reproduce.

Results of Habitat Evaluation Procedures Analysis

The following tables summarize the habitat outputs and the average annual habitat units for each of the alternatives (Tables 4.4-6 and 4.4-7). The alternatives differ in the area affected by restoration; however for the purposes of the economic analysis, the acreage for each alternative was normalized to Alternative 4, which restores the greatest amount of acreage (303.9 acres). For each alternative the habitat units for the restored area were calculated and then these were summed with the habitat units for the acreage that remained unrestored. Habitat units for the unrestored portion were based on the same

Habitat Suitability Index (HSI) derived for the No Action Alternative 1. Following this approach, only Alternative 4 would have all of its acreage restored. Conversely, for Alternative 2, 72.1 acres would be restored with HUs reflecting habitat benefits from the project. The remaining 231.8 acres remain unrestored and contribute HUs based on the HSIs calculated for Alternative 1.

Table 4.4-6 Summary of Habitat Outputs

ALTERNATIVE	Habitat Units					
	T=0	T=1	T=15	T=50	Average Annual	Net Average Annual Gain
Alternative 1 - No Action	77.72	77.72	63.21	63.21	65.63	-
Alternative 2 - Low Water Use	77.93	87.55	84.97	88.91	86.60	20.97
Alternative 3 - Moderate Water Use	78.57	89.80	90.37	95.47	91.78	26.16
Alternative 4 - High Water Use and Vegetation Management Areas	114.91	154.90	189.84	209.96	189.60	123.98
Alternative 5 - Low Water Use without Western Riparian Strip	76.73	82.15	75.69	78.55	77.69	12.07
Alternative 6 - Moderate Water Use without Western Riparian Strip	76.28	84.48	81.15	85.17	82.94	17.31
Alternative 7 - High Water Use and Vegetation Management Areas without Western Riparian Strip	111.46	147.35	179.04	197.01	178.74	113.11
Alternative 8 – Low Water Use, With Reduced Vegetation Management Areas and Western Riparian Strip	86.91	101.68	104.84	113.40	106.87	41.24

In Table 4.4-6 the habitat units are provided for the each timeframe T=0 the point in time before changes in land and water use result in habitat alterations; T=1 first year land and water use conditions are expected to deviate from base conditions; T=15 at the end of the fifteenth year of operation; and T=50 at the end of the fiftieth year of operation. It is important to note that for the other alternatives, the portion of the project area that remains unrestored influences the incremental increase in habitat units for each year: Alternatives 4 and 7, which restore the greatest acreage, present positive incremental increases each year over the project lifetime; and the remainder of the alternatives present a negative increment during the first fifteen years and a positive increment thereafter, when the influence of the unrestored portion becomes zero.

4.4.4 Water Requirements

Water requirements of the seven action alternatives are described in Table 4.4-7. As shown, Alternatives 4 and 7 require three to five times more water than Alternatives 2, 3, 5, 6 and 8. This extra water need is primarily a result of the larger extent of restoration area required by these alternatives.

Water requirements for the alternatives varied depending on the vegetation selected for restoration. Selection of species was based not only on their hydrologic component, but also for their low transpiration rate and ability to serve as ground cover that would reduce soil evaporative losses. The

plant palate is described in more detail in the outline of alternatives; Appendix B provides the complete list of selected species (FCDMC, 2001a).

Table 4.4-7 Summary of Water Needs by Alternative (millions of gallons per day)

Vegetation/Habitat Type	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt. 8
Xeric Riparian (desert scrub)	0.2	0.2	0.2	0.0	0.0	0.0	0.1
Mesic Riparian (woodland/scrubland)	0.2	0.4	1.5	0.2	0.4	1.5	0.1
Hydric Riparian	0.4	0.5	1.1	0.4	0.5	1.1	0.2
Hydric Riparian (channel herbaceous/wetland)	0.1	0.1	0.2	0.1	0.1	0.2	0.0
Vegetation Management Areas[1]	0.0	0.0	1.7	0.0	0.0	1.7	1.3
Construction Areas[2]	0.2	0.3	0.5	0.1	0.1	0.3	0.1
TOTAL	**1.1**	**1.5**	**5.2**	**0.8**	**1.1**	**4.8**	**1.9**

1 For Alternatives 4 and 7 it is assumed that current effluent discharge of 3.5 mGPD from AWWTP is used to satisfy water needs for restoration at the AWWTP site. For Alternative 8 it is assumed that 1 mGPD of effluent is available to satisfy water needs at the AWWTP site.

2 These are predominantly sparsely or unvegetated areas within the channel that are dominated by nonnative vegetation. Affected vegetated areas will be reseeded to native xeric vegetation.

Based on comments received at the technical workshop in May 2001, Alternatives 2 through 7 were developed with the idea of constructing new groundwater wells to supply water to restore varying lengths of habitat within the project reach. However, based on the complexities of permitting and establishing new wells, Alternative 8 subsequently reduced this effort by including a single existing well operated by the City of Avondale at the northern end of the project area. In any case, water would be used to initiate and sustain plant growth. Water would be delivered from the respective well(s) to the restoration site via pumps connected to the existing electrical system. Water would be directed via pipe to reservoirs at the upstream portion of each segment and then, subject to timed releases, allowed to flow by gravity downstream along the side channels.

For Alternatives 4 and 7 water needs near the AWWTP restoration site would be covered by the existing 3.5 mGPD effluent outflow from the plant, which would sustain the existing aquatic and terrestrial habitat.

For Alternative 8, the Recommended Plan, it is assumed that 1 mGPD of effluent from the plant would be retained at the site to support habitat. In addition, a filtration gallery would be constructed at this site to capture shallow groundwater at less than 20 feet, repump it to the surface and allow it to flow throughout the vegetation management area to supplement effluent. Despite this effort, it is likely that the depth and/or surface area of the pond, which is sustained by the current effluent discharge, will be reduced.

4.4.5 Effects on Environmental Quality

This comparison provides a relative evaluation of the long-term effects that the alternatives may have on significant environmental resources defined as ecological, cultural, and aesthetic environments, which, if affected by the alternative plans, could have a material bearing on the decision-making process.

A matrix was utilized to evaluate the degrees to which these alternatives may positively or negatively affect aspects of the physical biological and cultural environment. This table summarizes the environmental consequences discussed in Section 5.

Each alternative was qualitatively rated based on a range of evaluation factors. The rating system is presented in Table 4.4-8 and the evaluation factors are described in the text. The completed evaluation matrix is presented as Table 4.4-9.

Table 4.4-8 Rating System for Evaluation of Final Array of Restoration Alternatives

Rating	Definition
++	**Highly Compatible or Beneficial.** This rating is applied to a resource or characteristics of the resource that would permit it to thrive beyond a sustainable condition.
+	**Compatible.** This rating indicates an alternative that provides some benefit to the resource or characteristics of the resource.
0	**Neutral.** This rating indicates an alternative that neither benefits nor detracts from this aspect of the environment.
-	**Non-supportive.** This rating indicates an alternative that has a slightly negative effect on the environmental resource, but not enough to outweigh the habitat benefits of the restoration project.
--	**Incompatible.** This rating indicates an alternative that has a negative effect on the environmental resource and that may nullify any benefits from the restoration project.

Descriptions of Evaluation Factors

The factors utilized in evaluating the preliminary restoration alternatives are based on the project goals and wildlife objectives (Sections 3 and 4) that, if achieved, would provide a variety of ecological benefits for the lower Agua Fria River and the receiving Gila River ecosystems.

To help establish a consistent basis for the evaluation of alternatives, descriptions of the evaluation factors were prepared. The evaluation factors correspond to the column headings on the evaluation matrix (see Table 4.4-9 on the following page).

Biological Environment

Relative benefits to wildlife habitat are described through the following criteria. Section 5 identifies only temporary negative impacts from loss of existing vegetation and disturbance to habitat during the construction and initial implementation of the project. There are no anticipated impacts to Federal or State listed threatened or endangered species and their habitats, or other potentially sensitive species. Some environmental commitments are presented in Section 5 that ensure the prevention and minimization of impacts to biological resources during the construction phase to less than significant levels.

Waterfowl Habitat. Objectives for waterfowl include the provision of suitable habitat for resting and feeding by migratory and resident species. The essential habitat attributes necessary to achieve this objective would include surface water of varying depth (depending on the species) and ample amounts of emergent vegetation that produce seeds (e.g., smartweed) and provide protective cover. For breeding birds, suitable habitat would include dense grasslands or dense emergent vegetation for nesting and

Table 4.4-9 Restoration Alternatives Environmental Quality Matrix

Preliminary Restoration Alternatives	Waterfowl Habitat	Habitat for other Migratory and Resident Birds	Amphibian Habitat	Reptile Habitat	Small Mammal Habitat	Regional Habitat Continuity	Non-native Species Suppression	Habitat/ Species Diversity	Sedimentation and Erosion	Flooding and Conveyance Capacity	Water Quality	Water Quantity	Air Quality	Noise	Aesthetics and Recreation	Cultural Resources
Alternative 1: No Action Alternative	–	–	–	0	-	–	–	–	-	+	0	-	0	0	–	0
Alternative 2: Low Water Use	0	+	+	+	+	0	+	+	0	0	+	0	0	+	+	0
Alternative 3: Moderate Water Use	0	+	+	+	+	0	+	+	0	0	+	0	0	+	+	0
Alternative 4: High Water Use (and Vegetation Management Areas)	+	++	++	++	+	++	++	++	0	0	+	-	+	+	++	0
Alternative 5: Low Water Use w/o Western Levee Restoration	0	+	+	0	+	0	+	+	0	0	+	0	0	0	0	0
Alternative 6: Moderate Water Use w/o Western Levee Restoration	0	+	+	0	+	0	+	+	0	0	+	0	0	0	0	0
Alternative 7: High Water Use (and Vegetation Management Areas) w/o Western Levee Restoration	+	++	++	+	+	++	++	+	0	0	+	-	+	0	+	0
Alternative 8: Moderate Water Use and Vegetation Management Areas (Recommended Plan)	+	+	+	+	+	+	+	+	0	0	+	0	0	0	+	0

Key: ++ Highly Compatible; + Compatible; 0 Neutral; - Incompatible; - - Non-Supportive

stretches of dense emergent vegetation (more than 36 stems per square yard) with high macroinvertebrate populations for brood rearing (Baldassarre and Bolen, 1994).

Alternatives 4 and 7, followed by Alternative 8, provide the greatest benefit for waterfowl by seeking to preserve existing inputs of effluent into the AWWTP marsh and include this as a Vegetation Management Area.

Habitat for Other Resident and Migratory Species. Several guilds have resident species including the insectivores (e.g., verdin, wrens, bushtits, gnatcatchers, thrushes, and thrashers), granivores (e.g., sparrows, finches, blackbirds, grosbeaks, and cowbirds), frugivores (e.g., waxwings), and corvids (e.g., ravens and jays). The perching birds (Order Passeriformes, passerine birds) include the best-known songbirds and the neotropical migrants that are so popular with bird-watchers. They also provide insect control and are of general biological significance because they are prey species for many natural predators in the area. Passerines are a varied group with many strategies for foraging and other use of the habitat (typically they are organized into guilds based on their use of the habitat). They provide the benefits mentioned above year-around and thus play a more critical role in the ecosystem. Many of the passerines breed in southeastern Arizona (both migratory and residents), and the key attributes necessary for the majority of breeding birds is densely vegetated areas and/or cavities in trees. The species that build nests in cavities would respond favorably to nest boxes placed in wooded areas. Other essential habitat attributes necessary to achieve this objective are dense riparian vegetation and shallow marshes for the insectivores; grasslands or a mesquite bosque for the granivores; open riparian for the frugivores; and mesquite bosque or dense riparian for the corvids.

In general, the relative benefit provided by the alternatives is based on the restoration area, with Alternatives 4 and 7 being rated the highest and Alternative 5, the lowest.

Amphibian Habitat. Several toads (e.g., southern spadefoot, red-spotted toad) would use riparian or marsh areas. For these toads, moist grasslands near streams or pools would provide forage, and shallow, slow-moving or ponding water would create the necessary breeding habitat. One of the most important success factors for the toads is protection from aggressive predators such as bullfrogs.

In general, the relative benefit provided by the alternatives is based on the restoration area and the length of the side channel along the riparian strip, with Alternatives 4 and 7 being rated the highest.

Reptile Habitat. Native reptile species inhabit a variety of habitat types, including xeroriparian, riparian, and marsh areas; however, a larger number of reptile species inhabit xeroriparian areas. The key reptiles that could inhabit the project area include lizards (e.g., Arizona desert whiptail), turtles (e.g., Sonoran mud turtle), and snakes (black-necked garter snake). For the xeroriparian reptilian species (e.g., snakes, lizards), suitable habitat would include open rocky areas that typically support large populations of insects. The marsh and riparian areas would provide suitable habitat for skinks, garter snakes, and some lizards.

The relative benefit of the alternatives is based on a combination of moisture and suitable habitat conditions. In this respect, all the alternatives 2, 3, 4 and 8 that include the western riparian strip would provide a greater range of habitat conditions within the channel and are therefore, rated higher.

Small Mammal Habitat. The project area likely supports a variety of mammals such as coyotes, rabbits, bats, and rodent species. The combination of open foraging areas, water sources, and diverse cover (e.g., wetlands, riparian, and upland shrub habitats) would provide foraging areas, breeding habitat, and cover necessary for most mammalian species ecosystem requirements.

All the alternatives consider addition of sediment to the riparian strips, cobbles and artificial habitats and therefore, the area of restoration is the dominant distinguishing factor.

Regional Habitat Continuity and Connectivity. Habitat that is similar to existing habitat in the region would provide higher benefit than unique habitat. Plant and animal species would be able to expand into or colonize the restored habitat areas. Corridors with minimal habitat resources would allow wildlife to migrate between optimal habitat areas.

Isolated patches of restored area are not as beneficial as continuous strips, insofar as the latter are wide enough and well buffered from disturbance. In this respect all the alternatives provide for this type of configuration.

Suppression of Non-native Species. Non-native species degrade the natural integrity of habitat areas, upsetting the balance established within a natural ecosystem. Exotic plant and wildlife species can be destructive, often out-competing native species for space and limited resources. Exotic wildlife can prey upon native species. Some destructive, non-endemic species are already well established in the area and are expected to inhabit the restored habitat areas. Measures such as mechanical removal and herbicide treatment may need to be implemented to minimize the destructive effects of such species on wildlife habitats.

All the alternatives incorporate the control of exotic, invasive species; however Alternatives 4 and 7, followed by Alternative 8, propose to do this over the largest areas.

Habitat and Species Diversity. Increased habitat diversity within the project area would increase the available niches for plant and animal species, particularly in a desert environment with nearby water sources. Increased overall species diversity for the project area, in general, would serve to increase its value as habitat for the targeted species groups by enhancing and stabilizing such factors as food availability, water quality, and cover.

Physical

Some environmental commitments are described in Section 5 to prevent or reduce potential impacts to water quality during construction from mobilization of sediments and accidental spills, as well as ensure compliance with permits required for groundwater pumping.

Sedimentation and Erosion. The alternatives have been designed so as not to increase the risk of erosion, especially near bridge and other in-channel structures. During construction, the risk of erosion would increase, depending on the size of the work area; however best management practices would prevent any adverse significant impacts. Conversely they contribute only slightly to restoring natural sediment aggradation and degradation by proposing to periodically release imported sediments every five to ten years.

All the alternatives are rated the same over the life of the project.

Flooding or Conveyance Capacity. The restored habitats should be located in areas that are expected to sustain anticipated high flow events. The design of the restored habitat areas would need to consider the hydrological data/models to evaluate the best locations for restoration. Conversely, the proposed restoration should not reduce the capacity of the channel to effectively convey flood water.

Regardless of the extent of the restoration effort for each alternative, all are similarly designed so that the majority of the features remain intact during more frequent events from 10 to 15 years. Insofar as Alternatives 4 and 7 cover a greater length of the channel, it would be subject to a greater range of hydrologic and hydraulic conditions.

Water Quality. The proposed environmental restoration may serve as a biological buffer for reducing harmful constituents from storm water and agricultural run-off. Natural treatment of the water may occur through biological processes that are provided by established aquatic plant communities such as wetlands.

All alternatives would similarly benefit the discharge at the I-10 outfall. Alternatives 4, 7 and 8 would extend this benefit to the area around the AWWTP. Because of capacity constraints, this benefit would not be realized at Durango Regional Outfall Channel, which is the third major artificial drainage currently within the project reach.

Water Quantity. Self-sustaining aquatic habitats (e.g., self-sustaining wetland area and/or riparian area) do not require long-term maintenance, and provide a stable ecosystem function. Such a system would employ native species that are well adapted to natural variation in ecological conditions and establish species and community diversity by ensuring successful regeneration and reproduction during the initial years of project implementation and operation. Local sponsors and other entities that evaluated the restoration opportunities agreed that additional water input was a necessary element for the success of the effort. For all alternatives, ground water or effluent would be cycled through the system, the goal being to maximize plant use and recharge of the pumped water and eliminate losses through evaporation or runoff.

All the alternatives incorporate additional pumped ground water. An equivalent amount of water from other sources may be substituted by the local sponsors at the time of construction or at any point during the life of the project. Alternatives 4 and 7 have significantly greater water demands than the other alternatives in order to provide more habitat benefits.

Air Quality. There are differences among the alternatives in the amount of temporary dust emissions during construction, depending on the size of the restored area and construction period; however, appropriate environmental commitments would ensure that there are no significant adverse effects. Conversely, all of the alternatives would have some benefit in reducing aeolic erosion within the channel.

Noise. Additional vegetation within the channel may incidentally buffer noise from freeways and create a more hospitable environment for recreational users and pedestrians. Alternatives 2 to 4 and 8 provide slight, but similar benefits in the northern part of the project area to both fauna and humans. Alternatives 5, 6 and 7 provide somewhat less benefit by not including the western riparian strip.

Socioeconomic and Cultural Environment

There are no significant impacts associated with this aspect of the environment. Some minor preventative measures are suggested in Section 5.

Cultural Resources

Because there are no significant cultural resources in the project area, the restoration alternatives are all rated as neutral.

Aesthetics and Recreation

The project is in close proximity to residential and commercial areas, and could provide an opportunity to indirectly improve the value of the area, especially existing and planned recreational facilities. Recreational activities could be accommodated without allowing the public general access to the habitat areas. The alternatives are rated for this factor in proportion to the extent of the restoration effort. Alternatives that do not include the western riparian strip do not provide as much benefit.

4.4.6 Effects on Conveyance Capacity

The boundaries of the riparian strips were defined to maintain the SPF capacity. The primary area of concern was the area around bridges, especially near Buckeye Road and MC 85. There are limitations to capacity immediately north of this bridge, which excludes this area and a distance of several hundred feet downstream and within the double levee portions of the channel, in general. There are opportunities for including species with a moderate or high hydrologic component in other segments of the river, but if the entire channel width were filled with woody (i.e., inflexible) biomass, capacity would also become limited in other areas between I-10 and McDowell Road; hence, the configuration was limited to strips of riparian vegetation.

Figures 32 to 36 illustrate the relationship among the alternatives, available freeboard, and water surface elevations (WSEL) for the pre-New Waddell Dam SPF. The data presented for Alternative 4 in Figures 32 and 33 are applicable to Alternatives 2, 3 and 5 to 7. For Alternatives 5 to 7 the available freeboard would be slightly greater and WSEL would be slightly less with no western riparian strip.

4.4.7 Cost Effectiveness/Incremental Cost Analysis

The Corps' IWR-PLAN software was used to conduct the analyses. IWR-PLAN, developed by the Institute of Water Resources of the U.S. Army Corps of Engineers, is a Decision Support System that performs incremental analysis. It was used to identify the most cost-effective combinations of components and the best buys for the whole possible range of outputs of habitat units and associated costs. **Cost-effective combinations** incur the least cost for the same output of habitat units. **Best buy combinations** give the least incremental increase in cost per incremental increase in output of habitat units.

In addition to the construction cost, the following costs were included in the incremental analysis: OMRR&R costs over the project life (50 years), costs associated with LERRDs, and monitoring after construction. This analysis is displayed in Table 4.4-10.

Table 4.4-10 Average Cost per Habitat Unit Created

Plan	Total Annual Cost	Net Average Annual Gain in Habitat Units (HUs)	Annual Cost/HU ($/HU)
No Action (Alt 1)	$0	0.00	$0
Alternative 2	$805,922	20.99	$38,396
Alternative 3	$1,115,909	26.22	$42,559
Alternative 4	$2,151,906	125.22	$17,185
Alternative 5	$394,385	12.04	$32,756
Alternative 6	$603,630	17.33	$34,832
Alternative 7	$1,386,048	113.77	$12,183
Alternative 8	$521,831	41.41	$12,602

Through the IWR-PLAN software four alternatives, excluding the no action alternative, were identified as cost effective. These alternatives are 4, 5, 7, and 8. On an unconstrained basis, Alternatives 4 and 7 are identified as "best buys", whereas Alternative 8 does not receive this rating. Alternative 8 fails to receive this rating, on an unconstrained basis, because the marginal cost on a per habitat unit created basis of going from the no action alternative to the Alternative 7 level is lower. When the budgetary constraint is considered into the incremental analysis formulation only one alternative is identified as both cost effective and a best buy, Alternative 8. Accordingly, Alternative 8 – Low Water Use, With Reduced Vegetation Management Areas and Reduced Western Riparian Strip at a cost of $6,528,265 and yielding a net average annual gain in habitat units of 41.41 is recommended for plan implementation.

4.4.8 Formulation Criteria

Table 4.4-11 compares the final array of alternatives using the goals and objectives described in Section 2.2, with the following ranking criteria:

- Completeness: Considers whether or not the plans include all elements necessary to achieve the general and specific objectives of the plan described in Section 2.2. This evaluation is relative, since the size of the project area and limitations due to capacity of the channel essentially limit all the alternatives from optimally achieving the project goals. Therefore, if some objectives are significantly deficient or absent, those are identified by the number of the objective.

- Effectiveness: Estimates the extent to which a plan achieves its objectives. Alternatives are rated as not effective, less effective, moderately effective, or very effective.
- Efficiency: Indicates whether the plans provide net benefits as a measure of the cost-effectiveness of the plan. If there is a net cost, the alternative is marked as "net cost". All alternatives provide a net benefit and are relatively ranked according to their net average annual gain from (1) greatest to (7) least, and according to their annual cost per habitat unit from (1) least to (7) most.
- Acceptability: Since all the plans must be consistent with Federal law and policy, this defines each plan's acceptability to the local sponsor and public. Alternatives are valued as "Highly Acceptable", "Moderately Acceptable", or "Less Acceptable".

The following are the planning goals and objectives (partially adapted from Briggs [1996] and Shafroth et al. [1999]) outlined in Section 2.2 that are evaluated in Table 4.4-11.

1. Restore riparian habitat in a manner promoting ecological resiliency and self-sustaining qualities.
2. Establish habitats in a manner that supports the greatest diversity of target and beneficial wildlife species including mammals, resident and migratory songbirds, and other birds.
3. Establish riparian vegetative communities that represent historic and optimal conditions in the subject regions to include native plant species. Vegetation communities will demonstrate structural and species diversity, which is important for the success of riparian ecosystems.
4. Identify functional characteristics of the ecosystem that are critical for defining restoration opportunities and constraints.
5. Identify opportunities for maximizing the availability of surface water and ground water inputs to biota. Characterize the depth to saturated soils, stream flow, and channel morphology.
6. Develop the recovery effort from a watershed perspective. Ensure continuity with restoration and conservation efforts within the Gila River. Ensure that the flood control capacity of the channel is maintained consistent with existing and future conditions within the watershed.
7. Motivate adjacent communities to view the restoration project as a means of reclaiming the cultural and natural history of the area. Maximize the participation and commitment from the adjacent community.
8. Create a plan that is compatible with the local trail and park system without compromising the opportunities to maximize habitat output (i.e., emphasize perimeter recreational use of the area only).
9. Minimize the need for complicated operation and maintenance measures. Among other strategies, facilitate processes of natural regeneration that are self-sustaining, and develop an adaptive management plan.
10. Minimize chronic disturbances in the restoration project area.
11. Utilize knowledge gained from existing restoration efforts in the region and minimize experimentation.
12. Emphasize critical habitat elements for wildlife in addition to water and vegetation (e.g., soil flora and fauna, substrate for burrowing animals, soil chemistry woody debris, etc.).

Table 4.4-11 Relative Comparison of Alternatives using Formulation Criteria

Alternative	Completeness[1]	Effectiveness	Efficiency[2]	Acceptability
1: No Action	Meets no objectives	Not applicable	Not applicable	Less Acceptable
2: Low water use	Does not sufficiently meet objectives: 5, 6, 9, 10	5	5/6	Highly Acceptable
3: Moderate water use	Does not sufficiently meet objectives: 5, 6, 9, 10	3	4/4	Less Acceptable
4: High water use, w/ Vegetation Management Areas	Does not sufficiently meet objectives: 6, 9, 10	1	1/2	Moderately Acceptable
5: Low water use, w/o western riparian strip	Does not sufficiently meet objectives: 3, 5, 6, 9, 10	6	7/7	Highly Acceptable
6: Moderate water use, w/o western riparian strip	Does not sufficiently meet objectives: 3, 5, 6, 9, 10	4	6/5	Highly Acceptable
7: High water use, w/ Vegetation Management Areas, w/o western riparian strip	Does not sufficiently meet objectives: 3, 5, 9, 10	2	2/1	Moderately Acceptable
8: Low Water Use and Vegetation Management Areas (Recommended Plan)	Does not sufficiently meet objectives: 6, 9, 10	7	3/3	Highly Acceptable

1 See list from 1 to 12 in preceding text.
2 Ranked according to net average annual gain from (1) greatest to (7) least, and annual cost per habitat unit from (1) least to (7) most.

4.4.9 Trade-off Analysis

The first level of trade-off analysis involves the No Action Alternative, which ranks lower than the action alternatives by not meeting any of the planning objectives. It has no positive restoration-related benefits or impacts. It does not however, involve incurring the implementation cost, use of water resources or other adverse impacts associated with construction of the action alternatives.

The second level of trade-off considers those between the action alternatives. There are a multitude of trade-offs with a range of magnitude and import to the project. Of the action alternatives considered, there is an obvious trade-off between three major conditions:

Water use and the extent or success of the restoration effort. The consensus was reached during the technical workshop that the restoration effort would be severely limited without additional water inputs, and that water was the most important discriminator among the restoration alternatives. However, use of ground water resources for this effort would require permitting by the ADWR that necessitates the appropriate background studies to demonstrate adequate supply and no impacts to other users, among other things. Other potential sources of surface water were deemed unpredictable, including effluent from the AWWTP. In this respect, Alternatives 4 and 7 represent the biggest trade-off, since they use the greatest amount of water. Alternative 8, which relies on a single existing well (or other source that can satisfy water needs at the I-10 site) to supply water to the northern part of the project area and assumes 1 mGPD of effluent input from the AWWTP, significantly reduces the effort needed to bring additional sources online, but limits the extent of the restoration effort.

Value to the local community versus cost. At the technical workshop local representatives emphasized the desire that this project serve as a showcase for restoration along other portions of the river and planned recreational facilities (although it was understood that the restoration project itself would not provide such amenities). In order to achieve this expectation, the configuration of riparian strips would parallel or connect with parks and trails thereby increasing the incidental recreational benefits along a

more visible length of the river, while also being compatible with the linear configuration of riparian habitats. Nevertheless, this configuration and the necessary construction methodology (bank armor protection) are costly with respect to grading and fill requirements. In this respect Alternatives 2, 3 and 4 represent the greatest tradeoff to achieve value to the local community with increased construction costs.

Extent and type of vegetation in the channel and flood capacity. The linear configuration of the restoration alternatives was compatible with stream flow and the hydrologic analysis. The analysis itself was used to define the overall placement, maximum width and length of restoration areas along the project reach. Because the project was subject to the SPF condition, including the 3 feet minimum of freeboard, all the alternatives were subject to limitations in terms of the extent of the restoration area, the configuration, and the amount of vegetation that could be used.

Natural dynamics of the river channel versus the longevity or stability of restored areas. There is a natural tendency of the alluvial ecosystem to undergo changes induced by flood flows that include scouring and deposition of sediments, reshaping of flood plain topography and the position of side channels. These changes also imply washout of vegetated areas and reestablishment of vegetation in open patches. Conversely, the public expectation is to invest money in the construction of a restoration site, establish vegetation and wildlife habitat, and enjoy this investment into the foreseeable future. This implies the creation of an ecosystem that is relatively stable and isolated from physical changes. The alternatives were designed with terrace bank armor to minimize losses from frequent storm events, but not to exclude them entirely or exclude less frequent events. Alternatives 4, 7, and 8 also incorporated Vegetation Management Areas, which would not include any structural modifications, but provide seasonal additions of water, some revegetation and exotic species control. The investment in these areas would be less simply because flood flows would not guarantee preservation of any constructed features.

4.5 RISK AND UNCERTAINTY

Areas of risk and uncertainty are summarized in Table 4.4-12 so that decisions can be made with knowledge of the degree of reliability of the estimated benefits and costs and of the effectiveness of alternative plans. The response to risks may have two components: prevention (to reduce the probability of occurrence) and contingency (response if the risk occurs). The effort spent on planning and investing in the latter may be based on the relationship probability of occurrence and magnitude of the outcome. Only the major risks are described in Table 4.4-12.

Table 4.4-12 Areas of Risk and Uncertainty

Description	Likelihood	Potential Effect	Preventative or Contingency Response
Overtopping of levees or flooding outside the 100 year flood plain induced by biomass or material in channel related to the restoration project	Low – But existing vegetation growth may present a problem	Reshaping of flood zone, loss of property	Vegetation thinning/clearing of woody species; periodic assessment of channel cross-sections and N values in the models relative to current conditions.
Major loss of planted vegetation and constructed areas from flood events less than 15 years	Moderate – Likely to occur in some segments of the restored area	Vegetation and habitat loss, additional planting costs	Assess regenerative potential of remaining vegetation; reassess species and location; replant

Description	Likelihood	Potential Effect	Preventative or Contingency Response
Major loss or unsuccessful plantings	High – May occur for many reasons, mostly related to water supply and possibly salt content	Vegetation and habitat loss, additional planting costs	Assess reasons for loss and correct source of the problem (soil amendments, salt leaching, different watering regime or substrate), or reevaluate species and location
Inability to control exotic species	Moderate – Variable depending on the species, control likely – complete removal unlikely	Limit success of native species, reduce habitat quality	Develop invasive, exotic species control plan; emphasize initial effort during first two years; implement annual maintenance
Unidentified hazardous wastes within project foot print	Low – Investigations have not identified hazards that would impede the project. Pesticide sampling of sediments at the I-10 drainage indicate that pesticide levels are negligible.	Indicators of the presence of hazardous or toxic materials would require further study to define nature and extent. Delays project and/or limits extent of restoration area.	Depends on type and extent. Also dependent on cost agreement and local sponsor capabilities; redefine limits of restoration area.
Unsuccessful land or easement acquisition	Moderate	Limits extent of restoration area	Somewhat dependent on cost agreement and local sponsor capabilities; may not be completely preventable
Limitations or impediments to ground water use	High – Water resources are in high demand and highly regulated	Limits extent of restoration area and the success of the effort in restored areas	Requires commitment by local sponsors to participate in permitting process; limit habitat to drought tolerant conditions; research other sources of water
Errors in cost estimation	High in this phase of the project for some but not all items	Limits extent of restoration area; creates uncertainty in developing cost sharing agreement	Cost estimates are refined in next phase of study

4.6 PLAN SELECTION

The plan selection process provides rationale for selection of the:

- *National Ecosystem Restoration (NER) Plan* – reasonably maximizes net ecosystem restoration benefits by having the maximum excess of beneficial ecosystem effects for the costs
- *Locally Preferred Plan* – best meets the needs of the local community, in the opinion of the sponsor
- *National Economic Development (NED) Plan* – maximizes net national economic benefits
- *Optimum Trade-off Plan* – provides the best mix of contributions to net national economic development and ecosystem restoration by maximizing the sum net of net economic and ecosystem effects.

National Ecosystem Restoration (NER) Plan

Final conclusion from economic analysis pending completion of MCACES.

Locally Preferred/Recommended Plan

Alternative 8 is the Locally Preferred Plan. Alternative 8 (Recommended Plan) grew out of substantial discussions between the local sponsors and various stakeholders. Alternative 8 best balances the range of opportunities and constraints associated with the project, including: flood control restrictions within the channel; the availability and reliability of water sources; the availability and cost of lands required for restoration; coordination with planned, adjacent recreational uses; restrictions from the proximity of Goodyear Airport; feasibility of permitting new wells; and other issues described more completely in Section 2.

Alternative 8 is designated as the selected Recommended Plan because it best performs the following actions:

- Utilizes the existing outflow of treated wastewater near the AWWTP site to substantially enhance the existing habitat by restoring more natives species
- Restores several types of critical riparian habitat to the I-10 site
- Minimizes water needs and associated costs by limiting irrigation to the I-10 site
- Reduces permitting requirements and costs associated with constructing groundwater wells by utilizing an existing City of Avondale well for irrigation
- Avoids potential land use impacts with the nearby Goodyear Airport associated with bird air-strikes
- Minimizes the amount land that has to be acquired by private owners
- Enhances the aesthetic and recreational value of the areas around the I-10 site by providing natural riparian habitat that supports native wildlife better than the existing degraded habitat
- Is both cost effective and a best buy when budgetary constraints (i.e. the 75% or $5 million total Federal share max) are considered in the incremental analysis formulation.

Optimum Trade-Off Plan and National Economic Development (NED) Plan

For the Agua Fria Ecosystem Restoration Project, only the NER Plan is considered because there is no civil works element that provides economic benefit in the context of flood control, water supply, etc. As a result, there is no Optimum Trade-Off Plan or National Economic Development (NED) Plan.

4.7 DESCRIPTION OF THE RECOMMENDED PLAN

4.7.1 General Components

Section 4.3.6 and Tables 4.4-1 and 4.4-2 provide a thorough description and summary of the important components of Alternative 8, the Recommended Plan. Figure 29 illustrates a plan view of the Recommended Plan (Alternative 8), and Figures 30 and 31 provide cross-sections illustrating the range of habitats and general components. Section 5 provides an evaluation of impacts for each alternative, including the Recommended Plan.

Summary of Recommended Plan

To summarize, Alternative 8, the Recommended Plan, is an adaptation of Alternatives 2, 4, and 5 based on the opportunities and constraints identified by the local sponsors, the USACE, and the other key stakeholders. Alternative 8 requires a relatively low water use (see Table 4.4-6) and incorporates restoration activities at two locations within the study area: (1) the I-10 site near the Papago Diversion Channel and (2) the Avondale Wastewater Treatment Plant (AWWTP) site. Restoration options near the Durango Regional Outfall Channel (Buckeye Road) site were not considered under Alternative 8 to avoid the 10,000-foot exclusion zone around Goodyear Airport that imposes restrictions to prevent bird-strikes and other risks (see Figure 4).

Restoration at the two sites for Alternative 8 would involve four key measures:

- Removal of exotic and invasive species throughout the entire restoration site

- Construction of a riparian strip along the eastern and western levees
- Establishment of Vegetation Management Areas between the riparian strips and at the AWWTP site
- Introduction of water from an external City of Avondale well.

Table 4.7-1 summarizes the key features of the two restoration areas in the Recommended Plan.

Table 4.7-1 Restoration Features Associated With Recommended Plan*

Site	Restoration Features
I-10	• Restoration at the I-10 site would be similar to that described for Alternatives 2 and 5 (see Sections 4.3.2 and 4.3.5). • The eastern riparian strip would be planted with mesic and hydric riparian vegetation and irrigation would come from existing City of Avondale groundwater wells. Bank terrace armor that would protect the riparian areas would partially exclude frequent flows (up to 15-year events). The western levee restoration area would include added fill and xeric vegetation. Bank terrace armor would also protect the filled areas along the western levee from frequent flood events; however, flood protection would not be to the same extent as the eastern protection since most the western levee plantings would be elevated above very-frequent flood events. • A Vegetation Management Area of 63 acres would be established in the in-channel area south of McDowell Road and north of the grade-control structure immediately south of the I-10. The focus would be on increasing the percentage of native species in the Vegetation Management Area without significantly increasing the overall amount of plant biomass. No structural changes would occur. • A multi-use trail, which would connect Friendship Park to Coldwater Park and is operated by the City of Avondale is planned to intersect part of this site. Starting from Friendship Park, the trail would traverse south along the eastern levee and drop into the riverbed near the I-10 channel outflow area, where it would continue along the eastern levee and cross over the river on the grade-control structure located just south of I-10 and up onto the western levee before continuing south to Coldwater Park (see Figure 21). • City of Avondale is responsible for supplying a perennial source of irrigation water for the eastern riparian strip, periodic of the western riparian strip, and seasonal irrigation of Vegetation Management Areas. Water is presently assumed to come from an existing well, but other sources may be substituted. A delivery system would be constructed from the nearest connector to the restored area.
AWWTP	• Restoration near the AWWTP site would be focused on increasing the percentage of native species in the Vegetation Management Area without significantly increasing the overall amount of plant biomass. The Vegetative Management Area would cover a total of 18 acres. No structural changes would be added. • Currently, a small marsh and a vegetated strip downstream exists downstream of the AWWTP outflow pipe, supported by the perennial source of water from the treatment plant effluent and relatively shallow groundwater. Similar to Alternative 4, Alternative 8 would include a Vegetation Management Area at this site, which would include the existing marsh and surrounding areas (see Figure 29). In contrast to Alternative 4, there would be no riparian strip extending north of the effluent outfall because Alternative 8 requires substantially less water. Under Alternative 8, it is assumed that 1 mGPD of effluent from the AWWTP would be retained for the restoration site. (The remainder may be diverted for charge.).

*For a complete description of Alternative 8, see Section 4.3.6

4.7.2 Design and Construction Considerations

See Sections 4.3.6, 4.4.1, and Appendices I (Hydrology, Hydraulics and Engineering Analysis) and J (Cost Estimate Analysis).

4.7.3 Real Estate Requirements

See Section 4.4.2 and Appendix H (Real Estate Analysis).

4.7.4 Local Betterments

There are no local betterments included in the Recommended Plan. The Plan does incorporate measures to protect the site from adjacent recreational activities while maximizing the educational and aesthetic benefits to the local community without compromising the primary objective of the project to restore habitat.

4.7.5 Operations, Maintenance and Replacement Considerations

General Considerations

The major elements of the operation and maintenance phase of Alternative 8 are listed in Section 4.3.4. A monitoring and adaptive management plan would be developed during the plans and specification phase of the project. The monitoring plan would evaluate the success of the project based on characteristics such as:

- Vegetation structure, distribution and health
- Vegetation volume and relative amount of woody and herbaceous vegetation
- Plant and wildlife species presence and abundance
- Relative number of native and non-native species in managed areas
- Soil characteristics such as salinity, litter and organic material, texture
- Soil moisture
- Function of riparian strips and integration with the surrounding environment
- Disturbance regime.

Field information would also be used to support hydraulic evaluations to ensure that the SPF conditions are maintained.

Monitoring results would indicate sources of failure in the initial construction effort and suggest appropriate corrective measures. There are several aspects of the project design where the initial restoration completed during construction may subsequently prove to be unsuccessful and adaptive management would have to be applied:

- Initial planting method may be inappropriate or there is insufficient water
- Exotic, invasive species control methods are ineffective
- Native plants are unable to compete with exotic, invasive species or other site characteristics imply other native species should be used
- Vegetation cover in the vegetation management areas becomes too dense, which may compromise the conveyance capacity of the river, and vegetation must be thinned
- Riparian strips or terrace bank armor does not function as planned and some maintenance is needed
- Adjacent land use and recreation plans change requiring different or additional measures to protect restored areas
- Method of water delivery is inadequate; there is too much or too little infiltration in some areas, ponding, etc.

In the event that maintenance of the hard structures or the levee system itself is undertaken by the COA or the FCDMC and these activities result in a disturbance or loss of habitat, the affected area will be returned to the restoration design condition and the monitoring criteria for success will be adjusted accordingly.

Biological Monitoring

Vegetation. A monitoring and maintenance program should be implemented to evaluate the success of the restored areas in terms of vegetation growth and development, and to identify those areas that will require further re-planting and weed abatement. The monitoring program will consist of periodic assessments of the habitat for a period of five years after plant installation. Additional assessments may be required in the event of a flood, fire, or other occurrence that causes a substantial loss or degradation of habitat. Monitoring is also proposed during project construction to ensure that the habitat restoration activities are conducted as specified. In the first five years after construction, horticultural monitoring is recommended to qualitatively evaluate plant health and to identify and correct problem areas. A horticultural consultant with expertise in restoration ecology will oversee all phases of habitat restoration construction activities, conduct the post-construction horticultural monitoring program, and prepare reports documenting the status of the restoration. The horticultural consultant will be available on site during restoration implementation to assist in making any necessary modifications to the specifications so that work may proceed. Detailed records will be kept and any significant problems encountered, or necessary changes made to the specifications during the implementation activities, will be recorded. The horticultural consultant shall be present upon delivery of container-plant material and when the plants are spotted in place for planting, during excavation of plant holes and container-plant installation, and during seeding operations. A five-year horticultural monitoring program will be necessary upon completion of the vegetation installation and should run concurrent with the installation contactor's two-year contractual maintenance period. The primary purpose is to evaluate plant health and to identify and correct problem areas. The horticultural consultant will visit the site on a regular schedule during the five-year monitoring period to evaluate the following:

- Plant health, growth, and vigor
- Vegetation replanting/reseeding
- Irrigation review and adjustment
- Weed abatement, fuel modification (fire fuel reduction), thinning for flow conveyance
- Erosion control, culverts, pond, and depression desiltation, obstruction removals
- Urban impacts such as point and non-point pollution runoff, illegal dumping, signage for trespass and code enforcement, fencing and gate conditions.

The following schedule is recommended:

- The first year the horticultural consultant should visit the site every two months to monitor the installation of replacement stock or rehydroseed efforts, if required.
- Site assessment visits will be conducted every other month during the second year following the completion of the vegetation installation.
- Site assessment visits will be conducted once every three months from the third through the fifth years of the five-year post-construction monitoring program.

- Subsequent to the completion of the five-year monitoring program, the local sponsors will be responsible for future monitoring and maintenance of the restoration areas. A qualified biologist should conduct the annual site assessment visit under the direction of the COA or the FCDMC; the biologist will evaluate the health, vigor, and the integrity of the species composition of the restoration areas. The monitor shall make recommendations for the timely correction of any problems within the habitat and be present for quality control when landscaping and/or maintenance personnel implement the recommended measures.

The horticultural consultant will provide specific maintenance recommendations regarding watering of container plants, weed control, debris removal, re-planting/re-seeding, erosion control, horticultural treatments, pest control and site protection, if needed.

The success of the container stock portion of the revegetation efforts will be based on the percent survivability of the plantings. Providing that care is taken prior to and during planting (such as using only healthy stock, proper planting methodologies, etc.) an 80 percent survival rate for each species type is realistic during the first (and most critical) season. All dead plants will be replaced with new container stock. Should a species be found to have less than a 50 percent survival rate, regardless of the care used in installing and maintaining the plantings, a re-evaluation of the use of the species in the habitat and recommendations for using an appropriate alternate species will be made. One hundred percent replacement of dead plants will continue through the second year.

Success of any hydroseeded species will be based on the overall cover of the hydroseeded areas. Because some bare areas can occur in natural habitats and because hydroseed may take 1 to 2 years to establish fully, bare ground within the restoration areas will not be used as an indication of vegetation failure unless hydroseed cover is found to be less than 75 percent in non-understory areas after the second monitoring year. If hydroseed does not attain 75 percent cover after the second season, re-seeding will be implemented. However, large bare areas (greater than 10 feet in diameter and not part of an understory) will be considered problematic and require immediate re-seeding. Because riparian woodlands typically have little understory, a percent cover of 25 percent will be the minimum required after the second monitoring year.

Birds. Birds are typically used as indicators for monitoring success, simply because it is an easy class of animals to identify and monitor as opposed to small mammals and reptiles, which would also benefit from the restoration project but are difficult to survey. The horticultural consultant should utilize the local birding community to assist in implementing a monitoring program for birds by arranging a cooperative agreement with the local birding organizations. In exchange for providing birders access to the wildlife features at various times throughout the year, the birding community could complete a summary report of the species observed to be submitted to the habitat managers on a seasonal basis.

The horticultural consultant should provide the birding community with several standard forms that will allow the managers to track bird populations in the creek over time. First, a booklet should be created that contains the key potential species with a sidebar that allows the birders to rank the population size as abundant, common, uncommon, or rare. The booklet should also contain a checklist of all potential birds, which would allow birders to submit their lists of observed species without regard to abundance.

At the end of every season, the birding community should be asked to turn in their species observations and estimates of population abundance.

4.7.6 Relationship to Environmental Requirements

See Section 7 (Compliance with Environmental Requirements).

4.8 IMPLEMENTATION REQUIREMENTS

4.8.1 Institutional Requirements

The schedule for project implementation assumes authorization via the Water Resources Development Act. After project authorization, the project would be eligible for construction funding. The project would be considered for inclusion in the President's budget based on: national priorities, magnitude of the Federal commitment, economic and environmental feasibility, level of local support, willingness of the non-Federal sponsor to find its share of the project cost and the budget constraints that may exist at the time of funding. Once Congress appropriates Federal construction funds, the Corps and the non-Federal sponsor would enter into a project cooperation agreement (PCA) (see Draft PCA in Appendix N). This PCA would define the Federal and non-Federal responsibilities for implementing, operating and maintaining the project.

The Corps would officially request the sponsor to acquire the necessary real estate immediately after the signing of the PCA. The advertisement of the construction contract would follow the certification of the real estate.

The final acceptance and transfer of the project to the non-Federal sponsor would follow the delivery of an O&M manual and as-built drawings. The estimated schedule for project implementation is shown in the Table 4.8-1.

Table 4.8-1 Implementation Schedule

Item	Completion Date
Plans and Specifications Complete	April 2008
Approval of New Construction Start	April-May 2008
PCA Signed	May 2008
Real Estate Acquisitions Completed	To be determined
Advertise Construction Contract	June 2008
Completion of Construction	July 2008

4.8.2 Federal Financial, Technical, Real Estate and Other Responsibilities

As the Federal sponsor, the USACE will be responsible for the initial installation, maintenance and monitoring of the restoration project. As part of its obligation under the Section 1135 program, the USACE will contribute a portion of the total costs needed to implement the restoration project. In addition to its financial responsibility, the USACE will be responsible for the following activities:

- Design and prepare detailed plans and specifications for restoration of the Agua Fria according to the goals and objectives of the Recommended Plan (Alternative 8)

- Administer contracts for the habitat construction and supervision of the project after authorization; this will include a landscape architect, horticultural consultant and other specialists needed to effectively implement the restoration project
- Establish and administer a two-year maintenance program for the project immediately after construction but prior to turning over responsibility to the local sponsor to ensure that the vegetation is healthy and established before turning the project over to the local sponsor
- Establish and administer a five-year monitoring program for the project immediately after construction but prior to turning over responsibility to verify the restoration progress and correct problems as needed
- Conduct periodic inspections with the non-Federal sponsor to determine the progress of post-construction maintenance and to suggest ways to correct problems.

4.8.3 Non-Federal Financial, Technical, Real Estate and Other Responsibilities

Currently the estimated non-Federal share for the project is $1,632,066 or 25 percent of $6,528,264. The USACE has included in their costs the initial maintenance and monitoring programs that will begin after project installation.

The local sponsor will be responsible for the following:

- Provide necessary temporary and/or permanent easements, right of ways and access points.
- Ensure that all hazardous materials or wastes, if any, are cleaned up before planting is initiated.
- Notify the community about the project and the project schedule, in conjunction with the USACE.
- Establish a schedule, in coordination with the USACE, for the maintenance and monitoring of the restoration areas once the USACE's responsibilities are over.
- Assist with the establishment of the temporary water source for irrigating seric vegetation and permanent water source from the City of Avondale's existing well or other equivalent source.
- Dedicate a staff person to the overall management and coordination of the restoration project; a biologist would be needed to assist with the implementation and maintenance of the restoration program.

5.1 METHODOLOGY

This section provides an assessment of negative and beneficial impacts caused by the restoration project during the construction and operation phases. For each environmental medium: (1) significance criteria used to identify impacts are identified, if they exist; (2) the environmental consequences of the project are discussed; (3) environmental commitments are identified to ensure that all adverse impacts are reduced to less than significant levels; and (4) an analysis of cumulative impacts is provided.

Cumulative Impacts Projects

An assessment of projects within or adjacent to the Agua Fria project reach that could result in impacts similar to those caused by the restoration project include those briefly described below. The projects listed here are those projected to at least have initiated pre-construction, mobilization, or construction by the end of 2005.

Additional bridge improvements to MC 85. Projected year: 2004-2005.
This project may include additional scour protection for the bridge.

Friendship Park extension and trail extension along western levee from McDowell to Van Buren. Projected year: 2005.
This project extends from the eastern bank of the river, across McDowell and then south along the western levee to Coldwater Park. The trail will be constructed with underpasses into the channel at all road crossings. The park located between McDowell and I-10 will be completed probably by August 2004. The trail extension has not been initiated.

AWWTP expansion. Projected year: 2002-2004.
Further expansion of the AWWTP to a capacity greater than 6 mGPD. Capacity may be doubled again, to approximately 12 mGPD.

Tres Rios Greenway Trail. Planned year: 2004-2005
Planned trail to connect Van Buren Street to Buckeye Road, on the east side of the river. Trail would be 30 feet wide, with 20 feet of that landscaped, and 10 feet used as a multi-use trail.

Coldwater Springs Development. Projected year: 2002-2003
Project to build 1900 homes is 70 percent completed as of June 2002. Property is 523 acres, bounded by Van Buren Street to the north, the Agua Fria River to the west, Buckeye Road to the south and 115th to the east (Avondale, 2002c).

Tres Rios Landing. Projected year: 2003-2005
Planned project to build 500 homes. West side of Agua Fria River, south of Buckeye Road, east of Dysart Road (Avondale, 2002c).

Diamond Ridge Development. Projected year: 2002-2004
Approved project to build 212 homes. Located on the east side of the Agua Fria River, south of Buckeye Road, along El Mirage Road (Avondale, 2002c).

The following restoration projects, regional parks or preserved areas along the Gila River all serve to reverse the serious habitat fragmentation, degradation and loss of riparian, wetland and aquatic habitat that has occurred within Arizona. The Agua Fria ecosystem restoration project is compatible with these efforts. The following is a brief description of compatible restoration projects in the area.

Casey Abbot Recreation Area. Located near the confluence of the Gila River, this has been designated as open space by the City of Phoenix.

Tres Ríos Demonstration Constructed Treatment Wetland Project. This project consists of approximately 12 acres of emergent marsh, and free-water wetlands, and is located adjacent to and within the confines of the 91st Avenue Wastewater Treatment Plant. There are currently three operational wetlands sites: Cobble (4 acres), Hayfield (6 acres), and the Research Cells (1 acre). The formal Demonstration Project is a $3.6 million dollar study funded by the City of Phoenix/ Sub-Regional Multi-Cities Operating Group (SROG), U.S. Bureau of Reclamation (BOR), U.S. Environmental Protection Agency (EPA), Army Corps of Engineers, the Arizona Department of Water Resources (ADWR), and Arizona Game and Fish (AGFD) with three primary objectives:

- Determine if wetland systems can polish pre-treated wastewater to a level that would meet perceived future discharge requirements.
- Develop scale-up parameters for an approximately 800 acre full-scale system.
- Determine the net environmental benefit such a system and associated riparian habitat would have in the Salt/Gila, and Agua Fria River area.

This project can provide useful information on the use of treated water for habitat improvement. Along with the restoration project, it helps to contribute to overall habitat resources within the Gila and Agua Fria Rivers.

Tres Ríos Ecosystem Restoration Project. The purpose of this feasibility study is to investigate and recommend appropriate solutions to accomplish ecosystem restoration in the Tres Ríos study area. In developing these solutions attention would be given to reducing flood damages to surrounding developed and agricultural areas, providing additional water supply for municipal, industrial and agricultural purposes, and offering recreational opportunities consistent with maintaining a healthy ecosystem.

5.2 BIOLOGICAL RESOURCES

Impact Significance Criteria

The National Environmental Policy Act (NEPA) provides guidelines for determining the significance of environmental impacts. The significance criteria utilized to assess impacts to biological resources were:

a. Loss of a critical, yet limited, resource used by a Federal or State threatened or endangered species
b. Substantial loss of species diversity in natural vegetation and wildlife habitat
c. Loss of individuals or populations of a Federal or State-listed threatened or endangered species, or their habitat

d. Substantial loss of individuals or populations of a Federal candidate, regionally rare, or otherwise sensitive species

e. Loss of habitat that is regionally unique, declining, or designated sensitive by resource agencies

f. Disturbances to populations or breeding areas of listed threatened or endangered species or reductions in the foraging habitat for threatened or endangered species

g. Loss of individual specimens of endangered, rare endemic, or otherwise sensitive species dependent on the study area.

A potential impact is considered substantial if its severity or extent and if the duration and/or frequency of the impact is sufficiently great to impact the affected resource. Of the criteria listed above, it is important to note that in the absence of threatened or endangered species at the site or their critical habitat, only criteria (b) and (e) would apply to the analysis. With respect to criterion c and g, native plants are protected under the Arizona Department of Agriculture Native Plant Law, which presents guidelines for plants that are protected, salvage, or harvest restricted.

5.2.1 Alternative 1 No Action

Under the No Action Alternative, no restoration areas would be established within the study area and the existing sparse vegetation would continue to degrade and provide low quality wildlife habitat. Also, under this alternative no management measures to control exotic species would be implemented, and plant species such as tamarisk, tobacco tree, buffle grass, and Russian thistle would continue to persist and possibly spread further into unaffected areas. Local and regional projects would more than likely emphasize recreational use of habitat within the channel rather than restoration of wildlife habitat. Wetland and riparian habitat at the AWWTP site might be lost because there is currently no alternative mechanism to help retain water at the site as opposed to diverting all of it for recharge.

5.2.2 Alternative 2 Low Water Use

Alternative 2 would involve revegetation and restoration of portions of the Agua Fria River between McDowell Road and the Gila River confluence, using a low water use scenario. Currently, the river channel within the study area is protected by soil cement levees between McDowell Road and Buckeye Road. Alternative 2 would locate riparian corridors along the east and west side of the existing soil cement levees between the I-10 and Buckeye Road, each extending 100 to 600 feet in width into the channel. The restoration corridors would improve the quantity and quality of natural vegetation and increase the available wildlife habitat in the channel. Two constructed elements are part of Alternative 2: a low protective berm that would protect the interior of the riparian corridors (the outer edge being limited by the soil cement levees); and two groundwater wells along the eastern levee would supply water for establishing and sustaining the restoration sites. Vegetation along the western levee would be irrigated from existing water lines. The protective berms would be constructed either of soil-cement or a modified structure that included more natural features, such as plantings among the riprap.

Construction

Construction would result in the disturbance or loss of existing in-channel vegetation and could result in impacts to existing biological resources. All areas affected by construction will be included in the

restoration effort, insofar as these areas will be revegetated with a mix of native species tolerant of arid conditions. These areas that are restored after construction disturbance will be irrigated frequently after seeding for the first three months and then the schedule will be gradually reduced, depending on the time of year that the reseeding occurs and drought conditions.

No special status species or their habitats are presently known to occur within the project area, and none are expected to occur due to the low value of the existing degraded habitats. Nonetheless, precautionary measures such as construction timing restrictions and pre-construction surveys for special status plant and wildlife species would be implemented to avoid potential impacts to these resources (see Environmental Commitment BIO-1). This is especially the case for birds that may migrate into the area from optimal habitat areas to the north and south of the project reach. Native plant species like mesquite and palo verde that are covered by Arizona native plant laws and that may be removed during the construction period will be surveyed to note their general condition to ensure that salvage or replacement is achieved in the restoration effort (see Environmental Commitment BIO-2). If a listed species is in fact observed we will comply with section 7 by initiating consultation with the USFWS and adhering to other established processes under the ESA.

During the grubbing phase fine material may be removed along with plant roots and stems. Generally because of the abundance of non-native propagules, this material should be replaced with clean material. Because the existing substrate has been degraded by the lack of input of fine sediment the "topsoil" material that is brought in should be similar to the expected conditions of the channel (e.g., fine to medium sands).

Operation

Operation of the restoration areas would increase available water that could result in the establishment of non-desirable exotic plant species (e.g., tamarisk). To minimize the establishment and spread of exotic species, measures such as irrigation timing controls and mechanical and hand removal prior to and following revegetation (as part of continued operation and maintenance) will be incorporated into a Vegetation Management and Monitoring Plan (see Environmental Commitment BIO-2). An important component of the vegetation management strategy is to create physical conditions (e.g., through establishment of suitable regeneration sites and irrigation frequency) that favor native species.

The hydrological analysis demonstrates that vegetation growth associated with the riparian strips will not affect the capacity of the river to convey peak discharges under the standard project flood. This assumption should be monitored during operation to ensure that the assumptions are maintained. In this context, it is recommended that a post implementation check be carried our after the site has been established and periodically thereafter to ensure that vegetation growth does not reduce channel conveyance capacity below the Standard Project Flood (SPF) (see environmental commitment BIO-3). In the event that future land use or hydrological controls change the conditions of the river (e.g., increased discharge), then it is possible that vegetation thinning may be a contingent tool for reducing flood control risks.

It is likely that during the life of the project the COA or the FCDMC will have to affect maintenance of the terrace banks armor or the levees themselves. Impacts to the restored habitat for maintenance of the restoration project and/or compliance with the 221 agreement between the FCDMC and the Corps shall be minimized and mitigated, if necessary.

Proposed Environmental Commitments

Although impacts from this alternative may temporarily remove existing vegetation and marginal wildlife habitat, and may result in increased opportunities for invasive species establishment, implementation of the proposed actions would have a long-term net benefit by replacing degraded and low value habitat with high value riparian vegetation along a corridor connecting to one of Arizona's most significant river systems. With the implementation of Environmental Commitments BIO-1, BIO-2, and BIO-3, Alternative 2 would not result in any significant negative biological impacts.

BIO-1 Prior to construction, a Wildlife Resource Protection Plan (Plan) should be developed that outlines measures for minimizing potential disturbances to wildlife during construction of the restoration areas. The plan should include, but is not limited to, the following measures:

- Prior to construction and operation, a qualified biological monitor will be designated and assigned the task of ensuring the measures in the Plan are implemented.
- The Plan will require that the designated biological monitor conduct pre-construction biological surveys to determine if any wildlife species are at risk. Particularly, for special status wildlife species, the surveys will include a search for nesting birds within and in the vicinity of the construction activities. The Plan will also specify measures to be taken in the event special status species are encountered prior to or during construction activities.
- The Plan should include construction timing "windows" that minimize potential disturbance to wildlife, particularly during critical periods such as breeding and nesting.
- Prior to ground-disturbing activities in any existing riparian areas, the Corps would consult with the U.S. Fish and Wildlife Service and Arizona Game and Fish Department to identify the potential for the occurrence of any sensitive wildlife species. If sensitive species are determined to be present or to have the potential to occur, the schedule for invasive removal and other construction-related activities shall be revised to avoid breeding seasons of any sensitive species on site.
- The Corps would consult with the U.S. Fish and Wildlife agency pursuant to Section 7 of the Endangered Species Act if it determines that an action may affect a listed species under the subject Act. Results of Section 7 Consultation will be included in a Supplemental EA.

BIO-2 Prior to any on-site activities, a Vegetation Management and Monitoring Plan will be developed that outlines measures for establishing and monitoring native vegetation in the Agua Fria River restoration areas. The measures should include, but are not limited to, the following:

- Prior to construction remove existing exotic vegetation using mechanical and chemical controls (see HW-2 for herbicide application).
- During construction, excavated topsoil should be removed and replaced with suitable non-degraded soil (e.g., fine to medium sands).
- Prior to construction, delineate the location of existing native plant species (e.g., mesquite and palo verde) that are considered under native plant law to ensure that appropriate replacement is achieved in the restoration effort.

- Establish irrigation-timing controls to minimize the establishment and spread of exotic plant species during operation.
- Establish revegetation success criterion and a monitoring program that includes measures to maximize restoration success.
- Establish measures for hydrological monitoring that address vegetation and flood control issues (e.g., vegetation thinning and removal).
- Establish a long-term plan for controlling invasive, exotic species.

BIO-3 Hydrological modeling assumptions should be assessed approximately every five years to address unanticipated vegetation growth or changes in the channel cross-section that may be induced by the restoration project or to address increased discharges and flow rates. If necessary, vegetation clearing or thinning of woody vegetation should be incorporated into periodic maintenance to ensure the model assumptions are maintained.

BIO-4 The minimum criterion for any impacts shall be to reestablish the design condition within the affected area and achieve success criteria over the following five years that will be defined in the Vegetation Management and Monitoring Plan.

5.2.3 Alternative 3 Moderate Water Use

Under Alternative 3, the total restoration area would be slightly greater than Alternative 2. In addition to the restoration corridors along the east and west levees between McDowell Road and Buckeye Road, there would be a restoration area south of Lower Buckeye Road, on the east side of the channel. The restoration areas would be protected by berms as described for Alternative 2. Three groundwater wells would be constructed for irrigation: south of the I-10 and Van Buren Street; on the east side of the eastern levee; and south of Lower Buckeye Road, on the east side of the levee.

Construction and Operation Impacts

Construction impacts from Alternative 3 would result in a slightly greater disturbance or loss of existing vegetation than from Alternative 2. The greater area of disturbance increases the potential to impact existing biological resources. As with Alternative 2, all areas affected by construction will be revegetated, if necessary; no special status species or their habitats are known or expected to occur in the areas described by this alternative. No protected native plant species have been identified in the additional restoration area included under this alternative. An increase in irrigated area would increase the area subject to risk of invasion by exotic plant species; however, this additional area would be subject to the management plan identified by Environmental Commitment BIO-2.

Although impacts from this alternative may temporarily remove existing vegetation and marginal wildlife habitat, and may result in increased opportunities for invasive species establishment, implementation of the proposed actions would have a long-term net benefit by replacing degraded and low value habitat with high value riparian vegetation. With the implementation of measures BIO-1 to BIO-4, Alternative 3 would not result in any significant negative biological impacts.

5.2.4 Alternative 4 High Water Use

Under Alternative 4, the total restoration area would be significantly greater than Alternative 2 and Alternative 3. In addition to the restoration corridors along the east and west levees between McDowell Road and Buckeye Road, there would be restoration areas south of Buckeye Road and Lower Buckeye Road, on the east side of the channel, as well as vegetation management areas at the three major restoration sites. The restoration corridors would be constructed similarly to the other alternatives and include low protective berms modified to include more natural-appearing features, such as plantings among the riprap or herbaceous species on top of the berm. Five groundwater wells would be constructed for irrigation, located as needed on the east side of the levee. The west side would receive irrigation suitable for xeric species from existing water supplies. This alternative maximizes the amount of restoration areas that could be added without compromising the current Standard Project Flood (SPF) protection of the channel.

Three restoration locations in the interior of the channel, outside of the protected strips, have been designated as vegetation management areas to indicate that no structural changes will take place in these areas. Pumped ground water would be directed seasonally (not throughout the year) to these areas, and invasive species would be controlled to encourage establishment of native species. The vegetation management locations include the I-10 outfall (west side of the existing soil cement levees between the I-10 and Buckeye Road), south of the Durango Channel restoration area, and the AWWTP restoration area (at and below the AWWTP outfall). These are areas where vegetation is sustained by currently ephemeral surface water inputs and shallow ground water.

Construction and Operation

Under Alternative 4, temporary impacts to biological resources would be greater than for Alternative 2 or Alternative 3 since it would affect a greater area of existing vegetation. The greater area of disturbance increases the potential to impact existing biological resources including special status plant and wildlife species that may occur in these locations. As with Alternative 3, an increase in irrigated area would increase the total area where non-desirable exotic plant species (e.g., tamarisk) could establish, which would be addressed in the vegetation management and monitoring plan (BIO-2).

The black-necked stilt, a U.S. Forest Service sensitive species, was observed at the proposed Durango Channel restoration area (MCDOT, 2000), and may forage and nest in this location. Environmental Commitment BIO-1, however, requires pre-construction surveys for plant and wildlife species such as black-necked stilts, and proposes implementation actions if sensitive resources are observed.

Because of the incorporation of vegetation management areas into this alternative, the need for post construction monitoring of vegetation growth in relation to flood capacity would be most important for this alternative (see Environmental Commitment BIO-3). The intent of periodic additions of water to the site is not to significantly increase the biomass in the channel, since vegetation currently persists in these areas. Rather these areas are part of a strategy, along with invasive species control, to improve the health of the plant community towards greater diversity of native species.

The removal of exotic species within the vegetation management areas would temporarily remove soil and vegetation and could result in impacts to existing biological resources. Except for the black-necked stilts observed in the Durango Channel (MCDOT, 2000), no special status species or their habitat are known to occur in the vegetation management areas. As noted for Alternatives 2 and 3, impacts to this and other plant and wildlife species will be less than significant with implementation of Environmental Commitment BIO-1. Similarly, potential impacts related to increased irrigation and exotic species establishment and flood control would be less than significant with implementation of Environmental Commitment BIO-2 that specifies measures to minimize exotic species establishment and distribution, and monitor vegetation management needs (e.g., thinning or removal or debris) related to flood control issues.

Also under this alternative, several large athel tamarisk will be removed. Removing these trees may leave pockets where soil and roots have been excavated requiring fill replacement prior to revegetation and displace existing wildlife. The potential impact from athel tree removal, however, is not expected to be significant with implementation of Environmental Commitment BIO-2 that specifies that excavated soils will be replaced with suitable non-degraded topsoil, and Environmental Commitment BIO-1 that requires pre-construction wildlife surveys, as well as development of a Plan that identifies measures to be implemented if wildlife is present.

Although impacts from this alternative may temporarily remove existing vegetation and marginal wildlife habitat, and could result in increased opportunities for invasive species establishment and flood control conflicts, implementation of the proposed actions would have a long-term net benefit by replacing degraded and low value habitat with high value riparian vegetation along an important link to the Gila River. With the implementation of Environmental Commitments BIO-1 to BIO-4, Alternative 4 would not result in any significant negative biological construction and operation-related impacts.

5.2.5 Alternative 5 Low Water Use Without Riparian Corridor on Western Levee between I-10 and Buckeye Road

Construction and operation impacts associated with Alternative 5 would be similar to, but less than, Alternative 2 because there is no restoration along the western levee. With implementation of Environmental Commitments BIO-1 to BIO-4, Alternative 5 would not result in any significant biological impacts.

5.2.6 Alternative 6 Moderate Water Use without Riparian Corridor on Western Levee between I-10 and Buckeye Road

Construction and operation impacts associated with Alternative 6 would be similar to, but less than, Alternative 3 because there is no restoration along the western levee. With implementation of Environmental Commitments BIO-1 to BIO-4, Alternative 6 would not result in any significant biological impacts.

5.2.7 Alternative 7 High Water Use without Riparian Corridor on Western Levee between I-10 and Buckeye Road

Construction and operation impacts associated with Alternative 7 would be similar to, but less than, Alternative 4 because there is no restoration along the western levee. With implementation of Environmental Commitments BIO-1 to BIO-3, Alternative 7 would not result in any significant biological impacts.

5.2.8 Alternative 8 Low Water Use with Reduced Riparian Corridors, Vegetation Management Areas, and No Development of the Durango Channel Site

Alternative 8 has elements of Alternatives 2 and 4 with the following major features: (1) the length of the riparian corridors on the east and west levees is reduced near the I-10 site; (2) there are Vegetation Management Areas north of I-10 and at the Avondale Wastewater Treatment plant site, similar to Alternative 4; and (3) there are no restoration activities around the Durango Channel/Buckeye Road site to avoid interference with the 10,000-foot exclusion zone surrounding Goodyear Airport. The maximum width of the riparian strips on the eastern and western sides, near I-10 is 325 and 75 feet, respectively. Water at the I-10 site will be supplied by an existing COA well or equivalent source. Water at the AWWTP site will come from 1 mGPD of effluent that will be retained at the site and a system of filtration galleries and pumps to recirculate surface and subsurface water. Construction and operation impacts associated with Alternative 8 would be similar to all the preceding alternatives, but between Alternatives 2 and 4 in magnitude.

With implementation of Environmental Commitments BIO-1 to BIO-3, Alternative 8 would not result in any significant biological impacts.

5.2.9 Cumulative Effects

The habitat types and plant communities within the Agua Fria River channel have been degraded by sand and gravel mining, landfills, adjacent urbanization, flood control improvements, and flood control maintenance. These activities and their impacts exert a permanent influence on the river channel. The Agua Fria River is also currently degrading due to the introduction and spread of exotic plant species that have reduced the quality of the natural vegetation communities. Almost any surface disturbance in or adjacent to the channel facilitates the establishment of exotic plant species. The overall result of these impacts has been a reduction in the extent, quality, and diversity of natural biological communities in the Agua Fria River, and the associated reduction in wildlife use.

Some of the construction impacts caused by the cumulative projects identified at the beginning of this section would be similar to those caused by the restoration project. The disturbances caused by construction (e.g., noise and dust) could temporarily or permanently displace wildlife within or adjacent to the work areas. Any form of surface disturbance within or adjacent to the channel from residential or recreational development would also contribute to the spread of exotics. The contribution of the restoration project to impacts that are similar to the cumulative projects is negligible insofar as all the vegetated areas disturbed for construction will be replaced with native plant cover. The environmental

commitments identified for construction would ensure that the project does not contribute significantly to cumulative impacts.

Construction of recreational projects within or adjacent to the channel would result in the temporary and permanent loss of existing vegetation and reduction of wildlife habitat. The quality of remaining wildlife habitat, including the restoration project area, would be reduced by the presence of pedestrians and other recreational users. The restoration project alternatives consider some measures that would ameliorate the impact of recreation projects on restored areas, but the restoration project itself would not contribute to this impact.

Existing unattended vegetation growth in the channel will have a cumulative effect with the restored project areas in affecting the channel capacity. Inasmuch as hydrological modeling is an important diagnostic and design tool, it is not infallible, nor should it be viewed as a static assessment. For that reason, Environmental Commitment BIO-3 is necessary to address the cumulative effects of existing vegetation and the restored areas on the future conditions in the channel.

By restoring portions of the lower Agua Fria River, the proposed project has an overall significant cumulative benefit that increases the extent and quality of the proposed and existing natural communities in the vicinity. Particularly since the restoration effort would extend the riparian habitat and potential wildlife habitat corridor of the Gila River.

With implementation of Environmental Commitments BIO-1 to BIO-4, however, any negative impacts would not be cumulatively significant.

5.3 WATER RESOURCES

Impact Significance Criteria

Impacts to surface and ground water resources are considered significant if one or more of the following conditions would result from implementation of the proposed alternatives:

- Construction causes soil or water contamination at levels exceeding Federal, State and local hazardous waste limits
- Does not comply with Sections 401 and 404 of the Clean Water Act (CWA) and Section 10 of the Rivers and Harbors Act regarding the fill or discharge of material and alteration of waters of the U.S.
- Does not avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of floodplains and direct or indirect support of floodplain development wherever there is a practicable alternative per Executive Order 11988
- Implementation causes an impairment of beneficial uses of inland and coastal waters as defined in applicable water quality control plans
- Implementation causes substantial interference with groundwater recharge or direction and rate of groundwater flow
- Causes substantial and adverse increase in inundation, sedimentation, or damage from water or construction improvements (such as grading, construction of barriers and structures, and impervious surfaces) that will increase or divert stream flow or rainfall collection or conveyance
- Results in diversion or increase in sediments that cause a corresponding reduction in sensitive habitats.

5.3.1 Alternative 1 No Action

In the absence of restoration efforts within the Agua Fria River, there is no incentive or mechanism to preserve the remaining floodplains from encroachment by private development. In fact, the current degraded condition of the biotic environment would be used as a justification to encourage such development. The lateral migration analysis for the Agua Fria Watercourse Master Plan indicates that the river has been subject to sediment degradation because of controls in the watershed that prevent the input of new sediments. Low flows and frequent discharges have been significantly limited by such controls. Therefore, implementation of this alternative would perpetuate significant impacts to surface water resources.

Conversely, without implementation of the project, ground water would remain in storage available for future uses that have not yet been committed or identified. (It is presumed that no groundwater use would be permitted under the restoration alternatives that would interfere with other existing committed uses.)

5.3.2 Alternative 2 Low Water Use

Construction

Earth moving activities and construction of protective berms will be undertaken primarily during the dry season to minimize the potential for erosion and sedimentation. However, since exotic and invasive species control and revegetation must be timed to seasonal precipitation there may be conflicting objectives in the optimal scheduling of construction activities. It is therefore possible that the channel bed will be exposed to flowing water, or at least precipitation during or immediately after disturbance for grading and revegetation. Also, because of the ephemeral nature of the river, short duration, intense floods may occur during some part of the construction schedule. Even though the channel currently has poor vegetation cover, mechanical disturbance for construction will increase its susceptibility to erosion and scour. No equipment that may present an impediment to flow will be present in the channel during significant flow events. The final plans and specifications will include a sediment and erosion control plan to minimize the effects of such events (see Environmental Commitment WR-1).

Actions under this alternative are subject to conditions of the Clean Water Act Sections 401 and 404. In 2000a Kimley-Horn completed a wetlands delineation of the Agua Fria River in areas slated for sediment sampling for the watercourse master plan. The delineation identified wetlands present at all locations where there are intermittent (e.g., I-10 and Durango channel) or perennial discharges (AWWTP). The former are seasonal with boundaries dependent on precipitation and runoff.

There will be no net loss of wetlands in the channel at the I-10 outfall through fill, excavation or alteration of drainage. The water added to the constructed riparian strips will flow along a low flow channel that begins slightly downgradient of these areas along primarily mesic vegetation occupied by non-native and native ruderal herbaceous species and grasses. The final design of the eastern riparian strip will take into consideration the preservation of wetlands at this location and any disturbed or lost vegetation will be replaced (see Environmental Commitment WR-2).

This alternative includes the construction of two groundwater wells, small reservoirs and a conveyance system to the low flow channel of the eastern riparian strips. Added water is not spread out in the surface but conveyed along a low flow channel to avoid high evaporation losses and to ensure that water not used by vegetation is allowed to infiltrate back to the subsurface. Since groundwater at the I-10 site is outside the accessible depth of riparian plant species, bring groundwater to the surface for plant uptake and reinfliltration is a viable alternative to the sparse surface water that is currently available. The western riparian strip will be supplied with an irrigation system from existing city supplies. The location of the wells, their construction and production schedules will be defined in the plans and specification phase, subject to permitting from the ADWR and the COA (see Environmental Commitment WR-3). This will ensure that the action does not interfere with existing recharge facilities or committed ground water uses. Because the quality of the ground water is generally good, and no fertilizers will be used at the revegetation site, reinfiltrated water will not alter ground water or surface water quality.

During construction, accidental spills or losses of hydrocarbons, herbicides and other potentially contaminating liquids may occur. The hazardous waste section of this assessment provides for the development of a spill prevention and response plan to reduce the risk of surface water or sediment contamination.

All of the adverse impacts that may potentially occur during the construction phase are reduced to less than significant levels with the implementation of Environmental Commitments WR-1 to WR-4.

Operation

The primary concern of all the action alternatives is the effect on water surface elevations (WSEL) and freeboard (the remaining depth before overtopping of the levees or banks occurs) relative to the standard project flood (SPF) condition.[1] The analysis in Appendix I provides the results of the hydraulic modeling. Water surface elevations and the available freeboard for Alternatives 4 and 8 are presented in Figures 32 to 36 for the pre-New Waddell Dam SPF and more frequent discharges. The analysis for Alternative 4 is considered the maximum effect, i.e., Alternatives 2, 3 and 5 to 7 would have less impact in raising the WSEL or reducing the available freeboard.

In Alternative 2, the maximum increase in water surface elevation (WSEL) due to the proposed changes is about 1.7 feet for the SPF discharge event. This maximum increase occurs between the Van Buren Street and the grade control structure north of the Buckeye Road crossing. This section of the river has levees on both banks. The river conveyance capacity area in this reach is decreased by the fill material that will be placed to support the different vegetation types. Downstream of the grade control structure, there are no changes in WSEL. There are no proposed vegetative changes downstream of the grade control structure, so this was expected. In the area of maximum WSEL increase, the amount of freeboard provided by the levees is still above three feet.

[1] For this project, Alternatives 1 to 7 were developed first and then later Alternative 8 was added. For that reason, the hydrologic and hydraulic analysis was performed for Alternatives 1 to 7, and then additionally for Alternative 8. Accordingly, the text and figures for Appendix I discuss Alternatives 1 to 7, and then Alternative 8.

The project will not produce any adverse scouring effects at the bridge locations (see Appendix I.4 for more detail). It is estimated that the 10-year scouring depth along the toe down to the proposed vegetation will be 4 feet. This reflects two feet of single event scour and two feet of low flow channel scour. Again, two feet of low flow channel scouring is very conservative considering that the low flow channel would have to migrate several hundred feet to scour at the toe of the bank protection supporting the proposed vegetation.

With respect to water quality effects on the project, NPDES data from the I-10 outfall were not available for this study; however, this source of water may periodically contain elevated levels of common urban/agricultural contaminants that may be limiting to plant growth (e.g., pesticides and various salts like sodium and boron) during the first storm events of the rainy season (see Environmental Commitment WR-5). A preliminary analysis of the sediments at the I-10 site, which is the area most likely to accumulate pesticides, produced negative results (see Appendix F).

The addition of vegetation in the channel reestablishes some of the acknowledged benefits of riparian ecosystems by stabilizing areas subject to erosion and scouring, providing incidental improvement in surface water quality, trapping fine sediments for the establishment of a greater diversity of plant species and dissipating flood waters.

With implementation of the Environmental Commitments WR-1 to WR-5, no adverse significant impacts to water resources are anticipated.

Proposed Environmental Commitments

WR-1 A Stormwater Pollution Prevention Plan (SWPPP) will be developed by the construction contractor to obtain an NPDES construction permit. The SWPPP will include measures for sediment and erosion control to prevent or reduce the effects of earth moving and other disturbances in the channel that may cause accelerated erosion, scouring, and loss of sediments in the project area, as well as sedimentation downstream. The plan shall consider the most optimum construction and implementation schedule compatible with local environmental conditions, biological elements of the restoration plan, and flood or flow hazards.

WR-2 Existing wetland areas shall be identified and preserved or replaced in compliance with Section 404 of the CWA. Also see Appendix D of this DPR for the Corps' internal 404(b)(1) compliance report.

WR-3 If required, a study will be completed during the plans and specification phase of this project to identify the potential impact of well placement and ground water pumping for supplying water for habitat restoration in support of necessary ADWR and local permits.

WR-4 The operation and maintenance plan for the project shall include periodic monitoring to respond to potential long-term scouring of the protective berms and existing structures in the channel, as well as other potentially project-induced changes on conveyance capacity and hydraulic conditions, evaluated in the modeling (e.g., influence of vegetation).

WR-5 Additional sampling of water and sediments will be completed during the plans and specifications phase to provide more definitive conclusions on the presence of runoff contamination from urban and agricultural that may alter project design or construction plans. The effect of contaminant pulses during initial storm events on recently established vegetation may be ameliorated by supplying additional water to ensure that such contaminants do not accumulate in surface soils.

5.3.3 Alternative 3 Moderate Water Use

Given the similarity in size and design of Alternative 3 relative to Alternative 2, no additional adverse impacts are anticipated under this alternative.

The same maximum WSEL increase of 1.7 feet was experienced in Alternative 3 between Van Buren Street and the grade control structure. The proposed changes south of Lower Buckeye Road cause a maximum increase of 0.5 foot during the SPF discharge event and 0.4 foot during the 100-year discharge event. The west bank of the river has a levee and the amount of freeboard during the SPF event is still above three feet.

The magnitude of the impacts may be slightly greater; however, with implementation of Environmental Commitments WR-1 to WR-5, as well as others cited in the hazardous waste and biology discussions of this section, all impacts will be reduced to less than significant levels (see discussion in Section 5.3.2).

5.3.4 Alternative 4 High Water

Given the conceptual similarity of Alternative 4 relative to Alternative 2, no additional adverse impacts are anticipated under this alternative (see discussion in Section 5.3.2).

In Alternative 4, the maximum WSEL increase was also 1.7 feet, which occurred between Van Buren Street and the grade control structure. The proposed changes south of Lower Buckeye Road cause a maximum increase of 1.3 feet during the SPF discharge event and 1.1 feet during the 100-year discharge event. The west bank of the river has a levee, and the amount of freeboard during the SPF event is still above three feet with the exception of one minor violation of 0.1 foot at river mile 2.02.

The magnitude of the impacts are potentially greater because of the increased water needs, length of the construction period, and extent of the restored area; however, with implementation of Environmental Commitments WR-1 to WR-5, as well as others cited in the hazardous waste and biology discussions of this section, all impacts will be reduced to less than significant levels.

The benefits of riparian areas to water quality, bank and bed stability, and dissipation of flood flows are maximized in this alternative because it covers the greatest length and cross-sectional area of all the alternatives.

Monitoring carried out under WR-4 will be an especially important tool for providing feedback on the modeling results carried out prior to project implementation. In the event initial assumptions regarding biomass effects on conveyance capacity, scouring and other modeled conditions need to be altered, and in turn, this has a significant effect on channel capacity, then appropriate measures can be taken to

adjust the design and management of the restoration site. That is, as with any restoration project, post-construction management must be adaptive and responsive to the environment, which is difficult to predict. The amount of vegetation, location of restoration areas, and physical conditions can and should be monitored and adjusted, if the system cannot correct these problems naturally on its own.

5.3.5 Alternative 5 Low Water Use – without Western Riparian Strip

The potential impacts associated with this alternative are similar to those described for Alternative 2 (also see discussion in Section 5.3.2); however, the magnitude would be slightly less, especially for construction related impacts.

In Alternative 5, the maximum WSEL increase during the PMF event was 1.6 feet and occurred between the Van Buren Street crossing and the grade control structure. As in Alternative 2, the amount of freeboard in this area is still above three feet. The maximum WSEL increase is lower than that in Alternative 2. As no fill will be placed on the west bank, a lower WSEL maximum increase was expected.

With implementation of WR-1 to WR-5 no significant adverse impacts are anticipated during construction or operation.

5.3.6 Alternative 6 Moderate Water Use – without Western Riparian Strip

The potential impacts associated with this alternative are similar to those described for Alternative 3 (also see discussion in Section 5.3.2); however, the magnitude would be slightly less, especially for construction related impacts.

In Alternative 6, the maximum increase in WSEL is 1.6 feet, as in Alternative 5. In the area of proposed changes south of Buckeye Road, the maximum WSEL increase during the 100-year event is 0.5 foot.

With implementation of WR-1 to WR-5 no significant adverse impacts are anticipated during construction or operation.

5.3.7 Alternative 7 High Water Use and Vegetation Management Areas – without Western Riparian Strip

The potential impacts associated with this alternative are similar to those described for Alternative 3 (also see discussion in Section 5.3.2); however, the magnitude would be slightly less, especially for construction related impacts.

Alternative 7 has the same maximum WSEL increase of 1.6 feet between the Van Buren Street crossing and the grade control structure and has an increase in the 100-year SWEL of 1.1 feet in the area south of Lower Buckeye Road. In this area, the west bank of the river has a levee, and the amount of freeboard during the SPF event is still above three feet with the exception of one minor violation of 0.1 foot at River Station 2.02.

With implementation of WR-1 to WR-5 no significant adverse impacts are anticipated during construction or operation.

5.3.8 Alternative 8 Low Water Use with Reduced Riparian Corridors, Vegetation Management Areas, and No Development of the Durango Channel Site

The impacts to water resources that might be caused by Alternative 8 are similar to Alternatives 2 and 4.

The results presented in Appendix I only reflect areas of change in the hydraulic parameters. Any area upstream of River Mile 6.2 and downstream of River Mile 4.0 did not change. The maximum increase in water surface elevation (WSEL) due to the proposed changes is about 1.0 foot for the Old SPF discharge event. This maximum increase occurs about half way between I-10 and Van Buren Street at river mile 5.02. The available river conveyance in this area is decreased by the fill material that will be placed to support the different vegetation types. The amount of freeboard in this area is also decreased 1.0 foot. In the area of maximum WSEL increase, the amount of freeboard provided by the levees is still above 3 feet.

As stated, the hydraulic characteristics change very little under the proposed conditions and will not produce a greater scouring potential. It is estimated that maximum scouring depth will be approximately 6.5 feet during the 100-year storm event. This reflects 4.5 feet from single event scour and a standard 2 feet from scouring of the low flow channel. There are grade control structures downstream from the I-10 bridges and between Van Buren Street and the Lower Buckeye Road bridges that will control long-term scouring.

With implementation of Environmental Commitments WR-1 to WR-5, as well as others cited in the hazardous waste and biology discussions of this section, Alternative 8 would not result in any significant water resources impacts. Although no new wells are proposed for this alternative, WR-3 is still applicable insofar as the ADWR would be notified of any impacts to water resources due to the change in status and use of the existing well. The proposed filtration galleries that would be placed just outside the Vegetation Management Area would have a limited effect on subsurface groundwater because it would only capture groundwater that is less than 20 feet deep.

In the next phase of the project, the significance of the long-term scour event should be analyzed further using one-foot topography. Long-term damage may be avoided by an active maintenance program (see Environmental Commitment WR-4). In addition, it is unlikely that significant depths to armoring will ever be achieved.

5.3.9 Cumulative Impacts

Both surface and groundwater resources in the Agua Fria watershed have historically been subject to the cumulative impacts of surface water and drainage controls and ground water pumping. The concept of pumping ground water to the surface for restoration is a viable means of compensating for groundwater levels that, at best, have stabilized below historical levels, beyond the reach of most riparian species. This is especially the case in the northern half of the project area. In this respect,

pumping ground water is not proposed for areas where levels are currently at depths sufficient for vegetation growth (generally < 30 feet, but ideally < 10 feet) in the southern part of the project area. Exactly where this break-off occurs, e.g., where ground water pumping may be a viable and, ideally, temporary method for bringing water nearer to the surface in lieu of long-term efforts to increase aquifer levels or utilize other sources of surface water, is subject for more detailed study in the next phase of the project. Also, while cumulative impacts to ground water levels and gradients will occur, determining the magnitude of such effects requires modeling beyond the scope of this study (see Environmental Commitment WR-3); however, if these effects are significant, then the appropriate response is to reduce the extent of vegetated area and water needs of the project. This is the purpose of defining alternatives by water needs.

Because of its distance from potentially contaminated ground water located to the northwest, the project is unlikely to have any effect on altering the gradient of contaminant plumes. Especially since recharge efforts at McDowell Road may counteract the effect of localized ground water pumping.

Because the project can be designed to reduce any significant cumulative impacts to less than significant levels, no additional environmental commitments are proposed.

5.4 EARTH RESOURCES

Impact Significance Criteria

In accordance with NEPA, the effects of a project are evaluated to determine if they would result in a significant adverse impact on the environment. This DPR focuses on the potential environmental effects of the alternatives, and offers environmental commitments to reduce or avoid any significant impacts. The alternatives would have a significant adverse impact on the environment if they meet any of the criteria listed below.

- Substantially alter topography beyond that which would result from natural erosion or deposition
- Disturb or otherwise adversely affect unique geologic features or geologic features of unusual scientific value for study or interpretation
- Contribute to increased soil instability such that conditions pose an increased risk to human health or property from landslides, mudslides, and/or seismically induced geologic movements
- Expose people or structures to geologic hazards, soil and/or seismic conditions so unfavorable that they could not be overcome by special design using reasonable construction and/or maintenance practices
- Substantially increase long-term wind or water erosion of soils, either on or off site.

5.4.1 Alternative 1 No Action

The topography of the channel has already been highly modified by past activities, including sand and gravel mining, landfills, flood control improvements, and flood control maintenance. The Agua Fria River is currently degrading due to a history of watershed alterations and changes to the river channel, including sand and gravel mining and flood control improvements. Under the No Action Alternative, no

new restoration areas would be established within the study area. No topographical or geologic alterations would occur. The river channel would continue to degrade.

5.4.2 Alternative 2 Low Water Use

This alternative requires importation of material, as well as movement of earth within the channel, for construction of protective berms, fill for terraces and creation of small areas for natural establishment of vegetation and for water delivery along the riparian corridors.

Topography. Some landform changes would be required to implement Alternative 2. Grading would be required to form the terraces on the east and west side of the channels. The terraces would be a minimum of one foot in depth and would be intended to imitate a natural flood plain terrace. Excavations would be required to construct the protective berm (terrace bank armor) parallel to the restoration strips. The berms would protect the restoration strips against frequent flood events.

These modifications are intended to restore and sustain micro-topographic variations within the restored riparian habitats that have been lost due to floodplain encroachment and loss of sediments in the channel. While they do not perfectly imitate natural or historic conditions, these changes are intended to improve habitat resources for wildlife.

The topography of the channel has already been highly modified by past activities, including sand and gravel mining, landfills, flood control improvements, and flood control maintenance. Natural processes, primarily flood flows, also alter the form and shape of the river channel. The effects of grading and excavation that would be required for Alternative 2 would not be significant when compared to the current highly altered and degraded condition of the river channel.

Soil Erosion. During large flows, a continuing process of soil erosion, transport and aggradation occurs in the river channel. This natural process will continue with or without the implementation of Alternative 2. The alternatives may cause some minor changes in erosion and deposition process but they would not be significant. A detailed hydraulic review has been performed for this project to ensure that it would not create significant scour effects on existing bridges or flood control facilities. For details of the hydrologic and hydraulic analysis, see Appendix I.

The Agua Fria River is currently degrading due to a history of watershed alterations and changes within the river channel, including sand and gravel mining and flood control improvements. The proposed establishment of vegetation areas may help reduce erosion from surface runoff, potentially producing a beneficial effect. In addition, small quantities of fine material will be released approximately every five to ten years in the upstream portions of the riparian strips to simulate sediment renewal for establishment of native species.

Disturbance of soils during project construction would temporarily increase erosion potential. Since some construction activities may take place before or after periods of precipitation and/or strong winds, some erosion would likely occur. However, the construction schedule would be optimized such that earth-moving activities would take advantage of the dry season to reduce erosion related to

precipitation. Also, with the best management practices described under Environmental Commitment ER-1, erosion impacts would be reduced to a less than significant level.

Soils. Soils in the proposed restoration areas may have to be modified to create suitable growing conditions. Existing soils would be amended with fine textured soil and organic material that would be imported to the project site. It is not recommended to add nutrients since this may encourage the growth of non-native invasive species. These soil modifications would be minor and no negative impacts would occur. Soil test results imply that the channel substrate is currently degraded and nutrient poor. Therefore, the importation of fine materials and establishment of stabilizing vegetation along riparian corridors would provide a net benefit to soil quality.

As noted in the water resources section, sediments may be contaminated with pesticides in runoff from adjacent agricultural lands that drain into the channel. A preliminary analysis of the sediments at the I-10 site, which is the area most likely to accumulate pesticides, produced negative results. No other sources or occurrences of contaminated soils were identified in the project construction areas. Environmental Commitment WR-5 proposes additional sampling for the next phase to ensure that earth moving activities required for the project do not redistribute contamination, or do not generate soils that must be disposed of as hazardous waste.

Geologic Hazards. Alternative 2 would neither expose people or structures to geologic hazards, soil and/or seismic conditions so unfavorable that they could not be overcome by special design using reasonable construction or maintenance practices, nor would it contribute to increased soil instability such that conditions pose an increased risk to human health or property from landslides, mudslides, and/or seismically induced geologic movements. The establishment of vegetation would increase stability along the channel during small geologic events.

Alternative 2 would not result in any significant, unmitigatable geologic impacts. There would be localized beneficial impacts to soil conditions in the channel.

Proposed Environmental Commitments

ER-1 A comprehensive Erosion Control Plan shall be prepared for project construction as part of the SWPPP (see WR-1). The Plan shall identify measures to be implemented to minimize the erosion effects of grading and excavation. Erosion control methods to be described in the Plan and implemented shall include, but not be limited to, the following:

- Avoiding soil disturbance during periods of heavy precipitation or high winds
- Keeping disturbed areas to the minimum necessary for construction
- Reducing surface water flows across graded or exposed areas
- Using straw bales, soil mats, or silt fences to stabilize disturbed areas
- Using culvert, ditches, water bars and sediment raps to control runoff and sedimentation.

5.4.3 Alternative 3 Moderate Water Use

Under Alternative 3, the total restoration area would be greater than Alternative 2. In addition to the restoration corridors along the east and west levees between McDowell Road and Buckeye Road, there would be restoration area south of Lower Buckeye Road, on the east side of the channel. The restoration areas would be sheltered by terrace bank armor, which would be constructed either of soil-cement or a modified structure that included more natural features, such as plantings among the riprap. Three groundwater wells would be constructed for irrigation, located south of the I-10 and Van Buren Street, on the east side of the eastern levee, and south of Lower Buckeye Road, on the east side of the levee.

Impacts to earth resources under Alternative 3 would be slightly greater than Alternative 2 since it would require more extensive construction. This would result in more of a topographical change and would expose a larger area to increased erosion from construction. However, these changes would have a long-term net benefit by restoring topographic variation along the riparian corridors. With appropriate timing of the construction schedule and implementation of Environmental Commitment ER-1, Alternative 3 would not result in any significant negative impacts to earth resources. Alternative 3 would result in a beneficial effect by establishing restoration corridors with topographical modifications that provide more habitat resources and stable geological conditions.

5.4.4 Alternative 4 High Water Use

Under Alternative 4, the total restoration area would be greater than Alternative 2 and Alternative 3. In addition to the restoration corridors along the east and west levees between McDowell Road and Buckeye Road, there would be a restoration area added south of Buckeye Road and Lower Buckeye Road, on the east side of the channel, as well as vegetation management areas. The restoration areas would be sheltered by protective berms, which would be constructed either with soil-cement or modified structure that included more natural-appearing features, such as plantings among the riprap. Five groundwater wells would be constructed for irrigation, located as needed on the east side of the levee. This alternative maximizes the amount of restoration areas that could be added without compromising the current SPF protection of the channel.

Impacts to current topography for Alternative 4 would be greater than for Alternative 2 or Alternative 3 since it would entail construction of riparian strips over a longer segment of the river. This would result in more of a topographical change and would expose a larger area to erosion during construction. However, these changes would not result in a significant topographical change, nor would they expose people or structures to geologic hazards, soil, and/or seismic conditions so unfavorable that they could not be overcome by special design using reasonable construction or maintenance practices. With the implementation of Environmental Commitment ER-1, Alternative 4 would not result in any significant impacts to earth resources. Alternative 4 would have a beneficial effect by establishing restoration corridors with topographical modifications that provide more habitat resources and stable geological conditions.

5.4.5 Alternative 5 Low Water Use without Riparian Corridor on Western Levee between I-10 and Buckeye Road

Impacts associated with Alternative 5 would be similar to, but less than, Alternative 2. Please see Alternative 2. Alternative 5 would not result in any significant adverse impacts to earth resources.

5.4.6 Alternative 6 Moderate Water Use without Riparian Corridor on Western Levee between I-10 and Buckeye Road

Impacts associated with Alternative 6 would be similar to, but less than, Alternative 3. Please see Alternative 3. Alternative 6 would not result in any significant adverse impacts to earth resources.

5.4.7 Alternative 7 High Water Use without Riparian Corridor on Western Levee between I-10 and Buckeye Road

Impacts associated with Alternative 7 would be similar to, but less than, Alternative 4. Please see Alternative 4. Alternative 7 would not result in any significant adverse impacts to earth resources.

5.4.8 Alternative 8 Low Water Use with Reduced Riparian Corridors, Vegetation Management Areas, and No Development of the Durango Channel Site

Impacts associated with Alternative 8 would be similar to the other alternatives and intermediate in magnitude between Alternatives 2 and 4. With implementation of Environmental Commitment ER-1, Alternative 8 would not result in any significant impacts to earth resources.

5.4.9 Cumulative Effects

The topography of the channel has already been highly modified by past activities, including sand and gravel mining, landfills, flood control improvements, and flood control maintenance. Natural processes, primarily flood flows, also alter the form and shape of the river channel. The Agua Fria River is also currently degrading due to a history of watershed alterations and changes to the river channel, including sand and gravel mining and flood control improvements.

The proposed alternatives would potentially improve erosion resistance within the channel, reducing the rate of degradation. However, this is not expected to be a significant beneficial effect, nor would it offset the watershed-level causes of degradation to the river channel.

Soil erosion caused by construction could temporarily add to local erosion and sediment losses, but with the implementation of Environmental Commitment ER-1, this impact would not be cumulatively significant. There are no other construction disturbances scheduled within the channel that could overlap with project construction, except for bridge improvements at MC-85. Both would have temporary effects over a localized area. The topographical changes in the channel induced by project construction would be minor, and would not result in a significant negative cumulative impact, but rather would contribute to a positive impact when considered in the context of other restoration efforts. No significant negative cumulative geologic impacts would occur.

5.5 AIR QUALITY

The proposed project would not involve extensive long-term operational activities. Operational emissions would result from equipment exhaust associated with periodic minor maintenance activities. In addition, it is assumed that a relatively small increase in power would be required to be transmitted to the electrical grid in the project area for operation of proposed groundwater pumps. This would require increased electrical generation at power plants in the region. The air emissions resulting from this minor increase in power generation dispersed throughout the region would generate negligible impacts. As a result, long-term air quality emissions associated with the proposed project are considered negligible and are not discussed further in this section. The following discussion focuses on the short-term construction-related air quality impacts.

Impact Significance Criteria

- A project would normally be considered to have a significant effect on air quality if the project violates any ambient air quality standard, contributes substantially to an existing air quality violation, or exposes sensitive receptors to substantial pollutant concentrations. Because Maricopa County and the State of Arizona do not have regulatory numerical thresholds in place for pollutants that are more stringent than Federal standards, EPA *de minimis* emission thresholds are used to evaluate potential air quality impacts associated with the project (see the following paragraph for the *de minimis* values).
- If construction of the project would result in non-compliance with the Federal General Conformity Rule (40 CFR Parts 6, 51, and 93) requirements, air quality impacts would be considered significant (see Section 3.5.3, Regulatory Setting for more about the Federal General Conformity Rule). Because the study area is in serious non-attainment of the National Ambient Air Quality Standards for ozone (O_3), carbon monoxide (CO), and suspended particulate matter or fugitive dust (PM_{10}), the General Conformity *de minimis* emission thresholds for O_3 are 50 tons per year for the ozone precursors [nitrogen oxides (NOx) and reactive organic compounds (ROC)], 100 tons per year for CO, and 70 tons per year for PM_{10}. If the total estimated project emissions are above these *de minimis* values, air quality impacts would be considered significant.

5.5.1 Alternative 1 No Action

Under the No Action Alternative 1, existing vegetation would remain and no restoration components would be installed. Therefore, no impacts to air quality would result from the implementation of this alternative, because it would not include construction activities that would generate engine exhaust or fugitive dust emissions.

5.5.2 Alternative 2 Low Water Use

Construction Emissions

The majority of emissions associated with Alternative 2 would be generated from construction activities. Most of the construction activities would be associated with heavy machinery and would take place over the course of approximately three months, assuming 20 workdays a month.

Construction emissions can be distinguished as either on or off site. On-site air pollutant emissions during construction would principally consist of exhaust emissions from heavy-duty diesel- and gasoline-powered construction equipment, as well as fugitive particulate matter from soil disturbed during vegetation clearing and grading/fill operations. Off-site exhaust emissions would result from

workers commuting to and from the job site, as well as from trucks hauling material (e.g., vegetation and fill) to and from the construction sites. A description of the assumptions used in quantifying the total ozone precursor emissions from these sources is described in the following paragraphs.

On-site Construction Emissions. Construction exhaust and fugitive dust emissions were calculated by assuming an estimated fleet mix of equipment from other projects with similar size and type. For this alternative, it was assumed that there would be three active construction fronts. A mixture of on-site equipment including six loaders, one drill rig, one spray truck, one cement mixer, three bulldozers, three chippers, three graders, and ten chain saws are assumed to be used during construction activities.

Exhaust emissions for NOx, ROC, CO, and PM_{10} from on-site construction activities were calculated using published emission factors from California's South Coast Air Quality Management District's (SCAQMD) CEQA Guidelines Air Quality Handbook (SCAQMD, 1993). Equivalent factors have not been published by the State of Arizona or Maricopa County; the SCAQMD factors were used as a conservative alternative. Off-site fugitive dust emissions were calculated using published emission factors from USEPA's AP-42 Compilation of Air Pollutant Emissions Factors (EPA, 1998) and from SCAQMD's CEQA Guidelines Air Quality Handbook. Table 5.5-1 presents the maximum annual fugitive dust emissions and exhaust emissions from on-site construction sources.

Off-site Construction Emissions. Off-site exhaust and fugitive dust emissions would result from approximately 15 workers commuting daily to and from the job site, as well as from trucks hauling material (e.g., fill and vegetation matter) to and from the active project sites. An estimated 16,160 haul trips would be required for this alternative. The majority of the project haul trips would be conducted during a three-month period. Off-site exhaust and fugitive dust emissions were quantified using emission factors from EPA's AP-42. Table 5.5-1 presents the emissions for off-site emission sources. Refer to Appendix L for spreadsheets that list all assumptions used in quantifying the construction emissions associated with Alternative 2.

Table 5.5-1 Estimated Construction Emissions for Alternative 2 (tons/yr)

Source	ROC	NOx	PM_{10}	CO
Onsite Exhaust	2.15	7.25	0.33	7.95
Offsite Exhaust	0.28	1.68	0.08	1.42
Fugitive Dust	---	---	11.95	---
Total	2.43	8.93	12.36	9.37
De Minimis Threshold	50	50	70	100
Exceed the *De Minimis*?	No	No	No	No

Sources: SCAQMD, 1993; EPA, 1998.
Notes: ROC = reactive organic compounds; NOx = nitrogen oxides; PM_{10} = fugitive dust; CO = carbon monoxide.

Impact of Construction Emissions. As presented in Table 5.5-1, estimated project construction emissions for Alternative 2 are below the General Conformity *De Minimis* Thresholds for the subject pollutants. Therefore, impacts associated with project construction emissions would be considered less than significant (Class III) and mitigation measures would not be required.

However, because the project would involve the disturbance of well over ten percent of an acre, the project proponents would be required to obtain an Earth Moving Permit from the Maricopa County Air

Division pursuant to Control Rule 310 (see Section 3.5.3, Regulatory Setting). Stipulations of the permit would require the project proponents to develop a Dust Control Plan to be approved by the County that would outline measures to be incorporated into the project construction plans, such as watering the construction sites twice a day, installing gravel pads at site entrance and exit points, installing wind barriers, maintenance of proper freeboard on haul trucks, etc. In addition, if this alternative would involve the burning of any vegetation material, the project proponent would be required to obtain a Burn Permit from the County Control Officer, pursuant to County Control Rule 314 (see Section 3.5.3, Regulatory Setting).

5.5.3 Alternative 3 Moderate Water Use

The majority of emissions associated with Alternative 3 would be generated from construction activities. Most of the construction activities would be associated with heavy machinery and would take place over the course of approximately four months, assuming 20 workdays a month.

On-Site Construction Emissions. Construction exhaust and fugitive dust emissions were calculated by assuming an estimated fleet mix of equipment from other projects with similar size and type. For this alternative, it was assumed that there would be three active construction fronts. A mixture of on-site equipment including six loaders, one drill rig, one spray truck, one cement mixer, three bulldozers, three chippers, three graders, and ten chain saws are assumed to be used during construction activities. Table 5.5-2 presents the maximum annual exhaust emissions from on-site construction sources.

Off-Site Construction Emissions. Off-site exhaust and fugitive dust emissions would result from approximately 15 workers commuting daily to and from the job site, as well as from trucks hauling material (e.g., fill and vegetation matter) to and from the active project sites. An estimated 13,660 haul trips would be required for this alternative. The majority of the project haul trips would be conducted during a four-month period. Table 5.5-2 presents the emissions for off-site emission sources. Refer to Appendix L for spreadsheets that list all assumptions used in quantifying the construction emissions associated with Alternative 3.

Table 5.5-2 Estimated Construction Emissions for Alternative 3 (tons/yr)

Source	ROC	NOx	PM_{10}	CO
On-site Exhaust	3.10	9.73	0.44	11.40
Off-site Exhaust	0.25	1.43	0.07	1.34
Fugitive Dust	—	—	10.65	—
Total	3.35	11.16	11.16	12.74
De Minimis Threshold	50	50	70	100
Exceed the *De Minimis*?	No	No	No	No

Sources: SCAQMD, 1993; EPA, 1998.
Notes: ROC = reactive organic compounds; NOx = nitrogen oxides; PM_{10} = fugitive dust; CO = carbon monoxide

Impact of Construction Emissions. As presented in Table 5.5-2, estimated project construction emissions for Alternative 3 are below the General Conformity *De Minimis* Thresholds for the subject pollutants. Therefore, impacts associated with project construction emissions would be considered less than significant (Class III) and mitigation measures would not be required.

However, same as with Alternative 2, because the project would involve the disturbance of well over one tenth of an acre, the project proponents would be required to obtain an Earth Moving Permit from the Maricopa County Air Division pursuant to Control Rule 310. In addition, if this alternative would involve the burning of any vegetation material, the project proponents would be required to obtain a Burn Permit from the County Control Officer, pursuant to County Control Rule 314.

5.5.4 Alternative 4 High Water Use

The majority of emissions associated with Alternative 4 would be generated from construction activities. Most of the construction activities would be associated with heavy machinery and would take place over the course of approximately six months, assuming 20 workdays a month.

On-Site Construction Emissions. Construction exhaust and fugitive dust emissions were calculated by assuming an estimated fleet mix of equipment from other projects with similar size and type. For this alternative, it was assumed that there would be three active construction fronts. A mixture of on-site equipment including six loaders, one drill rig, one spray truck, one cement mixer, three bulldozers, three chippers, three graders, and ten chain saws are assumed to be used during construction activities. Fugitive dust emissions would also be generated from the project construction activities. Table 5.5-3 presents the maximum annual exhaust emissions from on-site construction sources.

Off-Site Construction Emissions. Off-site exhaust and fugitive dust emissions would result from approximately 15 workers commuting daily to and from the job site, as well as from trucks hauling material (e.g., fill and vegetation matter) to and from the active project sites. An estimated 26,200 haul trips would be required for this alternative. The majority of the project haul trips would be conducted during a six-month period. Table 5.5-3 presents the emissions for off-site emission sources. Refer to Appendix L for spreadsheets that list all assumptions used in quantifying the construction emissions associated with Alternative 4.

Table 5.5-3 Estimated Construction Emissions for Alternative 4 (tons/yr)

Source	ROC	NOx	PM_{10}	CO
On-site Exhaust	5.74	14.94	0.69	20.73
Off-site Exhaust	0.46	2.73	0.13	2.41
Fugitive Dust	—	—	20.25	—
Total	6.20	17.67	21.07	23.14
De Minimis Threshold	50	50	70	100
Exceed the *De Minimis*?	No	No	No	No

Sources: SCAQMD, 1993; EPA, 1998.
Notes: ROC = reactive organic compounds; NOx = nitrogen oxides; PM_{10} = fugitive dust; CO = carbon monoxide

Impact of Construction Emissions. As presented in Table 5.5-3, estimated project construction emissions for Alternative 4 are below the General Conformity *De Minimis* Thresholds for the subject pollutants. Therefore, impacts associated with project construction emissions would be considered less than significant (Class III) and mitigation measures would not be required.

However, same as with Alternatives 2 and 3, because the project would involve the disturbance of well over one tenth of an acre, the project proponents would be required to obtain an Earth Moving Permit from the Maricopa County Air Division pursuant to Control Rule 310. In addition, if this alternative

would involve the burning of any vegetation material, the project proponent would be required to obtain a Burn Permit from the County Control Officer, pursuant to County Control Rule 314.

5.5.5 Alternative 5 Low Water Use without Riparian Corridor on Western Levee between I-10 and Buckeye Road

Impacts associated with Alternative 5 would be similar to, but less than, Alternative 2 (see assessment of Alternative 2 above). It is assumed that construction associated with Alternative 5 would operate on two fronts. Alternative 5 would result in less than significant impacts and mitigation measures would not be required. However, the project proponents would need to obtain an Earth Moving Permit and a Burn Permit (if applicable) from the County. Refer to Appendix L for spreadsheets that list all assumptions used in quantifying the construction emissions associated with Alternative 5.

5.5.6 Alternative 6 Moderate Water Use without Riparian Corridor on Western Levee between I-10 and Buckeye Road

Impacts associated with Alternative 6 would be similar to, but less than, Alternative 3 (see assessment of Alternative 3 above). It is assumed that construction associated with Alternative 6 would operate on two fronts. Alternative 6 would result in less than significant impacts and mitigation measures would not be required. However, the project proponents would need to obtain an Earth Moving Permit and a Burn Permit (if applicable) from the County. Refer to Appendix L for spreadsheets that list all assumptions used in quantifying the construction emissions associated with Alternative 6.

5.5.7 Alternative 7 High Water Use without Riparian Corridor on Western Levee between I-10 and Buckeye Road

Impacts associated with Alternative 7 would be similar to, but less than, Alternative 4 (see assessment of Alternative 4 above). It is assumed that construction associated with Alternative 7 would operate on two fronts. Alternative 7 would result in less than significant impacts and mitigation measures would not be required. However, the project proponents would need to obtain an Earth Moving Permit and a Burn Permit (if applicable) from the County. Refer to Appendix L for spreadsheets that list all assumptions used in quantifying the construction emissions associated with Alternative 7.

5.5.8 Alternative 8 Low Water Use with Reduced Riparian Corridors, Vegetation Management Areas, and No Development of the Durango Channel Site

Impacts associated with Alternative 8 would be similar to Alternatives 2 and 4. Similar to Alternatives 2 and 4, it is assumed that construction associated with Alternative 8 would operate on three fronts. The duration would extend beyond that associated with Alternative 2 because of the additional area considered near the AWWTP, but it would be less than that of Alternative 4 because of the substantially reduced need for imported fill and the reduced restoration area. Alternative 8 would result in less than significant impacts and mitigation measures would not be required. However, the project proponents would need to obtain an Earth Moving Permit and a Burn Permit (if applicable) from the County. Refer to Appendix L for spreadsheets that list all assumptions used in quantifying the construction emissions associated with Alternative 8.

5.5.9 Cumulative Impacts

The combined effects of the proposed project with other cumulative actions would result in an incremental and cumulative effect to air quality during construction activities. However, these impacts would be reduced once construction is completed. In addition, the proposed project would not exceed the significance threshold criteria for construction or operational emissions. As a result the project would not contribute to a significant cumulative air quality impact.

Proposed Environmental Commitments

AQ-1 The Construction contractor shall obtain an Earth Moving Permit from the Maricopa County Air Division and develop a dust control plan. The project sponsors are responsible for ensuring compliance with this measure.

5.6 SOCIOECONOMICS

Impact Significance Criteria

In accordance with NEPA, the effects of a project are evaluated to determine if they would result in a significant adverse impact on the environment. This DPR focuses on the potential environmental effects of the alternatives, and offers environmental commitments to reduce or avoid any significant impacts. The alternatives would have a significant adverse impact on the socioeconomic environment if they cause the following:

- A labor shortage during construction in which project hiring exceeded the local availability of unemployed construction labor. Any decrease in unemployment in the region would be considered beneficial.
- A substantial long-term decrease in local employment due to direct loss of jobs or an adverse effect on the local economy that results in an indirect long-term loss of jobs.
- A shortage of temporary housing during project construction caused by construction workers seeking local accommodations that prevents normal users from being able to obtain temporary housing in the area. Temporary housing would include motels, hotels, campgrounds, RV parks, dormitories, and similar lodging.
- A substantial increase in demand for permanent housing
- Temporary or permanent disruption or displacement of local business. Beneficial impacts would occur if local businesses sell goods or services to construction contractors, or if some long-term increase in business activity is realized as a result of the proposed project.
- A decrease in public tax revenues. Any increase in public revenues would be considered beneficial.
- Disproportionately high and adverse impacts on minorities, low-income residents, or children.

5.6.1 Alternative 1 No Action

The No Action Alternative would not result in any changes to the socioeconomic conditions of the study area, and no beneficial improvement of scenic resources would occur. Currently the river channel is a highly degraded natural environment that provides minimal aesthetic value. Throughout much of the study area, the channel is dominated by weedy plant species and the presence of soil-cement levees. Currently, the river channel does not significantly enhance the socioeconomic value of the area.

Under the No Action Alternative, there would be no decrease in tax revenue or housing availability, relative to the project. There would be no increase in demands on public housing, educational facilities or fire/police protection services. No adverse socioeconomics impacts would occur.

5.6.2 Alternative 2 Low Water Use

Construction

Project construction would create temporary jobs for a small number of construction workers and tradesmen involved in constructing the restoration sites and features, including the protective berms and groundwater wells. The existing skilled and unskilled labor pool in the Avondale area could readily accommodate this new construction project and, therefore, there would be no inducement for workers to migrate to the area. As a result, project construction would not induce employment or population growth and would not create a demand for new housing in the region.

Operations

Alternative 2 would not directly induce population growth, and would not create any permanent new jobs. As a result, the project would not significantly affect local population or employment characteristics in the immediate area or the region, nor does it directly or indirectly entail the construction or demolition of any housing. The project would likely benefit the area by improving the scenic resources from surrounding roadways, residences, recreational areas and commercial areas. The restoration areas may attract more recreational users to the site, bringing a small level of tourism business to nearby stores. The project would not reduce local tax revenue, but would rather provide incidental benefits.

Impacts on Minority Populations, Low-income Populations, or Children. Since Alternative 2 would not cause any adverse significant, unmitigable environmental impacts, there would be no potential for disproportionate adverse environmental effects of the project on minority populations, low-income populations, or children. The project would not result in any degradation of socioeconomic conditions for minority populations, low-income populations, or children, but rather would improve the aesthetic, recreational and economic condition of the study area and surrounding land uses.

Ownership. A large portion of the proposed restoration area is owned by public agencies other than the City of Avondale and the FCDMC and a small portion near the AWWTP is privately owned. As part of the Agua Fria Restoration Project, the Corps and/or the local sponsor will contact the respective landowners regarding the use, exchange, or purchase of their properties for restoration purposes. The Corps and/or the local sponsor will negotiate the acquisition of the property or the right to use the property, which will ensure existing landowners are compensated for any losses. Other easements may be required during the construction or maintenance phases of the project, and these easements would also have to be acquired from existing landowners. Existing easements unrelated to the project would also be reviewed to ensure that the conditions of the easements are not significantly altered by construction or operation of the restoration project.

Since the project would not significantly affect local population, housing, or employment characteristics in the immediate area or the region, there would be no long-term, adverse socioeconomic impacts associated with Alternative 2 and no environmental commitments are proposed.

5.6.3 Alternative 3 Moderate Water Use

Under Alternative 3, the total restoration area would be greater than Alternative 2. Impacts and benefits would be very similar to Alternative 2. Since Alternative 3 would not significantly affect local population, housing, or employment characteristics of the immediate area or the region, there would be no long-term, adverse socioeconomic impacts associated with Alternative 3.

5.6.4 Alternative 4 High Water Use

Under Alternative 4, the total restoration area would be notably greater than Alternatives 2 and 3. Since Alternative 4 would not significantly affect local population, housing, or employment characteristics of the immediate area or the region, there would be no long-term, adverse socioeconomic impacts associated with Alternative 4

5.6.5 Alternative 5 Low Water Use without Riparian Corridor on Western Levee between I-10 and Buckeye Road

Impacts associated with Alternative 5 would be similar to, but less than, Alternative 2. Please see Alternative 2. Alternative 5 would not result in any significant adverse socioeconomic impacts.

5.6.6 Alternative 6 Moderate Water Use without Riparian Corridor on Western Levee between I-10 and Buckeye Road

Impacts associated with Alternative 6 would be similar to, but less than, Alternative 3. Please see Alternative 3. Alternative 6 would not result in any significant adverse socioeconomic impacts.

5.6.7 Alternative 7 High Water Use without Riparian Corridor on Western Levee between I-10 and Buckeye Road

Impacts associated with Alternative 7 would be similar to, but less than, Alternative 4. Please see Alternative 4. Alternative 7 would not result in any significant adverse socioeconomic impacts.

5.6.8 Alternative 8 Low Water Use with Reduced Riparian Corridors, Vegetation Management Areas, and No Development of the Durango Channel Site

Socioeconomic impacts associated with Alternative 8 would be similar to Alternative 2. Alternative 8 would not significantly affect local population, housing, or employment characteristics of the immediate area or the region, there would be no long-term, adverse socioeconomic impacts associated with Alternative 8.

5.6.9 Cumulative Effects

No adverse cumulative socioeconomic effects would result from the alternatives. Since no full time permanent jobs or housing units would be created or displaced, the alternatives would not contribute to any significant changes to the socioeconomic landscape of the area.

Although a few temporary jobs would be generated by the brief construction phase, and long-term maintenance the alternatives would have no significant long-term cumulative impact on the labor market in the Avondale area. Since the number of construction workers and equipment that would be required for the alternatives would be relatively small, the existing skilled labor pool in the Avondale area could readily accommodate this new construction project and, therefore, there would be no inducement for the migration of workers to the area. If there was a need for additional construction labor or equipment, there would be the construction labor pool of the entire greater Phoenix area to draw upon (within commuting distance of the study area), which could provide more than enough labor capacity. As a result, project construction would not induce employment or population growth and would not create a demand for new housing or public services in the region. No adverse cumulative socioeconomic impacts would result.

5.7 CULTURAL RESOURCES

Impact Significance Criteria

Section 106 of the National Historic Preservation Act states that any Federal agency engaging in an undertaking is required to take into account the effects of the undertaking on properties that are included in or eligible for inclusion in the National Register of Historic Places (NRHP). The guidelines for this procedure are found in 36 CFR 800: Protection of Historic Properties, and 36 CFR 60: The National Register of Historic Places. If a cultural resource is included in or is eligible for inclusion in the NRHP, it is then considered to be a historic property.

In accordance with the National Historic Preservation Act and 36 CFR Part 800.5(a)(1), impacts to cultural resources are considered significant if one or more of the following conditions would result from implementation of one of the alternatives:

- Physical destruction, damage, or alteration of all or part of a historical property
- Alteration of a historical property including restoration rehabilitation, repair, maintenance, stabilization, hazardous material remediation, and provision of handicapped access, that is not consistent with the Secretary's Standards for the Treatment of Historic Properties (36 CFR Part 68) and applicable guidelines
- Removal of a historical property from its historic location
- Change of the character of a historical property's use or of physical features within the property's setting that contribute to its historic significance
- Introduction of visual, atmospheric, or audible elements that diminish the integrity a historical property's significant historic features
- Neglect of a historical property that causes its deterioration, except where such neglect and deterioration are recognized qualities of a property of religious and cultural significance to an Indian Tribe organization

- Transfer, lease, or sale of a historical property out of Federal ownership or control without adequate and legally enforceable restrictions or conditions to ensure long-term preservation of the property's historic significance.

5.7.1 Alternative 1 No Action

Under the No Action Alternative, no new restoration areas would be established within the study. Without the implementation of the project, no construction activities would occur in the river channel related to this project, and therefore, no potential construction impacts would result. No cultural resources would be significantly impacted.

5.7.2 Alternative 2 Low Water Use

The Corps performed a qualified archeological investigation of the area. The results of that investigation are presented in the Cultural Resources section of this report. The Corps has also contacted and reviewed concurrence from the Arizona State Historic Preservation Officer regarding its findings (see Appendix C). Investigations were conducted over the last two years for Agua Fria River Watercourse Master Plan for cultural resources along the Agua Fria River, between the Waddell Dam and the Gila River, for the Flood Control District of Mariposa County (FCDMC, 2001a). The proposed restoration project area is within the boundary of the above investigations. Although there are recorded historic and prehistoric resources on terraces adjacent to the river, there are no recorded sites within the Area of Potential Effects (APE) of the proposed project.

Based on the Corps' record search and archeological surveys, no cultural resources are located in the study area. Alternative 2 would not affect a National Register of Historical Places (NRHP) listed or eligible property. However, in the event that a previously unknown cultural resource site is discovered during project construction, implementation of Environmental Commitment CR-1 would ensure the avoidance of any significant effects.

Proposed Environmental Commitments

CR-1 If evidence of subsurface cultural resources is found during construction, all excavation and other construction activity in the area shall cease. A Corps archeologist shall evaluate the findings in consultation with the Arizona State Historic Preservation Officer regarding eligibility for the National Resister of Historic Places, in accordance with Federal laws and regulations.

With the implementation of CR-1, Alternative 2 would not result in any significant adverse cultural resources impacts.

5.7.3 Alternative 3 Moderate Water Use

Under Alternative 3, the total restoration area would be greater than Alternative 2. In addition to the restoration corridors along the east and west levees between McDowell Road and Buckeye Road, there would be a restoration area south of Lower Buckeye Road, on the east side of the channel. The restoration areas would be sheltered by protective berms, which would be constructed either of soil-

cement or a modified structure that included more natural features, such as plantings among the riprap. Three groundwater wells would be constructed for irrigation, located south of the I-10 and Van Buren Street, on the east side of the eastern levee, and south of Lower Buckeye Road, on the east side of the levee.

Cultural resource impacts would be similar to Alternative 2. Alternative 3 would not affect any known registered or proposed historical properties. With the implementation of CR-1, Alternative 3 would not result in any significant adverse cultural resources impacts.

5.7.4 Alternative 4 High Water Use

Under Alternative 4, the total restoration area would be greater than Alternative 2 and Alternative 3. In addition to the restoration corridors along the east and west levees between McDowell Road and Buckeye Road, there would be restoration areas added south of Buckeye Road and Lower Buckeye Road, on the east side of the channel and vegetation management areas in the interior of the channel where no structural modifications would take place. The restoration areas would be sheltered by protective berms, which would be constructed either with soil-cement or modified structure that included more natural-appearing features, such as plantings among the riprap. Five groundwater wells would be constructed for irrigation, located as needed on the east side of the levee. This alternative maximizes the amount of restoration areas that could be added without compromising the current SPF protection of the channel.

Cultural resource impacts would be similar to Alternative 2 and Alternative 3. Alternative 4 would not affect any known registered or proposed historical properties. With the implementation of CR-1, Alternative 4 would not result in any significant adverse cultural resources impacts.

5.7.5 Alternative 5 Low Water Use without Riparian Corridor on Western Levee between I-10 and Buckeye Road

Impacts associated with Alternative 5 would be similar to, but less than, Alternative 2. With implementation of CR-1 Alternative 5 would not result in any significant land use impacts.

5.7.6 Alternative 6 Moderate Water Use without Riparian Corridor on Western Levee between I-10 and Buckeye Road

Impacts associated with Alternative 6 would be similar to, but less than, Alternative 3. Please see Alternative 3. With implementation of CR-1 Alternative 6 would not result in any significant land use impacts.

5.7.7 Alternative 7 High Water Use without Riparian Corridor on Western Levee between I-10 and Buckeye Road

Impacts associated with Alternative 7 would be similar to, but less than, Alternative 4. Please see Alternative 4. With implementation of CR-1 Alternative 7 would not result in any significant land use impacts.

5.7.8 Alternative 8 Low Water Use with Reduced Riparian Corridors, Vegetation Management Areas, and No Development of the Durango Channel Site

With implementation of Environmental Commitment CR-1, Alternative 8 would not result in any significant cultural resources impacts.

5.7.9 Cumulative Effects

None of the alternatives would result in adverse cumulative cultural resource impacts. The USACE has conducted a thorough archeological investigation and determined that no cultural resources are located in the study area. None of the alternative would affect a National Register of Historical Places (NRHP) listed or eligible property. Therefore, none of the proposed alternatives would cumulatively add to the degradation of cultural resources in the area or the region.

5.8 HAZARDOUS MATERIALS

Impact Significance Criteria

In accordance with NEPA, the effects of a project are evaluated to determine if they would result in a significant adverse impact on the environment. This DPR focuses on the potential environmental effects of the alternatives, and offers environmental commitments to reduce or avoid any significant impacts. The alternatives would have a significant adverse impact on the environment if they meet any of the criteria listed below.

- Result in soil contamination that exceeds Federal hazardous waste limits established by 40 CFR 261
- Involve construction activities that could mobilize contaminants currently existing in the soil, creating potential pathways of exposure to humans or wildlife
- Expose workers and/or the public to contaminated or hazardous materials that would exceed permissible exposure levels set by Federal OSHA in Title 29 CFR Part 1910
- Result in an increase in the generation of hazardous substances that would require disposal at regional landfill and/or treatment facilities.

5.8.1 Alternative 1 No Action

Under the No Action Alternative, no new restoration areas would be established within the study area. Without implementation of the project, no construction activities would occur in the river channel related to this project, and therefore, no potential construction or operational impacts would result. No hazardous material impacts would result. Riparian and wetland vegetation is capable of filtering and sequestering some contaminants like metals or excess nutrients in biomass. Roots and organic matter in the soil also help to bind organic contaminants. The lack of vegetation cover under current conditions will likely persist into the future, suggesting that the system is and will not be capable of performing this function to any extent.

5.8.2 Alternative 2 Low Water Use

Alternative 2 would involve the revegetation and restoration of portions of the Agua Fria River between McDowell Road and the Gila River confluence, using a low water use scenario. Currently, the river

channel within the study area has minimal to moderate vegetation and is dominated by soil cement levees between McDowell Road and Buckeye Road. Alternative 2 would locate riparian corridors along the east and west side of the existing soil cement levees between the I-10 and Buckeye Road, each extending at least 80 feet into the channel. The restoration corridors would improve the quantity and quality of natural habitat in the channel and would screen the existing soil cement levees. Two constructed elements are part of Alternative 2: a small berm that would run parallel to the existing soil cement levees for the purposes of protecting the restoration corridors; and two groundwater wells, which would be used for establishing and sustaining the restoration sites (located as necessary along the eastern side of the channel).

Construction

During project construction, various hazardous substances (e.g., fuel, hydraulic fluids, and lubricants) would need to be stored at the construction site for operation and minor maintenance of construction equipment. The major activities involving heavy equipment are earth moving, establishment of protective berms and ground water well drilling. An accidental spill or release of hazardous substances associated with these activities could contaminate the soil. However because the construction period requiring earth moving activities and the use of heavy equipment would likely be coincident with the driest season of the year, migration of any contaminants to surface waters and groundwater is unlikely. Nevertheless, the risk of contamination to soil and water resources does exist, and an accidental spill or release of these substances would be considered a significant impact. Implementation of Environmental Commitment HW-1 would reduce effects to less than significant levels.

In addition herbicides will be used on site for invasive, exotic species control. The herbicides will either be applied with back sprayers, or trucks for covering large areas. The use of herbicides presents a potential risk not only to the user, but humans and wildlife within the affected area or adjacent to the application area within the channel. Implementation of Environmental Commitment HW-2 would be intended to prevent and reduce these risks to less than significant levels.

Existing Contamination

A query of the EPA Hazardous Waste Sites list for Maricopa County, Arizona, revealed four Superfund sites (one of which was on the National Priority List [NPL]) within the general vicinity of the project area, as presented in Table 3.8-1 of this report. These sites are discussed below under ground water contamination.

The former Avondale Landfill was located north of Buckeye Road on the western portion of the river. Based on the as-built plans, a portion of the landfill extended into the river area and was relocated and the area was converted to the Coldwater Park. Based on historical aerial photographs, it appears that much of the project area was used for sand and gravel operations and subsequently filled. Based on ADEQ information and the FirstSearch report, there are no registered underground storage tanks (USTs) or leaking underground storage tanks (LUSTs) within the project area; however, USTs are registered for properties adjacent to the project area.

Based on historical agricultural and urban land use activities, impacts to soil sediments in the study area is possible by DDT by-products, such as DDE and/or other pesticides, such as toxaphene. Although sediment samples taken near the I-10 drainage (Papago Diversion Channel) were negative for pesticides (see Water Resources Section 5.3), such problems have been cited for the Gila River.

It is possible that grading, excavation, and/or debris removal associated with Alternative 2 could disturb areas of previously undetected contamination, potentially exposing workers to unsafe levels of hazardous substances. In addition, prior sand and gravels operations, the unknown source of sand and gravel operation fill material, and possible pesticides (including DDT, DDT by-products, and toxaphene) could represent a significant impact. However, implementation of Environmental Commitments HW-3, HW-4 and WR-5 would avoid any potentially significant effects related to existing soil contamination.

Generation of Hazardous Substances. The proposed restoration alternatives would not result in the generation of any hazardous substances.

Groundwater Contamination. Sites presenting groundwater contamination within the general vicinity of the project area are presented in Table 3.8-1. The Goodyear Dry Cleaners site is located slightly less than a mile to the west, and the Phoenix-Goodyear Municipal Airport is located approximately 1.5 miles to the west. The remaining two facilities, the Liberty Substation and Faith Cooperage, are approximately 12 miles to the west and downgradient from the site. Based upon information obtained from Arizona Department of Environmental Quality, it appears that the study area has not been impacted from these off-site facilities, due to the distance and groundwater flow direction. A study completed by the City of Avondale for recharge ponds located immediately north of McDowell Road concluded that the recharge facilities and pumping would not affect or be impacted by contaminant plumes originating in these sites (Integrated Water Technologies, 1997).

Proposed Environmental Commitments

HW-1 Contractors shall have an accidental spill prevention and response plan in place for all hazardous materials that may be used on site. In the event of a spill or release of hazardous substances at the construction site, the contaminated soil shall be immediately contained, excavated and treated per Federal and State regulations developed by the EPA, ADEQ, ADWR, as well as local hazardous waste ordinances.

HW-2 Only trained licensed contractors or personnel will participate in the application of herbicides. Such personnel shall adhere to regulations and guidelines for the safe application of herbicides, including, but not limited to, storage and handling of materials, operation of application equipment, suitable climatic conditions for application, and avoidance of sensitive receptors. Back spraying equipment should be sufficient to cover most areas; however, trained personnel will evaluate the use of truck sprayers where larger areas need to be covered. Large-scale application techniques will not be used if site conditions (e.g., climate, topography and proximity to residences, etc.) are not adequate.

HW-3 Prior to conducting earth-moving activities in areas that overlap with historical sand and gravel operations, a geophysical survey shall be completed to determine the location, extent, and type of fill material used upon closure of the sand and gravel operations. Prior to conducting earth moving, soil sampling and testing of areas of proposed earth moving activities shall also be completed to determine whether pesticides have contaminated the soil. If testing indicates that contamination does exist, the materials shall be removed and disposed of according to applicable Federal and State regulations.

HW-4 During construction, should an area of suspected contamination be encountered, construction activity in the area shall cease and soil sampling shall be conducted to determine the nature and extent of the potential contamination. If testing indicates that contamination does exist, the area shall be cleaned up in accordance with applicable Federal and State regulations.

5.8.3 Alternative 3 Moderate Water Use

Under Alternative 3, the total restoration area would be greater than Alternative 2. In addition to the restoration corridors along the east and west levees between McDowell Road and Buckeye Road, there would be a restoration area south of Lower Buckeye Road, on the east side of the channel. Construction of the restoration corridors is the same as that proposed under Alternative 2. Three groundwater wells would be constructed for irrigation, located south of the I-10 and Van Buren Street, on the east side of the eastern levee, and south of Lower Buckeye Road, on the east side of the levee.

The potential for accidental spills or releases of hazardous materials impact would be slightly greater for Alternative 3 than Alternative 2 since it would require construction over a slightly larger area and longer period of time. This would result in a greater potential for hazardous substance spills and/or the disturbance of areas of previously undetected contamination. However, with the implementation of Environmental Commitments HW-1, HW-2, HW-3, and HW-4, the potential for these impacts would be less than significant. Therefore, Alternative 3 would not result in a significant hazardous materials impact.

5.8.4 Alternative 4 High Water Use

Under Alternative 4, the total restoration area would be much greater than Alternative 2 and Alternative 3. In addition to the restoration corridors along the east and west levees between McDowell Road and Buckeye Road, there would be a restoration area added south of Buckeye Road and Lower Buckeye Road, on the east side of the channel, as well as vegetation management areas at I-10, Durango Channel at Buckeye Road and the AWWTP. Construction of the riparian corridors is the same as that considered under Alternatives 2 and 3 as described in Section 4 of this report. Five groundwater wells would be constructed for irrigation, located as needed on the east side of the levee. This alternative maximizes the amount of restoration areas that could be added without compromising the current SPF protection of the channel.

The potential for a hazardous materials impact would be greater for Alternative 4 than Alternative 2 or Alternative 3 since it would require more extensive construction. This would result in a greater potential for hazardous substance spills and/or the disturbance of areas of previously undetected

contamination. However, with the implementation of Environmental Commitments HW-1 through HW-4, the potential for these impacts would be less than significant. Therefore, Alternative 4 would not result in a significant hazardous materials impact.

5.8.5 Alternative 5 Low Water Use Without Riparian Corridor on Western Levee between I-10 and Buckeye Road

Impacts associated with Alternative 5 would be similar to, but less than, Alternative 2 (see assessment of Alternative 2 above). With implementation of Environmental Commitments HW-1 to HW-4 Alternative 5 would not result in any significant adverse hazardous materials impacts.

5.8.6 Alternative 6 Moderate Water Use without Riparian Corridor on Western Levee Between I-10 and Buckeye Road

Impacts associated with Alternative 6 would be similar to, but less than, Alternative 3 (see Alternative 3 above). With implementation of Environmental Commitments HW-1 to HW-4 Alternative 6 would not result in any significant adverse hazardous materials impacts.

5.8.7 Alternative 7 High Water Use without Riparian Corridor on Western Levee Between I-10 and Buckeye Road

Impacts associated with Alternative 7 would be similar to, but less than, Alternative 4 (see Alternative 4 above). With implementation of Environmental Commitments HW-1 to HW-4 Alternative 7 would not result in any significant adverse hazardous materials impacts.

5.8.8 Alternative 8 Low Water Use with Reduced Riparian Corridors, Vegetation Management Areas, and No Development of the Durango Channel Site

Alternative 8 is similar to Alternative 2 except for (1) the reduction in length of the riparian corridors on the east and west levees near the I-10 site, (2) the addition of Vegetation Management Areas north of the I-10 and near the Avondale Wastewater Treatment plant site, and (3) the absence of any restoration activities around the Durango Channel / Buckeye Road site in order to avoid any potential impacts associated with the 10,000-foot exclusion zone of the Goodyear Airport. Construction and operation impacts associated with Alternative 8 would be similar to, but less than, Alternative 2, except for the addition of the Vegetation Management Areas, which are associated with Alternative 4.

With implementation of Environmental Commitments HW-1 through HW-4, Alternative 8 would not result in any significant hazardous materials impacts.

5.8.9 Cumulative Effects

The proposed alternatives would not contribute to a cumulative increase in hazardous materials or the potential for contamination from such materials. Any potential disruption of contaminated soils would be mitigated prior to construction and any hazardous substance spill would be quickly and thoroughly cleaned up. With the exception of bridge improvements within the channel, there are no similar activities that will occur within the project site during the construction period. Also, the groundwater

pumping is not expected to affect any known contaminant plumes (see Environmental Commitment WR-3). No cumulative hazardous materials impact would result.

5.9 NOISE

The proposed project would not involve extensive long-term operational activities. Long-term operational noise would result from equipment and vehicles associated with periodic minor maintenance activities within and immediately adjacent to the channel of the Agua Fria River. In addition, the project would involve installation of two to five groundwater wells that would require electrical pumps. The groundwater pumps would be placed inside brick or wooden enclosures that significantly reduce audible noise outside of the shelters. Noise levels associated with active pumping adjacent to the proposed well pump enclosures would be negligible (Avondale, 2002d). As a result, long-term noise levels associated with the proposed project are considered to be less than significant (Class III) and are not discussed further in this section. The following discussion focuses on the short-term construction-related noise impacts.

Impact Significance Criteria

There are two criteria for judging noise impacts. First, noise levels projected for the planned project must comply with the relevant Federal, State, or local standards or regulations. Mitigation of noise impacts on worker safety and health is enforced by OSHA, but effectiveness depends on the vigilance of supervisors in seeing that workers use protective gear in high noise environments. The City of Avondale does not have any noise standards or regulations that would directly pertain to the Proposed Action. However, noise impacts to the surrounding community are handled by nuisance complaints to the City of Avondale Police Department, which are subsequently investigated.

The second measure of impact recognized by noise analysts is the increase in noise levels above the existing ambient level as a result of the introduction of a new source of noise. A change in noise level due to a new noise source can create an impact on people. The degree of impact is hard to assess because of the highly subjective character of individuals' reactions to changes in noise. Empirical studies have shown people begin to notice changes in environmental noise levels of around five dBA (EPA, 1974). Thus, average changes in noise levels less than five dBA cannot be definitively considered as producing an adverse impact. For changes in noise levels above five dBA, it is difficult to quantify the impact beyond the obvious: the greater the noise level change, the greater the impact. A judgment commonly used in community noise impact analyses associates long-term noise increases of 5 to 10 dBA with "some impact." Noise level increases of more than 10 dBA are generally considered severe. In the case of short-term noise increases, such as those from construction, the 10 dBA threshold between "some" and "severe" impact is often replaced with a criterion of 15 dBA. These noise-averaged thresholds are to be lowered when the noise level fluctuates, or the noise has an irritating character with considerable high frequency energy, or if it is accompanied by subsonic vibration. In these cases, the impact must be individually estimated.

For this analysis, impacts would be considered significant if:

- Adopted Federal, State, or local standards, noise elements, or ordinances would be exceeded in noise level, timing, or duration
- The project would increase the ambient noise level above ordinance-specified limits for the land use zoning
- An increase in noise levels of 15 dB or more would occur over a period of at least two work-days at a sensitive receptor with any ambient noise level; permanent increases of 5 dB would also be significant
- Noise increase increments to the ambient that are as low as 5 dB would be significant if they occur during quieter hours at night (between 10 p.m. and 7 a.m.); there is no precise threshold as the character of the noise is also important.

5.9.1 Alternative 1 No Action

Under No Action Alternative, existing vegetation would remain and no restoration components would be installed. Therefore, no impacts to the ambient noise environment would result from the implementation of this alternative because it would not include construction or operational activities that would generate noise.

5.9.2 Alternative 2 Low Water Use

On-site Noise Sources. On-site noise during construction activities would occur primarily from heavy-duty diesel- and gasoline-powered equipment, such as dozers, front-end loaders, graders, chippers, and chainsaws that would operate on three simultaneous construction fronts. Noise levels from these pieces of equipment range from 75 dBA to 90 dBA at a distance of 15 meters (approximately 50 feet), and 57 dBA to 72 dBA at a distance of 122 meters (approximately 400 feet).

It should be noted that noise originating from construction activities within the channel would be at a lower elevation than surrounding receptors and would be partially blocked and absorbed by the levees. Residential areas are also set back from the levees by at least 50 feet and some of these communities also have privacy walls. Both features will attenuate noise coming from the channel. In addition, although construction associated with Alternative 2 is anticipated to last for approximately three months, construction noise would not be expected to impact any one receptor for more than approximately one week because much of the construction activities would proceed in a linear fashion.

Off-Site Noise Sources. Off-site noise during construction would occur primarily from worker trips and from various truck trips to and from the construction sites. It is estimated that a maximum of 15 workers would need to commute to and from the project sites five days a week over a three-month period. In addition, trucks hauling materials (e.g., vegetation and soil matter) to and from the project sites would generate adverse off-site noise levels. It is estimated that approximately 16,160 haul trips (approximately 90 trips per workday at each construction front for an estimated 60 workdays) would be needed to transport vegetation matter, fill material, and supplies to and from the project sites.

Trucks would enter and exit the project area from various streets that dead-end adjacent to the channel. In the project area, hauling would be conducted along a cleared path within the riverbed, or along the access roads on the top of the levees. Out of the project area, trucks would follow routes that would be approved by the City of Avondale prior to the start of construction. Routes would be planned to reduce

excessive noise levels at sensitive and residential receptors by as much as possible. The peak noise levels associated with passing trucks and commuting worker vehicles would be approximately 60 to 75 dBA at 50 feet.

Construction

Temporary noise levels at sensitive and residential receptors immediately adjacent to the on-site construction areas and off-site haul routes would be substantially higher than the current ambient noise levels in the study area. Noise levels described above would be potentially significant, but would be reduced to less than significant levels with the implementation of Environmental Commitments N-1 through N-5, described below.

Environmental Commitments

N-1 Construction contractor will provide at least 72-hour advance notice at the commencement of construction to all sensitive receptors and residences adjacent to the project construction areas, including haul routes. The announcement shall state specifically where and when construction will occur. Notices shall provide tips on reducing noise intrusion, for example, by closing windows facing the planned construction areas.

N-2 Construction contractor shall establish a toll-free telephone number for dealing with public concerns/complaints about noise and other project-related issues. The notice issued (refer to Environmental Commitment N-1) shall advertise the contact telephone number.

N-3 Construction contractor will maintain properly functioning mufflers on all internal combustion and vehicle engines used during construction to reduce noise to the maximum feasible extent.

N-4 Construction contractor will monitor construction noise levels to ensure compliance with the noise ordinance. In the event of complaints by nearby residents or receptors, the contractor will monitor noise from the construction activity to ensure that construction noise does not exceed limits specified by the project's significance criteria. Measurements shall be conducted at adjacent residential uses. In the event that construction noise exceeds the specified limits, appropriate measures will be implemented to limit noise to acceptable levels.

N-5 If necessary, on a case by case basis, the construction contractor shall install temporary noise curtains along the construction perimeter adjoining noise sensitive land uses.

5.9.3 Alternative 3 Moderate Water Use

Most of the construction activities associated with Alternative 3 would be associated with heavy machinery and would take place over the course of approximately four months, assuming 20 workdays a month.

On-site Noise Sources. Similar to Alternative 2, on-site noise generated during construction activities associated with Alternative 3 would occur primarily from heavy-duty diesel- and gasoline-powered equipment that would operate on three simultaneous construction fronts. Noise levels from these pieces of equipment range from 75 dBA to 90 dBA at a distance of 15 meters (approximately 50 feet), and 57

dBA to 72 dBA at a distance of 122 meters (approximately 400 feet). However, noise originating from construction activities within the channel would be at a lower elevation than surrounding receptors and would be partially blocked and absorbed by the levees and that although construction associated with Alternative 3 is anticipated to last for approximately four months, it is anticipated that construction noise would not impact any one receptor for more than approximately one week.

Off-Site Noise Sources. Off-site noise generated during construction of Alternative 3 would occur primarily from workers and from various truck trips to and from the construction sites. It is estimated that a maximum of 15 workers would need to commute to and from the project sites five days a week over a four-month period. In addition, trucks hauling materials (e.g., vegetation and soil matter) to and from the project sites would generate adverse off-site noise levels. Approximately 13,660 haul trips (approximately 57 trips per work day at each construction front for an estimated 80 workdays) would be needed to transport vegetation matter, fill material, and supplies to and from the project sites for this alternative. Routes would be planned to reduce excessive noise levels at sensitive and residential receptors by as much as possible. The peak noise levels associated with passing trucks and commuting worker vehicles would be approximately 60 to 75 dBA at 50 feet.

Impact of Construction Noise. Temporary noise levels at sensitive and residential receptors immediately adjacent to the on-site construction areas and off-site haul routes would be substantially higher than the current ambient noise levels in the study area. Although construction noise levels would last for approximately one month longer than those associated with Alternative 2 and off-site average noise levels associated with haul trips would be slightly lower with Alternative 3 compared to Alternative 2 because of reduced amount of trips, noise impacts would essentially be the same as those described for Alternative 2. Noise impacts associated with Alternative 3 would be potentially significant, but would be reduced to less than significant levels with the implementation of Environmental Commitments N-1 through N-5.

5.9.4 Alternative 4 High Water Use

Most of the construction activities associated with Alternative 4 would be associated with heavy machinery and would take place over the course of approximately six months, assuming 20 workdays a month.

On-Site Noise Sources. Similar to Alternatives 2 and 3, on-site noise during construction activities would occur primarily from heavy-duty diesel- and gasoline-powered equipment that would operate on three simultaneous construction fronts. Noise levels from these pieces of equipment range from 75 dBA to 90 dBA at a distance of 15 meters (approximately 50 feet), and 57 dBA to 72 dBA at a distance of 122 meters (approximately 400 feet). However, noise originating from construction activities within the channel would be at a lower elevation than surrounding receptors and would be partially blocked and absorbed by the levees and that although construction associated with Alternative 4 is anticipated to last for approximately six months, it is anticipated that construction noise would not impact any one receptor for more than approximately one or two weeks.

Off-Site Noise Sources. Off-site noise during construction of Alternative 4 would occur primarily from worker trips and from various truck trips to and from the construction sites. It is estimated that a maximum of 15 workers would need to commute to and from the project sites five days a week over a six-month period. In addition, trucks hauling materials (e.g., vegetation and soil matter) to and from the project sites would generate adverse off-site noise levels. There would be approximately 26,200 haul trips (approximately 73 trips per work day at each construction front for an estimated 120 workdays) associated with Alternative 4 that would be needed to transport vegetation matter, fill material, and supplies to and from the project sites. Routes would be planned to reduce excessive noise levels at sensitive and residential receptors by as much as possible. The peak noise levels associated with passing trucks and commuting worker vehicles would be approximately 60 to 75 dBA at 50 feet.

Impact of Construction Noise. Temporary noise levels at sensitive and residential receptors immediately adjacent to the on-site construction areas and off-site haul routes would be substantially higher than the current ambient noise levels in the study area. It is anticipated that noise levels associated with Alternative 4 would be audible at receptor locations for approximately twice the duration of those associated with Alternatives 2 and 3. Noise impacts associated with Alternative 4 would be potentially significant, but would be reduced to less than significant levels with the implementation of Environmental Commitments N-1 through N-5.

5.9.5 Alternatives 5, 6, and 7 - Alternatives 2, 3, and 4 without Western Riparian Strip

Impacts associated with Alternatives 5, 6, and 7 would be slightly less than their counterparts, Alternatives 2, 3, and 4 (see the assessments of Alternatives 2, 3, and 4 above) because they would include only limited construction activities on the western levee. However, similar to Alternatives 2, 3, and 4, construction noise impacts would be considered potentially significant, but mitigable to levels that are less than significant with implementation of Environmental Commitments N-1 through N-5.

5.9.6 Alternative 8 Low Water Use with Reduced Riparian Corridors, Vegetation Management Areas, and No Development of the Durango Channel Site

Alternative 8 is similar to Alternative 2 except for (1) the reduction in length of the riparian corridors on the east and west levees near the I-10 site, (2) the addition of Vegetation Management Areas north of the I-10 and near the Avondale Wastewater Treatment plant site, and (3) the absence of any restoration activities around the Durango Channel / Buckeye Road site in order to avoid any potential impacts associated with the 10,000-foot exclusion zone of the Goodyear Airport. Construction and operation impacts associated with Alternative 8 would be similar to, but less than, Alternative 2, except for the addition of the Vegetation Management Areas, which are associated with Alternative 4.

With implementation of Environmental Commitments N-1 to N-5, Alternative 8 would not result in any significant noise impacts.

5.9.7 Cumulative Impacts

The cumulative increase in ambient noise levels in the project area as a result of the implementation of the proposed project would temporarily increase the ambient noise levels in the area. However, due to

the short-term nature of the construction activities and the lack of significant operational noise that would be associated with the proposed project, significant cumulative noise impacts would not occur.

5.10 LAND USE AND RECREATION

Impact Significance Criteria

In accordance with NEPA, the effects of a project are evaluated to determine if they would result in a significant adverse impact on the environment. This DPR focuses on the potential environmental effects of the alternatives, and offers mitigation measures to reduce or avoid any significant impacts. The alternatives would have a significant adverse impact on the environment if they meet any of the criteria listed below.

- Cause an incompatibility with local General Plan or Zoning designations
- Cause long-term disturbances or incompatibilities that would significantly diminish the quality and character of a particular land use
- Permanently preclude a permitted use because of unmitigated project noise, dust, public health hazard or nuisance, traffic, or visual impacts
- Disrupt or divide the physical arrangement of an established community
- Degrade or displace existing recreational facilities
- Permanently disrupt existing recreational activities
- Temporarily cause the closure of a recreational facility.

5.10.1 Alternative 1 No Action

Under the No Action Alternative, no new restoration areas would be established within the study area and the beneficial improvements to local scenic resources would not occur. No adverse land use or recreation impacts would occur.

5.10.2 Alternative 2 Low Water Use

General Plan and Zoning Compliance

Current City of Avondale General Plan and Zoning designations along each side of the river channel are a mixture of low- to high-density residential, commercial, and mixed-use zones. The river channel itself is designated by the City of Avondale General Plan as Open Space, which would be consistent with the use of restoration sites. The river channel does not have a specific Zoning Code designation (City of Avondale, 2002a-d). The FCDMC has use and maintenance easements over the entire 100-year floodplain of the Agua Fria river channel, and it owns a portion of the study area. The County of Maricopa does not have any designated land uses or zoning uses for areas between McDowell Road and Buckeye Road but there are pockets of unincorporated areas within the channel south of Buckeye Road. These are designated Rural 43, which restricts use to agricultural or single-family homes, with a one-acre minimum lot size (Stelling, 2002). The restoration project would be consistent with the Rural 43 designation (Stelling, 2002). Unincorporated areas are located in Township 1 North, Range 1 West, Section 14; Township 1 North, Range 1 West, Section 33; and Township 1 North, Range 1 West, Section 127.

Construction and Operation

Since Alternative 2 would not change any established land use activities along the river channel, no land use impacts are anticipated during ongoing operation of the restoration sites. Alternative 2 would not permanently preclude a permitted use or a particular land use from unmitigated project noise, dust, public health hazard or nuisance, traffic, or visual impacts. The restoration project would provide long-term visual resources benefit to the area and would not resultant in any significant, permanent environmental impacts.

During the short period of project construction, nearby residents and other sensitive receptors may experience some temporary negative visual and noise impacts. However, given the temporary nature of these impacts, and the existing ambient noise levels in the area (from existing roadways and sand-and-gravel operations), these impacts would not be significant. There are no other significant, unmitigated impacts that would affect nearby land uses during construction.

Large portions of the proposed restoration areas for this alternative are owned by public agencies other than the City of Avondale and the FCDMC, primarily ADOT and the State of Arizona. As part of the Agua Fria Restoration Project, the Corps and/or the local sponsor would contact the respective landowners regarding the use, exchange, or purchase of their properties for restoration purposes. The Corp and/or the local sponsor will negotiate the acquisition of the property or the right to use the property, which would ensure existing landowners are compensated for any losses. Temporary easements for the sole purpose of access may be required during the construction or maintenance phases of the project. These easements would also have to be acquired from existing landowners. Conversely if utility easements will be affected by the project, the parties to the easements will be notified to ensure consistent compliance with the terms of such agreements.

Recreation Activities and Facilities

Alternative 2 would not permanently disrupt, degrade, or displace an existing recreational facility. Construction activities may cause temporary noise or aesthetic impacts to recreationists, but these impacts would be short-lived and less than significant. Unregulated use of off-road vehicles in river channel would be discouraged in restoration areas, but this would not cause an adverse recreation impact since these activities are not currently endorsed by the City of Avondale or FCDMC. The project would not result in the inflow of temporary or permanent residents, nor would it directly or indirectly result in the construction of new housing in the area. Therefore, there would be no increased demand on existing recreational facilities because of this project.

Recreational activities within the study area would be enhanced by the improved aesthetic value of the area, particularly in the northern portion of the study area. This increased recreational value would not significantly increase demand on existing recreational facilities, but rather would increase the recreational experience of current and new recreationists.

Alternative 2 would not result in any long-term land use disturbances or incompatibilities, or diminish the character of any existing land uses. Alternative 2 is consistent with the applicable local plans and policies. Alternative 2 would not permanently disrupt, degrade or displace an existing recreational

facility. The beneficial visual effects of Alternative 2 would improve the quality of adjacent land uses and recreational facilities. No significant adverse impacts would occur.

5.10.3 Alternative 3 Moderate Water Use

Alternative 3 would establish more restoration areas within the study area than Alternative 2. The increased restoration area size would require more extensive construction, which might increase temporary noise or visual construction impacts for recreationists. However, these impacts would be temporary and not significant in nature. The increased restoration area size may require more land rights to be purchased from private or public landowners. However, this would not represent a significant land use impact since the landowners would be compensated for any loss of property or use.

Alternative 3 would not result in any long-term land use disturbances or incompatibilities, or diminish the character of any existing land uses. Alternative 3 is consistent with the applicable local plans and policies. Alternative 3 would not permanently disrupt, displace or degrade an existing recreational facility or activity. The beneficial visual effects of Alternative 3 would improve the quality of adjacent land uses and recreational facilities. No significant adverse impacts would occur.

5.10.4 Alternative 4 High Water Use

Alternative 4 would establish more restoration areas within the study area than any of the other alternatives. The increased size of the restoration area would require more extensive construction, which might increase temporary noise or visual construction impacts for recreationists. However, these impacts would be temporary and not significant in nature. The increased restoration area size may require more land rights to be purchased from private or public landowners. For example, the vegetation management area near the AWWTP effluent discharge coincides with property in the channel owned by a sand and gravel interest. Use of this area, as well as other areas located on private or public lands is obviously contingent on the ability to acquire such lands from the landowner. However, this would not represent a significant land use impact since the landowners would be compensated for any loss of property or use.

Alternative 4 would not result in any long-term land use disturbances or incompatibilities, or diminish the character of any existing land uses. Alternative 4 is consistent with the applicable local plans and policies. Alternative 4 would not permanently disrupt, displace or degrade an existing recreational facility or activity. The beneficial visual effects of Alternative 4 would improve the quality of adjacent land uses and recreational facilities. The visual benefits would be extended along the greatest segment of the channel under this alternative. No significant negative impacts would occur.

5.10.5 Alternative 5 Low Water Use Without Riparian Corridor on Western Levee between I-10 and Buckeye Road

Impacts associated with Alternative 5 would be similar to, but less than, Alternative 2. Please see Alternative 2. Alternative 5 would not result in any significant adverse land use impacts.

5.10.6 Alternative 6 Moderate Water Use without Riparian Corridor on Western Levee between I-10 and Buckeye Road

Impacts associated with Alternative 6 would be similar to, but less than, Alternative 3. Please see Alternative 3. Alternative 6 would not result in any significant adverse land use impacts.

5.10.7 Alternative 7 High Water Use without Riparian Corridor on Western Levee between I-10 and Buckeye Road

Impacts associated with Alternative 7 would be similar to, but less than, Alternative 4. Please see Alternative 4. Alternative 7 would not result in any significant adverse land use impacts.

5.10.8 Alternative 8 Low Water Use with Reduced Riparian Corridors, Vegetation Management Areas, and No Development of the Durango Channel Site

Alternative 8 is similar to Alternative 2 except for (1) the reduction in length of the riparian corridors on the east and west levees near the I-10 site, (2) the addition of Vegetation Management Areas north of the I-10 and near the Avondale Wastewater Treatment plant site, and (3) the absence of any restoration activities around the Durango Channel/Buckeye Road site in order to avoid any potential impacts associated with the 10,000-foot exclusion zone of the Goodyear Airport. Construction and operation impacts associated with Alternative 8 would be similar to, but less than, Alternative 2, except for the addition of the Vegetation Management Areas, which are also part of Alternative 4.

Alternative 8 would not result in any long-term land use disturbances or incompatibilities, or diminish the character of any existing land uses. Alternative 8 is consistent with the applicable local plans and policies. Alternative 8 would not permanently disrupt, displace or degrade an existing recreational facility or activity. The beneficial visual effects of Alternative 8 would improve the quality of adjacent land uses and recreational facilities. The visual benefits would be extended along the greatest segment of the channel under this alternative. No significant negative impacts would occur.

5.10.9 Cumulative Effects

No adverse cumulative land use or recreation effects would result from the proposed alternatives. Due to the small, expected increase in recreation use, the impacts on recreational facilities in the surrounding area would be negligible. The City of Avondale multi-use trail that is planned to connect Friendship Park with Coldwater Park would benefit from the improved scenic resources of proposed alternatives. Some minor disruption to land use and recreation activities may occur during construction, buy these disruptions would be less than significant and would end with the termination of the brief construction phase. No negative significant cumulative adverse land use impacts would occur. Rather this project along with similar restoration projects in the area would have a positive impact on the quality of adjacent residential or commercial land use and recreational facilities.

5.11 PUBLIC HEALTH AND SAFETY

Impact Significance Criteria

In accordance with NEPA, the effects of a project are evaluated to determine if they would result in a significant adverse impact on the environment. This DPR focuses on the potential environmental effects of the alternatives, and offers environmental commitments to reduce or avoid any significant impacts.

Each of the project alternatives would employ standard construction practices that would meet State of Arizona Title 36 Public Health and Safety statutes, and Federal Occupational Safety and Health Administration (OSHA) Standards of Construction (29 CFR Part 1926). Therefore, the analysis below focuses on potential effects associated with flooding and public health and safety. A review of the flood control reliability of the channel can be found in the Water Resources section of this analysis and Appendix I.

The proposed project would cause a significant impact if an unauthorized release of a hazardous material and/or waste resulted in the exposure of people to a risk of contamination beyond acceptable levels or exposure to public safety threats. Such levels are defined by applicable laws and regulations (hazardous waste action levels, etc.) and relevant planning documents. A description of the potential hazardous materials impacts of this project can be found in Section 5.8 of this report.

An alternative would be considered to have a significant impact on public health and safety if it caused the following:

- The exposure of construction workers to hazardous materials and/or waste encountered during construction
- The exposure of the public to an increased threat of flooding related accidents and deaths
- An increase in mosquito breeding habitat and subsequent exposure of individuals to disease and discomfort from an increase in the mosquito population.

5.11.1 Alternative 1 No Action

Under the No Action Alternative, no new restoration areas would be established within the study. No public health and safety impacts would be created or increased if the project were not implemented.

5.11.2 Alternative 2 Low Water Use

Alternative 2 would involve the revegetation and restoration of portions of the Agua Fria River between McDowell Road and the Gila River confluence, using a low water use scenario. Alternative 2 would locate riparian corridors along the east and west side of the existing soil cement levees between the I-10 and Buckeye Road, extending approximately 80 to 100 feet into the channel. The restoration corridors would improve the quantity and quality of natural habitat in the channel and would screen the existing soil cement levees. Two constructed elements are part of Alternative 2: a protective berm that would run parallel to the existing soil cement levees for the purposes of protecting the restoration corridors, and two groundwater wells, which would be used for establishing and sustaining the restoration sites.

Construction

The majority of construction would be undertaken during the dry season. Periodic inspection and maintenance in the channel will be required following storm events; however, any activities would be undertaken with appropriate consideration of weather conditions according to the Environmental Commitment PS-1 to ensure that neither equipment nor personnel are at risk from floodwaters.

No authorized recreational activities currently occur within the river channel, and no recreational facilities are located therein. Alternative 2 has been designed such that it would not jeopardize the flood control capacity of the channel. Therefore, no recreational facility or activity within or adjacent to the flood channel would be subjected to a higher level of flood risk as a result of Alternative 2. However, the habitat created in the channel, in addition to locally constructed recreational facilities, may attract more people to the channel that may be at risk during infrequent, but significant flood events. Appropriate measures will be taken to inform recreational users in adjacent areas (see PS-2).

Hazardous Materials Exposure. Under normal operating conditions, construction workers would not be exposed to hazardous materials that would be detrimental to their health. However, in the event of any accidental hazardous material spills, the contaminated areas would be cleaned up rapidly and thoroughly, as described by Environmental Commitments HW-1, HW-3, and HW-4. Environmental Commitment PS-3 will ensure that the health and safety of construction workers would not be compromised during such an event.

Mosquito Control. Alternative 2 would not result in the creation of new open water habitat in the area. Thus, it would not cause an increase in mosquito breeding habitat. Releases of ground water would try to mimic natural flows and the low flow channel would be relatively narrow with sandy bottoms and filled with coarse material to avoid formation of standing surface water without impeding flow: a design that is not conducive to the development of mosquitoes. However some minor alterations to the topography of the restoration areas may be required after project implementation to ensure there are no puddles forming, which would be a part of the project's long-term maintenance (PS-4). If some mosquito development does occur, it should be in patches that could be easily controlled, since the restoration areas do not entail large areas of shallow-ponded surface water.

With implementation of PS-1, PS-2, and PS-3, adverse impacts to public health and safety would be reduced to less than significant levels.

Proposed Environmental Commitments

PS-1 Transportation agencies, as well as local public works and safety agencies, should be notified of any major scheduled and unscheduled maintenance of the restoration site during periods subject to flood events. Such maintenance will be defined and planned so as not to present a risk to structures or personnel in the channel during flood events, and will consist only of activities that cannot be postponed until the non-flood season.

PS-2 Warnings will be incorporated into educational signs to advise observers of the restoration area not to enter into the channel, especially during flood events.

PS-3 The City of Avondale and the Flood Control District of Maricopa County shall ensure that any and all hazardous waste spills are removed promptly and thoroughly. During such a cleanup period, construction workers and all other unauthorized people will be restricted from the contaminated area until it is thoroughly remediated.

PS-4 The restoration site shall be monitored for the formation of standing water that may serve as a breeding area for mosquitoes that may pose a health risk. The project has been designed to reduce or eliminate this risk; however, if post-construction monitoring indicates this is not the case, then alternate design or control measures will be implemented.

5.11.3 Alternative 3 Moderate Water Use

Potential impacts associated with Alternative 3 would be the same as Alternative 2. With implementation of PS-1 to PS-4, adverse impacts to public health and safety would be reduced to less than significant levels.

5.11.4 Alternative 4 High Water Use

Potential impacts associated with Alternative 4 would be the same as Alternative 2. With implementation of PS-1, PS-2, and PS-3, adverse impacts to public health and safety would be reduced to less than significant levels.

5.11.5 Alternative 5 Low Water Use without Riparian Corridor on Western Levee between I-10 and Buckeye Road

Impacts associated with Alternative 5 would be similar to, but less than, Alternative 2. Please see Alternative 2. With implementation of PS-1 to PS-4 Alternative 5 would not result in any significant land use impacts.

5.11.6 Alternative 6 Moderate Water Use without Riparian Corridor on Western Levee between I-10 and Buckeye Road

Impacts associated with Alternative 6 would be similar to, but less than, Alternative 3. Please see Alternative 3. With implementation of PS-1 to PS-4 Alternative 6 would not result in any significant land use impacts.

5.11.7 Alternative 7 High Water Use without Riparian Corridor on Western Levee between I-10 and Buckeye Road

Impacts associated with Alternative 7 would be similar to, but less than, Alternative 4. Please see Alternative 4. With implementation of PS-1 to PS-4 Alternative 7 would not result in any significant land use impacts.

5.11.8 Alternative 8 Low Water Use with Reduced Riparian Corridors, Vegetation Management Areas, and No Development of the Durango Channel Site

Alternative 8 is similar to Alternative 2 except for (1) the reduction in length of the riparian corridors on the east and west levees near the I-10 site, (2) the addition of Vegetation Management Areas north of the I-10 and near the Avondale Wastewater Treatment plant site, and (3) the absence of any restoration activities around the Durango Channel/Buckeye Road site in order to avoid any potential impacts associated with the 10,000-foot exclusion zone of the Goodyear Airport. Construction and operation impacts associated with Alternative 8 would be similar to, but less than, Alternative 2, except for the addition of the Vegetation Management Areas, which are also part of Alternative 4.

With implementation of Environmental Commitments PS-1, PS-2, and PS-3, Alternative 8 would not result in any significant, adverse impacts to public health and safety.

5.11.9 Cumulative Effects

The proposed alternatives have been designed such that they would not jeopardize the flood control capacity of the channel. No sponsored recreational activities currently occur within the river channel, and no recreational facilities are located therein. No increased exposure to hazardous materials would result, nor would there be a significant increase in local mosquito populations. Therefore, the proposed alternatives would not result in any cumulatively significant public health and safety concerns.

5.12 PUBLIC UTILITIES AND SERVICES

Impact Significance Criteria

In accordance with NEPA, the effects of a project are evaluated to determine if they would result in a significant adverse impact on the environment. This DPR focuses on the potential environmental effects of the alternatives, and offers environmental commitments to reduce or avoid any significant impacts. The alternatives would have a significant adverse impact on the environment if they caused any of the following actions:

- Increase the need for additional capacity of existing facilities, including water, sewer, storm water drainage, solid waste, natural gas, electrical power, and telephone service
- Decrease existing levels of fire and/or police protection services
- Result in the need for new, altered or expanded educational facilities
- Result in an interruption of utility service.

5.12.1 Alternative 1 No Action

Under the No Action Alternative, no new restoration areas would be established within the study area. Without the implementation of the project, no construction activities would occur in the river channel related to this project, and therefore, no potential construction impacts would result. No public utilities and services would be significantly impacted.

5.12.2 Alternative 2 Low Water Use

Construction and Operation

Alternative 2 would not result in any increase in the permanent population of the surrounding area, the temporary in-migration of construction workers, or the construction of any new industrial, commercial, or residential buildings. As a result, no new demands on existing public utility facilities, sewer, stormwater drainage, solid waste, natural gas, electrical power, and/or telephone service would occur. There would be an increased use of groundwater in the immediate vicinity of the channel, sufficient enough to sustain vegetation. However, the construction and operation of the wells and ground water use would be subject to permitting and evaluation by the ADWR and the City of Avondale (see PU-1 below) that would ensure that no significant adverse impacts occur to other permitted users.

Police and Fire Protection. Alternative 2 would not result in any increase in the permanent population of the surrounding area, the temporary in-migration of construction workers, or the construction of any new industrial, commercial or residential buildings. As a result, Alternative 2 would not decrease existing police or fire protection services. In fact, reestablishment of native vegetation and augmentation of water for vegetation in the channel would reduce the fire hazard associated with many non-native grasses.

Educational Facilities. Alternative 2 would not result in any increase in the permanent population of the surrounding area, the temporary in-migration of construction workers, or the construction of any new industrial, commercial or residential buildings. The proposed project would not bring any more children to the area, or reduce the use of existing school facilities. As a result, Alternative 2 would not require any new or expanded school facilities.

Interruption of Service. Sewer and water identified in this report intersect the general study area. Underground gas and aboveground transmission lines also intersect the channel (exact location pending from COA and/or FCDMC); however, presently it is anticipated that all lines will be avoided and no relocation or interruption of service will be necessary. However, if interruption of utility service occurs, it would be considered a significant impact. In order to avoid this potential impact, Environmental Commitments PU-2 and PU-3 (below) are proposed.

Environmental Commitments

PU-1 Construction and operation of ground water wells shall be subject to the approval and conditions established by the ADWR and City of Avondale.

PU-2 The Flood Control District of Maricopa County shall coordinate with the City of Avondale and the appropriate utility agencies to identify all utility lines that may be affected by project construction.

PU-3 If relocation of utility lines is required, the Flood Control District of Maricopa County shall coordinate relocation actions with the City of Avondale and the appropriate utility agencies. Relocation actions shall be done in conjunction with the construction contract for the project.

The Flood Control District of Maricopa County and the City of Avondale shall be responsible for coordinating with the utility providers to notify local residents of any disruption of services.

With the adoption of Environmental Commitments PU-1 through PU-3, no significant adverse public utilities and services impacts would result from the implementation of Alternative 2. A small public services benefit may result from the replacement of native vegetation and addition of surface water, which would help to reduce fire hazards in the channel.

5.12.3 Alternative 3 Moderate Water Use

The potential for public utilities and services impacts would be similar for Alternative 3 as Alternative 2. With the adoption of Environmental Commitments PU-1 through PU-3, no significant adverse public utilities and services impacts would result.

5.12.4 Alternative 4 High Water Use

Under Alternative 4, the total restoration area would be greater than Alternative 2 and Alternative 3. In addition to the restoration corridors along the east and west levees between McDowell Road and Buckeye Road, there would be restoration areas added south of Buckeye Road and Lower Buckeye Road, on the east side of the channel and vegetation management areas in the interior of the channel where no structural modifications would take place. The restoration areas would be sheltered by protective berms, which would be constructed either with soil-cement or modified structure that included more natural-appearing features, such as plantings among the riprap. Five groundwater wells would be constructed for irrigation, located as needed on the east side of the levee. This alternative maximizes the amount of restoration areas that could be added without compromising the current SPF protection of the channel.

The potential for public utilities and services impacts would be similar for Alternative 4 as Alternative 2. With the adoption of Environmental Commitments PU-1 through PU-3, no significant adverse public utilities and services impacts would result.

5.12.5 Alternative 5 Low Water Use without Riparian Corridor on Western Levee between I-10 and Buckeye Road

Impacts associated with Alternative 5 would be similar to, but less than, Alternative 2. Please see Alternative 2. With implementation of PU-1 to PU-3 Alternative 5 would not result in any significant land use impacts.

5.12.6 Alternative 6 Moderate Water Use without Riparian Corridor on Western Levee between I-10 and Buckeye Road

Impacts associated with Alternative 6 would be similar to, but less than, Alternative 3. Please see Alternative 3. With implementation of PU-1 to PU-3 Alternative 6 would not result in any significant land use impacts.

5.12.7 Alternative 7 High Water Use without Riparian Corridor on Western Levee between I-10 and Buckeye Road

Impacts associated with Alternative 7 would be similar to, but less than, Alternative 4. Please see Alternative 4. With implementation of PU-1 to PU-3 Alternative 7 would not result in any significant land use impacts.

5.12.8 Alternative 8 Low Water Use with Reduced Riparian Corridors, Vegetation Management Areas, and No Development of the Durango Channel Site

Alternative 8 is similar to Alternative 2 except for (1) the reduction in length of the riparian corridors on the east and west levees near the I-10 site, (2) the addition of Vegetation Management Areas north of the I-10 and near the Avondale Wastewater Treatment plant site, and (3) the absence of any restoration activities around the Durango Channel/Buckeye Road site in order to avoid any potential impacts associated with the 10,000-foot exclusion zone of the Goodyear Airport. Construction and operation impacts associated with Alternative 8 would be similar to, but less than, Alternative 2, except for the addition of the Vegetation Management Areas, which are associated with Alternative 4.

With implementation of Environmental Commitments PU-1, PU-2, and PU-3, Alternative 8 would not result in any significant, adverse impacts to public utilities.

5.12.9 Cumulative Effects

The alternatives would not result in any cumulatively significant public utilities and services impacts. The alternatives would not result in any increase in the permanent population of the surrounding area, the temporary in-migration of construction workers, or the construction of any new industrial, commercial, or residential buildings. Therefore, the alternatives would not add to any regional demand for public utilities, educational facilities, or fire/police protection. No significant adverse impacts would result.

5.13 AESTHETICS

Impact Significance Criteria

The criteria used to assess the significance of impacts on aesthetics within the study area are based the potential of the alternatives to cause impacts related to scenic resources, views, vistas or features of cultural or historical significance. The following would be considered significant impacts if the project caused the following:

- Substantially degrade or obstruct views of important scenic resources within the study area
- Substantially degrade or obstruct views of a ridgeline visible from a designated scenic resource area, hiking/riding trails, or designated/eligible scenic highway
- Permanently degrade a scenic feature that is rare or unique in the region, or is highly valued for its cultural or historical significance
- Substantially degrade the natural environmental character of local cities, communities, or the region as a whole

- Temporarily disturb or obstruct views of important scenic resources, from scenic resource areas depicted, hiking/riding trails, or designated/eligible scenic highways
- Create changes that would generate new and objectionable sources of light and glare
- Create changes that would add significantly to a cumulative visual alteration.

5.13.1 Alternative 1 No Action

Under the No Action Alternative, no new restoration areas would be established within the study area and the beneficial improvements to local scenic resources would not occur. Under this scenario, the soil cement levees would continue to be a visually unappealing attribute within the channel from viewing areas such as I-10, Buckeye Road, Friendship Park and Coldwater Park and from adjacent residential areas. The river channel would continue to be degraded environmental habitat with limited aesthetic value. No adverse impacts would result.

5.13.2 Alternative 2 Low Water Use

Alternative 2 would involve the revegetation and restoration of portions of the Agua Fria River between McDowell Road and the Gila River confluence, using a low water use scenario. Currently, the river channel within the study area has minimal to moderate vegetation and is dominated by soil cement levees between McDowell Road and Buckeye Road. Alternative 2 would locate riparian strips along the east and west side of the existing soil cement levees between the I-10 and Buckeye Road, each extending approximately 80 feet into the channel. The restoration corridors would improve the quantity and quality of natural habitat in the channel and would screen the existing soil cement levees.

Two types of constructed elements are part of Alternative 2: a protection berm that would run parallel to the existing soil cement levees for the purposes of protecting the riparian strips, and two groundwater wells, which would be used for establishing and sustaining the restoration sites (located as necessary along the eastern side of the channel). The protective berm would not improve the visual attributes of the area, but it would be smaller and substantially less visually obtrusive than the existing soil-cement levees. Reasonable steps would be taken to hide the protective berm visually by using materials that have a more natural look, such as vegetated riprap. Grasses or other shallow-rooted vegetation would be planted on the berm, reducing it conspicuousness. Therefore, the net effect of the protective berm with the addition of the restoration areas would be a highly beneficial one. The groundwater wells would be constructed with an inconspicuous design in areas that would not be highly visible, and therefore, would not significantly degrade the existing visual qualities of the area.

Aesthetic Impact on Northern Portion of the Study Area. The northern portion of the study area (north of Buckeye Road) is currently developed with urban and residential uses, and therefore has a scarcity of natural, native vegetation areas such as would be established by Alternative 2. The northern portion of the study area also has the most viewers from existing roadways, parks and trails, and these viewers would benefit from the improved scenic value of the channel. The restoration areas would shield the aesthetically unappealing, existing soil cement levees and would significantly improve views of the Agua Fria River from the I-10, Buckeye Road, Van Buren Street, Friendship Park, Coldwater

Park, and other nearby side streets or walking areas. In addition, the restoration would improve the views from a planned multi-use trail that would connect Friendship Park and Coldwater Park, along the top of the western levee.

Aesthetic Impact on Southern Portion of the Study Area. Visual attributes of the southern portion of the study area would not be significantly improved by Alternative 2. No restoration areas would be located south of Buckeye Road. However, an exotic, weedy species removal program would be initiated for portions of the river south of Buckeye Road. The exotic species removal would remove several large tamarisk trees, near Buckeye Road and the Avondale Wastewater Treatment Plant, as well as a number of other exotic species. Some minor disruption to the visual quality of the area may occur during the removal process, but this impact would be temporary and less-than-significant. Removal of exotic species would be more than offset by replanted native vegetation. Removal of several tamarisk trees would alter views but this change would not be significantly adverse since significantly more native cottonwoods, palo-verde and other trees that would be added in their place.

Construction

Construction equipment would likely create short-term, temporary visual impacts during the construction phase from localized dust plumes. Removal of exotic species would also create some bare patches in the channel where vegetation currently exists. Nonetheless, construction activities would be short-lived (approximately three to four months to complete the entire construction and revegetation) and would not significantly impact existing scenic resources, which are generally very degraded and of little aesthetic value.

Operations

Operational impacts would be very minor. Periodic weed removal and minor maintenance activities of the protection berms would be required to maintain the restoration areas. These operational activities would be temporary in nature and would not create a significant visual impact.

Scenic Resources. Alternative 2 does not significantly degrade views from any designated scenic areas or obstruct views of any scenic resources. Alternative 2 does not permanently degrade any rare or unique scenic features, nor substantially degrade the character of the surrounding community. Alternative 2 would not generate new and objectionable sources of light and glare, nor create changes that would add to cumulative visual alteration to the area.

In general, Alternative 2 would substantially improve the visual quality of the area by adding natural habitat in a highly developed urban area that lacks natural settings. Alternative 2 improves views of the channel from all roads that cross the Agua Fria River within the northern portion of the study area, as well as from existing parks and trails. Since Alternative 2 would result in a beneficial change to the scenic qualities of the area and would not impair public views of designated scenic resources, no significant, long-term impacts to the scenic qualities of the area would result from project implementation. Rather, Alternative 2 would have a beneficial effect on the visual resources of the area river channel and surrounding areas.

5.13.3 Alternative 3 Moderate Water Use

Under Alternative 3, the total restoration area would be greater than Alternative 2. In addition to the restoration corridors associated with Alternative 2, a restoration area would be added just south of Lower Buckeye Road, on the east side of the channel. Alternative 3 would require the construction of an additional well near Lower Buckeye Road and another protective berm. Otherwise, the type and scale of construction activities would be very similar to Alternative 2.

Alternative 3 would improve the scenic resources of the channel south of the I-10. Currently, this area has minimal to moderate vegetation cover and is dominated by soil cement levees between McDowell Road and Buckeye Road. The restoration areas would shield the aesthetically unappealing soil cement levees and would significantly improve views of the Agua Fria River from the I-10, Buckeye Road, Van Buren Street, Friendship Park, Coldwater Park, and other nearby side streets or walking areas. In addition, the restoration would improve the views from a planned walking trail that would connect Friendship Park and Coldwater Park, along the top of the western levee.

Construction impacts from Alternative 3 would be slightly greater than Alternative 2 because the latter covers a smaller area. However, construction activities would still be temporary and would not significantly degrade the aesthetic quality of the area. Visual impacts involved with the removal of existing non-native vegetation would be minimal, and would be more than offset by the increased vegetation of the restoration areas. Impacts would be less than significant.

The exotic species removal would remove several large tamarisk trees, near Buckeye Road and the Avondale Wastewater Treatment Plant, as well as a number of other exotic species. Some minor disruption to the visual quality of the area may occur during the removal process, but this impact would be temporary and less-than-significant. Removal of exotic species would be more than offset by replanted native vegetation. Removal of several tamarisk trees would alter views but this change would not be significantly adverse since significantly more native cottonwoods, palo verde and other trees that would be added in their place.

Alternative 3 would result in even a greater beneficial improvement to the scenic qualities of the area than Alternative 2. In addition, Alternative 3 does not significantly degrade views from any designated scenic areas or obstruct views of any scenic resources. Alternative 3 does not permanently degrade any rare or unique scenic features, nor substantially degrade the character of the surrounding community. Alternative 3 would not generate new and objectionable sources of light and glare, nor create changes that would add to cumulative visual alteration to the area. Therefore, since Alternative 3 would result in a beneficial change to the scenic qualities of the area and would not impair public views of designated scenic resources, no significant, long-term, adverse impacts to the scenic qualities of the area would result from project implementation. Rather, Alternative 3 would have a beneficial effect on the visual resources of the area river channel and surrounding areas.

5.13.4 Alternative 4 High Water Use

Alternative 4 would involve the revegetation and restoration of the greatest area of the Agua Fria River between McDowell Road and the Gila River confluence. Currently, the river channel within the study area has minimal to moderate vegetation and is dominated by soil cement levees between McDowell Road and Buckeye Road. This alternative extends restoration areas along the greatest length of the 5.5-mile project reach and occupies the maximum total area that is possible without affecting the SPF condition. These restoration areas would be located in narrow riparian corridors along (1) the east and west side of the existing soil cement levees between the I-10 and Buckeye Road, (2) south of Buckeye Road along the eastern levee, and (3) south of Lower Buckeye Road along leveed and unleveed portions of the eastern channel to south of the Avondale Wastewater Treatment Plan. Vegetation management areas would be added north of I-10 and south of Buckeye Road. These areas would involve the addition of water and the removal of exotic species, but not any construction or the addition of any protective structures. Otherwise, the type and scale of construction activities would be very similar to Alternative 2 and Alternative 3.

Alternative 4 would improve the scenic resources of the channel south of the I-10 more than any of the other alternatives. Currently, this area has minimal vegetation cover, except in areas receiving ephemeral or perennial inputs of effluent or drainage and is dominated by soil cement levees between McDowell Road and Buckeye Road. The restoration areas would shield the aesthetically unappealing soil cement levees and would significantly improve views of the Agua Fria River from the I-10, Buckeye Road, Van Buren Road, Friendship Park, Coldwater Park, and other nearby side streets or walking areas. In addition, the restoration would improve the views from a planned walking trail that would connect Friendship Park and Coldwater Park, along the top of the western levee.

Construction impacts would be greater than Alternative 2 and 3 because the riparian strips extend further along the east side under this alternative. However, the disturbance would still be temporary (earth moving and well construction activities would take up to three months) and would not permanently or significantly degrade the aesthetic quality of the area. Visual impacts involved with the removal of existing non-native vegetation would be minimal, and would be more than offset by the increased vegetation of the restoration areas. Impacts would be less than significant.

The exotic species removal would remove several large tamarisk trees, near Buckeye Road and the Avondale Wastewater Treatment Plant, as well as a number of other exotic species. Some minor disruption to the visual quality of the area may occur during the removal process, but this impact would be temporary and less-than-significant. Removal of exotic species would be more than offset by replanted native vegetation. Removal of several tamarisk trees would alter views but this change would not be significantly adverse since significantly more native cottonwoods, palo verde and other trees that would be added in their place.

Alternative 4 would result in even a greater beneficial improvement to the scenic qualities of the area than Alternative 2 and Alternative 3. In addition, Alternative 4 does not significantly degrade views from any designated scenic areas or obstruct views of any scenic resources. Alternative 4 does not

permanently degrade any rare or unique scenic features, nor substantially degrade the character of the surrounding community. Alternative 4 would not generate new and objectionable sources of light and glare, nor create changes that would add to cumulative visual alteration to the area. Therefore, since Alternative 4 would result in a beneficial change to the scenic qualities of the area and would not impair public views of designated scenic resources, no significant negative impacts to the scenic qualities of the area would result from project implementation. Rather, Alternative 4 would have a beneficial effect on the visual resources of the area river channel and surrounding areas.

5.13.5 Alternative 5 Low Water Use without Riparian Corridor on Western Levee between I-10 and Buckeye Road

Impacts associated with Alternative 5 would be similar to, but less than, Alternative 2. Please see Alternative 2. Alternative 5 would not result in any significant adverse aesthetics impacts.

5.13.6 Alternative 6 Moderate Water Use without Riparian Corridor on Western Levee between I-10 and Buckeye Road

Impacts associated with Alternative 6 would be similar to, but less than, Alternative 3. Please see Alternative 3. Alternative 6 would not result in any significant adverse aesthetics impacts.

5.13.7 Alternative 7 High Water Use without Riparian Corridor on Western Levee between I-10 and Buckeye Road

Impacts associated with Alternative 7 would be similar to, but less than, Alternative 4. Please see Alternative 4. Alternative 7 would not result in any significant adverse aesthetics impacts.

5.13.8 Alternative 8 Low Water Use with Reduced Riparian Corridors, Vegetation Management Areas, and No Development of the Durango Channel Site

Alternative 8 is similar to Alternative 2 except for (1) the reduction in length of the riparian corridors on the east and west levees near the I-10 site, (2) the addition of Vegetation Management Areas north of the I-10 and near the Avondale Wastewater Treatment plant site, and (3) the absence of any restoration activities around the Durango Channel/Buckeye Road site in order to avoid any potential impacts associated with the 10,000-foot exclusion zone of the Goodyear Airport. Construction and operation impacts associated with Alternative 8 would be similar to, but less than, Alternative 2, except for the addition of the Vegetation Management Areas, which are also part of Alternative 4.

Alternative 8 would result in a beneficial improvement to the scenic qualities of the area. In addition, Alternative 8 does not significantly degrade views from any designated scenic areas or obstruct views of any scenic resources. Alternative 8 does not permanently degrade any rare or unique scenic features, nor substantially degrade the character of the surrounding community. Alternative 8 would not generate new or objectionable sources of light and glare, nor create changes that would add to cumulative visual alteration to the area. Therefore, since Alternative 8 would result in a beneficial change to the scenic qualities of the area and would not impair public views of designated scenic resources, no significant negative impacts to the scenic qualities of the area would result from project implementation. Rather,

Alternative 8 would have a beneficial effect on the visual resources of the area river channel and surrounding areas.

5.13.9 Cumulative Effects

The alternatives would reintroduce native vegetation areas, which would improve the scenic attributes of the study area. Construction impacts would be temporary and less than significant. None of the alternatives would add to the cumulative scenic degradation of the area, rather would improve the scenic resources of the area in conjunction with similar projects in the region, this project would have a cumulative beneficial aesthetic effect. No adverse visual impacts are associated with any of the alternatives. No significant negative cumulative aesthetic impacts would occur.

5.14 TRANSPORTATION

The proposed project would not involve extensive long-term operational activities. Long-term operational activities that could potentially affect the transportation system in the project area would be limited to commuting worker trips associated with periodic maintenance activities within and immediately adjacent to the channel of the Agua Fria River. As a result, long-term transportation impacts associated with the proposed project are considered to be less than significant (Class III) and are not discussed further in this section. The following discussion focuses on the short-term construction-related transportation impacts.

Impact Significance Criteria

An impact would be considered significant if any of the following would occur:

- A major roadway (arterial or collector classification) would be closed to through traffic as a result of project activities and there would be no suitable alternative route available
- An increase in roadway wear in the vicinity of the work zone would occur as a result of heavy truck or equipment movements, resulting in noticeable deterioration of roadway surface
- Project activities or operation of the project would result in safety problems for vehicular traffic, transit operations, or trains
- An increase in vehicle trips associated with additional commuter and truck trips would result in an unacceptable reduction in level of service (LOS) standards of local jurisdictions on roadways in the project vicinity.

5.14.1 Alternative 1 No Action

Under the No Action Alternative, existing vegetation would remain and no restoration components would be installed. Therefore, no impacts to transportation would result from the implementation of this alternative because it would not include construction or operational activities that would generate traffic or affect transportation systems.

5.14.2 Alternative 2 Low Water Use

Construction and Operation

Traffic Congestion. It is anticipated that construction activities associated with Alternative 2 would last for approximately three months on three simultaneous construction fronts. Additional traffic would be generated on roadways in the project area from a maximum of approximately 15 workers commuting to and from the construction sites each workday for the duration of the construction period. Potential impacts to local traffic conditions associated with commuting workers would be less than significant.

In addition to commuting worker trips, the project would require haul truck trips to remove vegetation and other debris and deliver fill material and supplies to the construction sites. It is estimated that approximately 16,160 haul trips (approximately 90 trips per workday at each construction front for an estimated 60 workdays) would be required for Alternative 2. Although the exact locations of where the debris would be deposited and where the fill material and supplies would arrive from have not yet been determined, it is anticipated that these locations would be relatively close to the project sites and that haul trip lengths would average approximately 10 miles per roundtrip.

Trucks would enter and exit the project area from various streets that dead-end adjacent to the channel. In the project area, hauling would be conducted along a cleared path within the riverbed, or along the access roads on the top of the levees. Out of the project area, trucks would follow routes that would be approved by the City of Avondale and the County of Maricopa (if applicable) per permit specifications prior to the start of construction. Haul routes would be planned to reduce traffic related impacts as much as possible. Implementation of the permit specifications that would be required by the local transportation authorities would insure that potentially significant impacts associated with project haul trips would be reduced to less than significant levels.

Roadway Damage. Equipment used for the project would be primarily limited to use within the river channel with the exception of haul trucks. Although it is not anticipated that permanent physical damage to public and private roadways would occur during construction activities, there is a potential for the integrity of roadways to be compromised by the high number of truckloads that would utilize local roads. However, potentially significant impacts related to physical damage of public and private roads would be reduced to less than significant levels with implementation of Environmental Commitment T-1 (see below).

Potential Street Closures. The project proponents do not anticipate the need for street closures during construction activities at this time. However, if during the development of construction plans it becomes apparent that street closures would be necessary, the project proponents would be required to obtain a Right of Way Permit from the City of Avondale's Engineering Division prior to the commencement of construction activities. Conditions mandated by the Right of Way Permit would ensure that short-term road closure impacts would result in adverse, but less than significant impacts.

Disruption of Public Transportation. Project operation and maintenance activities would not disrupt bus or rail transit services within the project area. Therefore, no impacts would occur.

Goodyear Airport Exclusion Zone. Goodyear Airport, which is owned and operated by the City of Phoenix, maintains a Federal Aviation Administration (FAA) policy that excludes all development projects within 10,000 feet of the airport that would contain open water. The intent of this policy is to limit the attraction of birds and other wildlife to the area of the active airport to avoid potential hazards associated with wildlife strikes by airplanes.

Portions of the Agua Fria River Restoration Project are within 10,000 feet of Goodyear Airport, and therefore, the local sponsors, the Corps, and the FAA would have to reach an agreement to allow the project to proceed in these areas.

In that respect, the restoration project will not induce population growth beyond that already considered in local planning documents. It does not create any permanent open water areas; the only surface water conveyance is a low flow channel that will receive surface water inputs based on seasonal needs. Terrestrial wildlife attracted to the area is highly unlikely to leave the leveed or unleveed portions of the channel and traverse urbanized areas to reach the airport. The vegetation growth that will be induced throughout the restoration areas in the middle and northern sections is not suitable migratory waterfowl habitat.

Environmental Commitments

Impact: Physical damage to sidewalks or roads from construction equipment or vehicles.

T-1 If damage to roads and sidewalks occurs, the operator shall coordinate repairs with the affected public agencies to ensure that any impacts to area reads are adequately repaired. Roads and sidewalks disturbed by construction activities or construction vehicles shall be properly restored to ensure long-term protection of road and sidewalk surfaces. Staging areas for the project, which are located in unoccupied, sparsely vegetated areas within the river floodplain, will be cleaned and restored to their prior condition.

5.14.3 Alternative 3 Moderate Water Use

Traffic Congestion. It is anticipated that construction activities associated with Alternative 3 would last for approximately four months on three simultaneous construction fronts. Additional traffic would be generated on roadways in the project area from a maximum of approximately 15 workers commuting to and from the construction sites each workday for the duration of the construction period. Potential impacts to local traffic conditions associated with commuting workers would be less than significant.

In addition to commuting worker trips, the project would require haul truck trips to remove vegetation and other debris and deliver fill material and supplies to the construction sites. It is estimated that approximately 13,660 haul trips (approximately 57 trips per workday at each construction front for an estimated 80 workdays) would be required for Alternative 3.

Trucks would enter and exit the project area from various streets that dead-end adjacent to the channel. Trucks would follow routes to and from the project area that would be approved by the City of Avondale and the County of Maricopa (if applicable) per permit specifications prior to the start of

construction. Haul routes would be planned to reduce traffic related impacts as much as possible. Implementation of the permit specifications that would be required by the local transportation authorities would insure that potentially significant impacts associated with project haul trips would be reduced to less than significant levels.

Other Transportation Related Impacts. Other transportation related issues associated Alternative 3 would be essentially the same as those described above for Alternative 2. Impacts associated with potential street closures would be less than significant, pursuant to local agency permit conditions and implementation of Environmental Commitment T-1 would be required to ensure that significant impacts associated with potential roadway damage would be less than significant. In addition, project construction would not disrupt public transportation, and it is anticipated that an agreement about the Goodyear Airport Exclusion Zone Policy would be reached.

5.14.4 Alternative 4 High Water Use

Traffic Congestion. It is anticipated that construction activities associated with Alternative 4 would last for approximately six months on three simultaneous construction fronts. Additional traffic would be generated on roadways in the project area from a maximum of approximately 15 workers commuting to and from the construction sites each workday for the duration of the construction period. Potential impacts to local traffic conditions associated with commuting workers would be less than significant.

In addition to commuting worker trips, the project would require haul truck trips to remove vegetation and other debris and deliver fill material and supplies to the construction sites. It is estimated that approximately 26,200 haul trips (approximately 73 trips per workday at each construction front for an estimated 120 workdays) would be required for Alternative 4.

Trucks would enter and exit the project area from various streets that dead-end adjacent to the channel. Trucks would follow routes to and from the project area that would be approved by the City of Avondale and the County of Maricopa (if applicable) per permit specifications prior to the start of construction. Haul routes would be planned to reduce traffic related impacts as much as possible. Implementation of the permit specifications that would be required by the local transportation authorities would insure that potentially significant impacts associated with project haul trips would be reduced to less than significant levels.

Other Transportation Related Impacts. Other transportation related issues associated Alternative 4 would be essentially the same as those described above for Alternative 2. Impacts associated with potential street closures would be less than significant, pursuant to local agency permit conditions and implementation of Environmental Commitment T-1 would be required to ensure that significant impacts associated with potential roadway damage would be less than significant. In addition, project construction would not disrupt public transportation, and it is anticipated that an agreement about the Goodyear Airport Exclusion Zone Policy would have to be reached for this alternative to be implemented.

5.14.5 Alternatives 5, 6, and 7 - Alternatives 2, 3, and 4 without Western Riparian Strip

Impacts associated with Alternatives 5, 6, and 7 would be slightly less than their counterparts, Alternatives 2, 3, and 4 (see the assessments of Alternatives 2, 3, and 4 above) because construction activities on the western levee would be very limited under these alternatives. However, similar to Alternatives 2, 3, and 4, transportation impacts during construction would be considered less than significant associated with traffic congestion and potential street closures and potentially significant, but mitigable to levels that are less than significant with Environmental Commitment T-1 for potential damage to roadways. In addition, project construction would not disrupt public transportation, and it is anticipated that an agreement about the Goodyear Airport Exclusion Zone Policy would be reached.

5.14.6 Alternative 8 Low Water Use with Reduced Riparian Corridors, Vegetation Management Areas, and No Development of the Durango Channel Site

Alternative 8 is similar to Alternative 2 except for (1) the reduction in length of the riparian corridors on the east and west levees near the I-10 site, (2) the addition of Vegetation Management Areas north of the I-10 and near the Avondale Wastewater Treatment plant site, and (3) the absence of any restoration activities around the Durango Channel/Buckeye Road site in order to avoid any potential impacts associated with the 10,000-foot exclusion zone of the Goodyear Airport. Construction and operation impacts associated with Alternative 8 would be similar to, but less than, Alternative 2, except for the addition of the Vegetation Management Areas, which are associated with Alternative 4.

Transportation impacts for Alternative 8 during construction would be considered less than significant associated with traffic congestion and potential street closures and potentially significant, but mitigable to levels that are less than significant with Environmental Commitment T-1 for potential damage to roadways. Alternative 8 would have no impact on the Goodyear Airport because all construction activities would occur outside of the airport's 10,000-foot exclusion zone. Impacts would be less than significant.

5.14.7 Cumulative Impacts

Development of all approved or proposed projects in the vicinity and implementation of the proposed project would result in an overall increase in traffic volumes on the existing and roadway network. However, pursuant to permit conditions that would be required of the project proponents and implementation of Environmental Commitment T-1, the proposed project would result in less than significant impacts. Although it is anticipated that this project would not result in significant impacts, cumulative development in the project area may incrementally affect the existing street network. Project-specific environmental commitments for the cumulative actions would reduce cumulative transportation impacts to below a level of significance.

6.1 PUBLIC PARTICIPATION AND SCOPING PROCESS

Purpose of Scoping Process

To identify key issues and concerns relevant to the scope of the DPR, the USACE and FCDMC encouraged participation in the environmental review process from all involved stakeholders. The stakeholder comments were used to help formulate preliminary alternatives as well as project opportunities and constraints. Public scoping is not required for an Environmental Assessment.

Stakeholder Meeting

The USACE, FCDMC, and the City of Avondale held a stakeholder meeting on May 6, 2002 at the City of Avondale offices. The purpose of the meeting was to discuss the preliminary alternatives array with the USACE, local sponsors, the Arizona Game and Fish Department, and local experts. The meeting entailed an overview of the project, a site visit, and a group discussion of project opportunities and constraints.

Public and Stakeholder Review

The general public were afforded an opportunity to comment on the Draft DPR during the circulation period in 2005. The document was made available at all local government offices as well as at local libraries. Copies of the document were sent to all stakeholders for review and comment. Comments have been incorporated into the Final DPR and included as an appendix.

6.2 INSTITUTIONAL INVOLVEMENT (AGENCY COORDINATION)

As stated above, a stakeholder working meeting was held on May 6, 2002 to review preliminary alternatives and outline project constraints and opportunities. Representatives from the following agencies attended:

- U.S. Army Corps of Engineers
- Flood Control District of Maricopa County
- City of Avondale
- Arizona Game and Fish Department
- Experts on local riparian restoration projects.

Coordination with the Federal, State, and local concerned agencies has been initiated for the proposed Agua Fria Riparian Restoration Project.

Coordination with Federal Agencies

U.S. Fish and Wildlife Service. The USFWS was contacted at the beginning of the project regarding the proposed project's potential for impacting protected wildlife species. The required Fish and Wildlife Coordination Act protocol was followed, and the USFWS determined that no sensitive species currently use the project site.

National Resources Conservation Service (NRCS). Beginning on December 27, 2001, the DPR preparers contacted the NRCS office in Phoenix regarding soil classifications in the project area. The NRCS provided a determination of exemption for this project from the Farmland Protection Policy Act (FPPA) (Appendix C).

Coordination with State Agencies

Arizona Game and Fish Department (AGFD). Beginning January 23, 2002, the DPR preparers contacted AGFD regarding sensitive species in the project area.

Arizona Department of Water Resources (ADWR). Beginning on January 7, 2002, the DPR preparers contacted the ADWR to begin coordination for the project.

Arizona Department of Transportation (ADOT). Beginning January 7, 2002, the DPR preparers contacted the Environmental Division of ADOT to begin consultation for the project. The DPR preparers requested water quality data and NPDES information for the I-10 outflow, and the potential to use a portion of the I-10 outflow channel for restoration purposes. The DPR preparers also sought information on maintenance activities that could affect restoration areas in the Agua Fria river channel. The DPR preparers were unable to obtain information from ADOT despite repeated efforts.

Arizona Department of Environmental Quality. Beginning December 20, 2001, the DPR preparers contacted the Arizona Department of Environmental Quality regarding water quality at the Avondale Wastewater Treatment Plant, and data on historical hazardous waste spills in the Agua Fria River.

Coordination with Local Agencies and Interested Parties

County of Maricopa Flood Control District. Beginning October 11, 2001, the DPR preparers contacted Michael Ellegood, P.E., Chief Engineer, and Manager of the Flood Control District of Maricopa County (FCDMC). This initiated coordination with the FCDMC that has continued throughout the project. As the local sponsor of the restoration project, FCDMC has provided a significant amount of resources, support and baseline information. The Agua Fria River Watercourse Master Plan, prepared for the FCDMC, was partially incorporated into this DPR.

County of Maricopa, Waste Management Division. Beginning October 16, 2002, the DPR preparers contacted the division regarding water quality requirements.

City of Avondale. Beginning December 20, 2001, the DPR preparers contacted the City of Avondale. This initiated coordination that has continued throughout the project. The City of Avondale has provided a significant amount of background information and support of the project. The DPR preparers contacted the Utilities Department to obtain a partial description of utility lines that could be impacted by the proposed project.

Maricopa County Department of Transportation. Beginning on January 4, 2002, the DPR preparers contacted MCDOT to begin coordination for the project; specifically to obtain information on projected road improvements that may overlap with the restoration sites.

Buckeye Irrigation District. The DPR preparers contacted the district for baseline information on water sources and groundwater levels.

Roosevelt Irrigation District. The DPR preparers contacted the district for baseline information on water sources.

Salt River Project. The DPR preparers contacted the Project for baseline information on ground water studies.

Goodyear Airport/City of Phoenix. Beginning March 23, 2002, the DPR preparers contacted the Goodyear Airport to determine the airport's criteria for determining potential bird-strike impacts from surrounding land uses.

6.3 ADDITIONAL REQUIRED COORDINATION

Prior to project construction additional coordination will be required with the following agencies/entities:

- ADOT, MCDOT, City of Avondale, Maricopa County, FCDMC and the State of Arizona for the definition of use agreements or easements on public lands for the purpose of restoration.
- Acquisition of real estate or easements from private landowners.

6.4 REPORT RECIPIENTS

CITY OF AVONDALE

Mayor Ron Drake
City Hall
525 North Central Avenue
Avondale, AZ 85323

Dan Davis, Director
Community/Recreation Services
City Hall
525 North Central Avenue
Avondale, AZ 85323

Nathan Crane
City Planner
1225 S. 4th Street
Avondale, AZ 85323

Robert Emmett
Utilities Director
1211 S. 4th Street
Avondale, AZ 85323

David Fritzhugh
City of Avondale
Assistant City Manager
525 N. Central Ave.
Avondale, AZ 85323

MARICOPA COUNTY

Maricopa Association of Governments
302 North 1st Ave.
Suite 300
Phoenix, AZ 85003

Honorable Mary Rose Wilcox
County Board of Supervisors
301 W. Jefferson, 10th Floor
Phoenix, AZ 85004

Darren Gerard
Principal Planner
Maricopa County
411 North Central, 3rd Floor
Phoenix, AZ 85004
(602) 506-7139

Mike Ellegood
Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, AZ 85009

Greg Jones
Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, AZ 85009
(602) 506-1501

Maricopa County Depart. of Transportation
The Durango Complex
2901 West Durango Street
Phoenix, AZ 85009

Goodyear Airport
1658 S. Litchfield Road
Goodyear, AZ 85338
623-932-1200

STATE OF ARIZONA

Honorable Janet Napolitano
Governor of Arizona
State Capitol
1700 West Washington
Phoenix, AZ 85007

Arizona Department of Environmental Quality
1110 W. Washington Street
Phoenix, AZ 85007

Arizona Department of Water Resources
500 N. Third Street
Phoenix AZ 85004
(602) 417-2455 Fax (602) 417-2467

Bill Werner
Arizona Game and Fish Department
2221 West Greenway Road
Phoenix, AZ 85023
(602) 942-3000

Russ Haughey
7200 E. University
Mesa, AZ 85207
(480) 981-9400

Mr. James Garrison
State Historic Preservation Officer
Arizona State Parks Department
1300 W. Washington St.
Phoenix, AZ 85007

Arizona Department of Air Quality
3033 N. Central Ave.
Phoenix, AZ 85012

John Hauskins
Arizona Department of Transportation
205 South 17th Ave.
Mail Drop 619E
Phoenix, AZ 85007
(602) 712-6550

Arizona Department of Agriculture
1688 W. Adams St.
Phoenix, AZ 85007

FEDERAL GOVERNMENT

Honorable Ed Pastor
411 North Central Ave., Suite 150
Phoenix, AZ 85004

Honorable Raul Grijalva
810 East 22nd St., Suite 102
Tucson, AZ 85713

Mr. David Harlow, Field Supervisor
U.S. Fish and Wildlife Service
Division of Ecological Services
Arizona State Office
2321 W. Royal Palm Rd., Suite 103
Phoenix, AZ 85021-4951
(602) 640-2720, Fax (602) 640-2730

Mr. Mike Martinez, Biologist
U.S. Fish and Wildlife Service
Division of Ecological Services
Arizona State Office
2321 W. Royal Palm Rd., Suite 103
Phoenix, AZ 85021-4951

ORGANIZATIONS

Southwest Valley Chamber of Commerce
289 North Litchfield Road
Goodyear, AZ 85338
(623) 932-2260 Fax (623) 932-9057

Arizona Riparian Council
Center for Environmental Studies
Arizona State University
Tempe, AZ 85287

Sierra Club
202 E. McDowell Road, Suite 277
Phoenix, AZ 85004
(602) 253-8633 Fax (602) 258-6533

Scott Barge
Maricopa Audubon Society
P.O. Box 15451
Phoenix, AZ 85060
(480) 897-8608

The Nature Conservancy
Phoenix Conservation Center
333 E. Virginia Avenue
Phoenix, AZ 85004
(602) 712-0048 Fax (602) 712-0059

University of Arizona
School of Renewable Resources
216 Biological Sciences (E)
Tucson, AZ 85721

Mr. Kieran Suckling, Executive Director
The Center for Biological Diversity
P.O. Box 710
Tucson, AZ 85702
(520) 623-5252, Fax (520) 623-9797

UTILITIES

Jackie Meck
Buckeye Water Conservation and
Drainage District
P.O. Box 1726
Buckeye, AZ 85326
(623) 386-2196 Fax (623) 386-7789

Dallas Reigle
Salt River Project
Water/Irrigation
P.O. Box 52149
Phoenix, AZ

Roosevelt Irrigation District
103 W. Baseline Road
Buckeye, AZ 85326
(623) 386-2046

LIBRARY

Avondale Public Library
328 W. Western Avenue
Avondale, AZ 85323
(623) 932-9415

INDIAN TRIBES

Bureau of Indian Affairs
Phoenix Area Office
P.O. Box 10
Phoenix, AZ 85001
(602) 379-6699 Fax (602) 379-4413

Ak Chin Indian Community Council
42507 W. Peters & Nall Road
Maricopa, AZ 85239
(520) 568-2227
Fax (520) 254-6133

6.5 PUBLIC VIEWS AND RESPONSES

No comments received during the public review period for the Draft Detailed Project Report.

7. COMPLIANCE WITH ENVIRONMENTAL REQUIREMENTS

The proposed project has been developed in accordance with the requirements of the environmental statutes and regulations outlined below. Conclusions concerning compliance or responsibility for compliance are identified in italics for each requirement.

National Environmental Policy Act (NEPA) of 1969, as amended (42 U.S.C. §§4321-4347)

The National Environmental Policy Act (NEPA), which took effect on January 1 1970, requires all Federal agencies, to the fullest possible extent, to carry out their regulations, policies and programs in accordance with NEPA's policies of environmental protection. The intent of NEPA is to protect, restore, or enhance the environment by providing Federal agencies, and the public at-large, with adequate information regarding environmental impacts. The Council of Environmental Quality (CEQ) was established under NEPA for the purpose of implementing and overseeing Federal policies as they relate to this process. In 1978, the CEQ issued Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act (40 CFR 1500-1508), which were revised in 1986. These regulations specify that an Environmental Assessment (EA) be prepared to provide sufficient analysis and evidence for determining whether an Environmental Impact Statement (EIS) or Finding of No Significant Impact (FONSI) needs to be prepared. A Federal agency must prepare an EIS if the EA determines there is a reasonable chance that the proposed action would result in a significant impact on the environment.

This Detailed Project Report (DPR) has been prepared in accordance with the requirements set forth in Section 102 of NEPA, CEQ Regulations for Implementing the Procedural Provisions of NEPA (40 CFR 1500 et seq.), and the Corps of Engineers, Department of the Army Environmental Quality, Procedures for Implementing the National Environmental Policy Act (NEPA) (33 CFR Parts 230 and 325). Reasonable alternatives have been considered during the planning process. Environmental commitments have been included in the evaluation of the project alternatives, and all procedural review requirements of the aforementioned rules and regulations will have been met as part of the DPR process.

Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.)

Passed in 1973, the ESA became one of the most comprehensive wildlife conservation laws in the world. The purpose of the ESA is to conserve "the ecosystems upon which endangered and threatened species depend" and to conserve and recover listed species. Under the law, species may be listed as either endangered or threatened. An endangered species is any species of fish, animal, or plant that is in danger of extinction throughout all or a significant portion of its range. Subspecies and distinct population segments of vertebrate species may also be listed. All species of plants and animals, except pest insects, are eligible for listing as endangered or threatened.

The Department of the Interior, acting through the U.S. Fish and Wildlife Service (USFWS), is responsible for protecting most threatened and endangered species. The Department of Commerce, through the National Marine Fisheries Service (NMFS), is responsible for marine species, including marine mammals and anadromous fish, such as salmon. The USFWS and NMFS are required to "take

into consideration the economic impact, and any other relevant impact of specifying any area as critical habitat." The agencies may exclude any area from critical habitat designation if "the benefits of such exclusion outweigh the benefits of specifying such areas as part of the critical habitat, unless the failure to designate such areas as critical habitat will result in the extinction of the species concerned."

Critical habitat is defined as the geographic area containing physical or biological features essential to the conservation of a listed species or as an area that may require special management considerations or protection. Unless the USFWS or NMFS finds that it is not "prudent" or "determinable," critical habitat must be designated concurrently with a species' listing. If "not determinable," the USFWS has an additional year to determine critical habitat.

Consultation with the USFWS or the NWFS is required before any takings of endangered or threatened species are allowed, as described below.

ESA, Section 7 Consultation. Any Federal agency is required to consult with the USFWS on actions involving listed species. The USFWS is to conduct an internal consultation regarding the effects of any proposed action. A Section 7 consultation is initiated when a Federal agency presents a biological assessment that examines the potential effects of a specified action on a species. It is concluded when the USFWS issues a written statement (Biological Opinion) that pronounces whether the action would jeopardize a listed or proposed species, or adversely affect critical habitat. If the species is not in jeopardy, the written statement will include authorization for incidental take. If a species is in jeopardy, mitigation and minimization actions will be included in the written statement. If a Jeopardy Opinion is issued, it will include reasonable and prudent alternatives that will not violate subsection (a)(2) of the Act (i.e. will not jeopardize the continued existence of the species or adversely modify critical habitat).

ESA, Section 9. The USFWS has defined under Section 9 the "taking" of listed species. Under the ESA, "taking" means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or to attempt to engage in such conduct."

ESA, Section 10. Where a potential "take" may occur under actions not requiring a Federal permit, compliance with the ESA is pursued through a permit obtained under Section 10. The applicant must submit a Habitat Conservation Plan to obtain the Section 10(a) permit.

The USACE determined the project will have no effect on any federally listed species or species proposed for listing, proposed or designated critical habitat. Therefore, consultation (or conferencing) with the United States Fish and Wildlife Service (USFWS) under section 7 of the ESA is not required. In the event federally-listed species are observed in the project are during pre-construction surveys, no construction will be initiated or continued that could affect a federally-listed species until consultation with the USFWS pursuant to section 7 of the ESA is completed.

Fish and Wildlife Coordination Act (16 U.S.C. § 661 et seq.)

The Fish and Wildlife Coordination Act directs the Department of the Interior to provide assistance to Federal agencies in order to promote wildlife conservation in water resource development projects. Agencies must consult with the section of the Department of the Interior that has jurisdiction over the project, in this case the U.S. Fish and Wildlife Service (USFWS), on wildlife conservation measures to be implemented during construction and maintenance of the project. The Act also requires consultation with the head of the State agency that administers wildlife resources in the affected State. Although the recommendations of the USFWS and State officials are not binding, the Federal agency must give them full consideration.

A draft and final Fish and Wildlife Coordination Act Report, dated March 14, 2002, was prepared for this project (see Appendix C). The USACE will continue to maintain coordination with the USFWS during all phases of this project. The proposed project is in compliance with the Fish and Wildlife Coordination Act.

Clean Water Act of 1977 (33 U.S.C. § 1251 [1994])

The Clean Water Act (CWA), a 1977 amendment to the Federal Water Pollution Control Act of 1972, is the primary Federal law that protects the nation's waters, including lakes, rivers, aquifers and coastal areas. Its main objective is to restore and maintain the chemical, physical, and biological integrity of the nation's waters. Relevant sections of the CWA include:

Section 401: requires Federal agencies to obtain State water quality certification for any Federal project or permitted project that may affect water quality. The USACE will coordinate with the ADEQ to ensure Section 401 compliance.

Section 402: establishes conditions and permitting for point-source discharges of pollutants under the National Pollution Discharge Elimination System (NPDES). Pursuant to NPDES requirements, a General Construction Activity Storm Water Permit is required for project construction, and a standard NPDES permit is required for the direct discharges of groundwater into the river channel. A Storm-Water Pollution Prevention Plan (SWPPP) must be prepared in order to obtain the NPDES permit. At the time of writing this DPR, the ADEQ does not require a permit for herbicide application in a waterway under their AZPDES program; however, application of Section 402 to this activity should be confirmed prior to initiating construction. Section 402 compliance is the responsibility of the construction contractor.

Section 404(b): prohibits the discharge of dredged or fill materials into the waters of the United States, including wetlands, except as permitted under separate regulations by the USACE and the EPA. Appendix D of this document demonstrates the USACE's internal compliance with Section 404(b)(1).

Clean Air Act of 1970

This Act directs the attainment and maintenance of National Ambient Air Quality Standards (AAQS) for six "criteria" pollutants (e.g., ozone, carbon monoxide). Under the Clean Air Act, the EPA must approve a State Implementation Plan (SIP), which defines the actions to be taken, and the time schedule for achievement of attainment, when a geographical area is classified as "nonattainment." The EPA implements the New Source Review (NSR) and Prevention of Significant Deterioration (PSD) regulations in areas of "attainment." Additional Federal laws related to air quality control are:

1977 Clean Air Act: enacted legislation to control seven air toxic pollutants. EPA adopted the National Emission Standards for Hazardous Air Pollutants (NESHAP), which were designed to control Hazardous Air Pollutants (HAP) emissions to prevent adverse health effects in humans.

1990 Amendments to the Clean Air Act: determine the attainment and maintenance of NAAQS (Title I), motor vehicles and reformulation (Title II), hazardous air pollutant (Title III), acid deposition (Title IV), operating permits (Title V), stratospheric ozone protection (Title VI), and enforcement (Title VII).

General Conformity. Under Section 176(c) of the Clean Air Act Amendments (CAAA) of 1990, the Lead Agency is required to make a determination of whether the proposed project "conforms" with the State Implementation Plan (SIP). Conformity is defined in Section 176(c) of the CAAA as compliance with the SIP's purpose of eliminating or reducing the severity and number of violations of the National Ambient Air Quality Standards (NAAQS) and achieving expeditious attainment of such standards. However, if the total direct and indirect emissions from the proposed project are below the General Conformity Rule *de minimis* emission thresholds, the proposed project would be exempt from performing a comprehensive Air Quality Conformity Analysis, and would be considered to be in conformity with the SIP.

A Federal consistency determination has been prepared for the proposed alternatives (see Section 5.5 and Appendix L). The proposed alternatives are consistent with the State of Arizona SIP and would not have any significant, un-mitigable impacts to air quality. The proposed project would not exceed de minimis emission thresholds for NOx, ROCs, carbon monoxide and/or particulates.

Farmland Protection Policy Act (FPPA) (7 U.S.C. §§ 4201 et seq.)

Protection and management of agricultural resources is guided by the U.S. Department of Agriculture, which, through the Farmland Protection Policy Act, discourages activities that result in the permanent conversion of farmlands to other uses. Implementation of the proposed project will not affect any designated prime or unique farmland, or farmland of statewide importance. The proposed alternatives are therefore not subject to the FPPA (see NRCS correspondence in Appendix C).

National Historic Preservation Act (NHPA) of 1966, as amended (Public Law 89-665; 16 U.S.C. 470-470m, as amended, 16 U.S.C. 460b, 470l-470n)

The National Historic Preservation Act (NHPA) of 1966, Amendments of 1992 and 1999, establishes preservation as a national policy and directs the Federal government to provide leadership in preserving, restoring and maintaining the historic and cultural resources of the United States. Preservation is dined as the protection, rehabilitation, restoration and reconstruction of districts, sites, buildings, structures, and objects significant in American history, architecture, archeology or engineering.

The NHPA (16 U.S.C. 470) created the Advisory Council on Historic Preservation (ACHP), an independent Federal agency, to advise the President and Congress on matters involving historic preservation. The ACHP is authorized to review and comment on all actions licensed by the Federal government which will have an effect on properties listed in the National Register of Historic Places (NRHP), or eligible for such listing. Specifically, Section 106 of the Act (16 U.S.C. 470(f)) requires that a Federal agency involved in a proposed project or activity is responsible for initiating and completing the review process. The agency must confer with the State Historic Preservation Officer (an official appointed in each State or territory to administer the National Historic Program) and the NHPA.

In accordance with 36 CFR 800, regulations implementing Section 106 of the National Historic Preservation Act, a records search and an archeological survey of the project area have been performed. The cultural resource evaluation prepared for the project were submitted to the State Historic Preservation Officer (SHPO) for review, per the requirements of Section 106 of the NHPA. The SHPO concurrence with the conclusions of the evaluation is provided in Appendix C.

Wild and Scenic Rivers Act (16 U.S.C. § 1271 et seq.)

According to the Nationwide Rivers Inventory (NPS 1982), no listed wild or scenic rivers or stretches of river under consideration as wild or scenic are located within the project area. The proposed project is therefore not subject to the requirements of the Wild and Scenic Rivers Act.

Migratory Bird Treaty Act of 1918 (1989 Amendments)

The Migratory Bird Treat Act (MBTA) prohibits the taking or harming of any migratory bird, its eggs, nests, or young without an appropriate Federal permit. The take of all migratory birds is governed by the MBTA's regulation of taking migratory birds for educational, scientific, and recreational purposes and requiring harvest to be limited to levels that prevent over-utilization. Section 704 of the MBTA states that the Secretary of the Interior is authorized and directed to determine if, and by what means, the take of migratory birds should be allowed and to adopt suitable regulations permitting and governing take.

Preconstruction surveys and avoidance measures will be implemented to ensure that the proposed project will not entail the taking, killing, or possession of any migratory birds or waterfowl subject to

this Act or adverse impact to their associated habitat, and is therefore in compliance with the requirements of the Migratory Bird Treaty Act.

Executive Order 11990, Protection of Wetlands

This Executive Order requires that Federal agencies provide leadership to protect the natural and beneficial values served by wetlands and to minimize the destruction or degradation of wetlands. The proposed project would improve degraded wetland habitat in the Agua Fria river channel, and therefore, would benefit the protection of regional wetlands. This project would comply with Executive Order 11990.

Executive Order 11988, Floodplain Management

Executive Order (EO) 11988 of 1977 requires all Federal agencies to avoid to the extent possible the long and short term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct or indirect support of floodplain development wherever there is a practicable alternative, it is hereby ordered as follows. Each agency must: (1) take action to avoid development in the 100-year floodplain unless it is the only practicable alternative; (2) reduce hazard and risk associated with floods; (3) minimize the impact of floods on human safety, health, and welfare; and (4) restore and preserve the natural and beneficial value of the 100-year floodplain.

The proposed project would be located in the floodplain of the Agua Fria River. However, the project has been designed such that it would not compromise the flood control capacity of the river channel. In addition, the restoration areas would act to restore and preserve the natural and beneficial value of the 100-year floodplain. The proposed project would be in compliance with Executive Order 11988.

Executive Order 12898, Environmental Justice

Executive Order (EO) 12898 of 1997 directs Federal agencies to assess the effects of their actions on minority and/or low-income populations within their region of influence. Agencies are encouraged to include demographic information related to race and income in their analysis of the environmental and economic effects associated with their actions.

The proposed project would not result in any significant, adverse, disproportionate impacts to any minority populations, low-income populations, or children in the project vicinity area. Furthermore, the project would not have a significant adverse effect on human or socioeconomic resources. Therefore, the proposed action is consistent with Executive Order 12898.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)

Congress passed CERCLA, also known as "Superfund", in response to a growing national concern about the release of hazardous substances from abandoned waste sites. CERCLA gives the Federal government broad authority to regulate hazardous substances, to respond to hazardous substance emergencies, and to develop long-term solutions for the nation's most serious hazardous waste problems. CERCLA also created a Hazardous Substance Response Trust Fund. This fund, supported by

an excise tax on feedstock chemicals and petroleum, is used to pay for cleanup activities at abandoned waste sites.

CERCLA requires the parties responsible for the contamination to conduct or pay for the cleanup. If the EPA's efforts to take an enforcement action for the cleanup are not successful, the Federal government can clean up a site using the CERCLA Trust Fund. If the Superfund program conducts the cleanup, the government can take court action against responsible parties to recover up to three times the cleanup costs.

Under Section 120 of CERCLA, each department, agency, and instrumentality of the United States is subject to, and must comply with, CERCLA in the same manner as any nongovernmental entity. However, funds from the Superfund do not generally go towards paying for the cleanup of releases from Federally owned facilities [Section 111(e)(3)]. Executive Order 12580, signed in January of 1987 and modified in August 1996 by Executive Order 13016, further clarified that Federal agencies and departments are responsible for sites within their jurisdiction.

A query of the EPA Hazardous Waste Sites list for Maricopa County, Arizona, revealed four Superfund sites (one of which was on the NPL) within the general vicinity of the project area, as presented in Table 3.8-1 of this report. The Goodyear Dry Cleaners site is located slightly less than a mile to the west, and the Phoenix-Goodyear Municipal Airport is located approximately 1.5 miles to the west. The remaining two facilities, the Liberty Substation and Faith Cooperage, are approximately 12 miles to the west and downgradient from the site. Based upon information obtained from Arizona Department of Environmental Quality, it appears that the study area has not been impacted from these off-site facilities. The distance and groundwater flow direction with respect to the project area indicates there is a low likelihood that the project area has been impacted by these off-site facilities. A study completed by the City of Avondale for recharge ponds located immediately north of McDowell Road concluded that the recharge facilities and pumping would not affect or be impacted by contaminant plumes originating in these sites (City of Avondale, 1997). Therefore, the proposed project would not affect, or be affected by, a CERCLA site.

National Flood Insurance Program

The National Flood Insurance Program (NFIP) is administered by the Federal Emergency Management Agency's (FEMA's) Flood Insurance Administration. The program makes flood insurance available to the residents of communities that have adopted flood plain management ordinances that regulate development in designated flood hazard areas and require flood-proofing of new construction ins such areas. Federal flood insurance is needed because homeowners' policies do not provide coverage for flood damage.

The proposed project would not entail the direct or indirect construction of any facilities or residences in the 100-year floodplain. In addition, the project has been designed such that it would not compromise the Standard Project Flood (SPF) capacity of the channel. Therefore, the project would comply with the National Flood Insurance Program.

State

State of Arizona - Native Plant Law. Arizona native plants cannot be removed from any lands, whether they are owned by a private individual or managed by a government agency, without permission and a permit from the Arizona Department of Agriculture. Lessees of State or Federal land must obtain specific authorization from the landlord agency to remove protected native plants.

By law, Arizona landowners have the right to destroy or remove plants growing on their land, but 20 to 60 days prior to the destruction of any protected native plants, landowners are required to notify the Arizona Department of Agriculture. Arizona landowners also have the right to sell or give away any plant growing on the land. However, protected native plants growing may not be legally possessed, taken or transported from the growing site without a permit from the Arizona Department of Agriculture.

There are five categories of protected plants:

- *Highly Safeguarded (HS)* – No collection allowed
- *Salvage Restricted (SR)* – Collection with permit only
- *Export Restricted (ER)* – Transport out of State is prohibited
- *Salvage Assessed (SA)* – Permit required to remove live trees
- *Harvest Restricted (HR)* – Permit required to remove plant by-products.

The Arizona Department of Agriculture, Plant Services Division determined that a Notice of Intent to Clear Land and an Arizona Native Plants and Wood Removal Application would need to be filed at least three months prior to the construction date. A minimum of one month is usually required by the ADA, but three months would allow time for any questions posed by the Division. Native mesquite species covered by this law may be present in affected areas. This restoration project will include a survey of all potentially affected native species covered by this law and would comply with the three-month notice. On the applicant's form it will be indicated whether native species will be salvaged. In the event that this occurs and the species are taken off site, an additional permit shall be requested for the transport and temporary storage of these species. A native species survey will be completed for the filing of this permit. The construction contractor will be responsible for ensuring compliance with the Native Plant Law prior to any ground disturbance.

State of Arizona - Wildlife of Special Concern in Arizona. The Arizona Game and Fish Department (AGFD) has prepared a listing of plant and animal species (State of Arizona–Wildlife of Special Concern) that are believed to be in peril within the State of Arizona. These species may have management guidelines established by the State. The species on this list do not have any regulatory protection. The State has also published the *Habitats in Jeopardy* listing with recommended management techniques. The guidelines recommend that Resource Category I habitats (wetlands, perennial streams) be protected with a goal of no loss of habitat and Resource Category II habitats (Sonoran Upland) be managed for no net loss. Where practical, proposed activities should be conducted

within the AGFD guidelines. The goal of this project is to restore native wildlife habitat suitable to the current conditions of the area; therefore, the project is in compliance with these guidelines.

Arizona Groundwater Management Act. To address the over-drafting of Arizona's groundwater supplies, the Arizona State Legislature passed the Groundwater Management Act in 1980. The Groundwater Management Act specified areas that are depleting groundwater resources to be designated as Active Management Areas or AMAs. The Phoenix metropolitan area and four other areas with severe groundwater overdraft fall into these categories. The goal of the Phoenix AMA is to reach Safe Yield by 2025. Safe Yield is defined as the hydrologic concept of achieving and maintaining a long-term balance between the annual amount of groundwater withdrawn in an AMA and the annual amount of natural and artificial recharge in the AMA. The Groundwater Management Act divided the time period between 1980 and 2025 into five intervals. Each interval has an associated Management Plan that will incrementally move the Phoenix AMA into Safe Yield. All large municipal providers (e.g. City of Avondale) within the Phoenix Active Management Area must comply with reducing groundwater use and achieving Safe Yield (Avondale, 2002a).

The proposed project would potentially use groundwater to sustain the restoration areas. All groundwater wells will be authorized by the City of Avondale and the ADWR and are therefore, subject to the goals of the Act. Therefore, the proposed project would comply with the Arizona Groundwater Management Act.

Arizona Administration Code, Title 18, Chapter 9. The Arizona Administration Code, Title 18, Chapter 9 regulates hazardous waste generation, handling and transport in Arizona. The proposed project would not generate or transport any hazardous wastes.

The State Implementation Plan (SIP). The Arizona Department of Environmental Quality (ADEQ) Air Quality Division has compliance and enforcement responsibility for all portable sources in the project area. Stationary and construction dust sources in the project area are regulated by the Maricopa County Environmental Services Department (MESD). The ADEQ and MESD adopt rules designed to fulfill the State's responsibilities under the Federal Clear Air and its amendments to provide a legally enforceable SIP for the attainment and maintenance of the NAAQS.

The State Implementation Plan (SIP) is the cumulative record of all air pollution strategies, non-attainment area plans (NAPs), statutes, rules, and ordinances implemented under Title I of the Clean Air Act by governmental agencies within Arizona, such as ADEQ and MESD. Revisions to Arizona's SIP must be submitted to the EPA by the director of the ADEQ on behalf of the governor. Once approved by EPA as published in the Federal Register, the provisions contained in the SIP revision become enforceable by the Federal government as well as by the appropriate governmental entities of Arizona. The following rules that have been adopted by ADEQ or the MESD that may be applicable to the restoration project are:

- **Arizona Administrative Code Rule Title 18, Chapter 2, Title 606 (R18-2-606), Material Handling.** No person shall cause, suffer, allow or permit crushing, screening, handling, transporting or conveying of materials or other operations likely to result in significant amounts of airborne dust without taking reasonable

precautions, such as the use of spray bars, wetting agents, dust suppressants, covering the load, and hoods to prevent excessive amounts of particulate matter from becoming airborne.

- **R18-2-607, Storage Piles.** (A) No person shall cause, suffer, allow, or permit organic or inorganic dust producing material to be stacked, piled, or otherwise stored without taking reasonable precautions such as chemical stabilization, wetting, or covering to prevent excessive amounts of particulate matter from becoming airborne. (B) Stacking and reclaiming machinery utilized at storage piles shall be operated at all times with a minimum fall of material and in such manner, or with the use of spray bars and wetting agents, as to prevent excessive amounts of particulate matter from becoming airborne.
- **R18-2-802, Off-road Machinery.** (A) No person shall cause, allow or permit to be emitted into the atmosphere from any off-road machinery, smoke for any period greater than 10 consecutive seconds, the opacity of which exceeds 40 percent. Visible emissions when starting cold equipment shall be exempt from this requirement for the 1st 10 minutes. (B) Off-road machinery shall include trucks, graders, scrapers, rollers, locomotives and other construction and mining machinery not normally driven on a completed public roadway.
- **House Bill (HB) 2538 Section 1.** By July 1, 2002, Maricopa County must adopt an ordinance that limits the idling time of heavy-duty diesel vehicles (gross weight over 14,000 pounds).
- **House Bill (HB) 2538 Section 10.** The ADEQ will encourage the voluntary replacement of old diesel equipment with less polluting newer equipment, as well as the voluntary usage of ultra-low sulfur diesel fuel, on an accelerated basis to achieve higher Federal standards.

A Federal consistency determination has been prepared for the proposed alternatives (see Section 5.5). The proposed alternatives are consistent with the State of Arizona SIP and local State Implementation Plan and would not have any significant, un-mitigable impacts to air quality. In addition, the construction contractor is responsible for complying with the rules described above.

Local

Maricopa County Air Pollution Control Rule 310. Rule 310 applies to sources of fugitive dust within Maricopa County, including construction sites. The PM_{10} SIP for Maricopa County relies upon Rule 310 for its demonstration of attainment. It establishes limits for the emissions of particulate matter into the ambient air from any property, operation, or activity that may serve as an open fugitive dust source. Construction projects that disturb a total surface area of 0.1 acre or more require a permit from the MESD. These projects are required to have a valid permit before the soil is disturbed. If the project continues for more than 1 year, the permit must be renewed.

Maricopa County Air Pollution Control Rule 314. Rule 314 requires a project proponent to obtain a Burn Permit from the County Control Officer before igniting, causing or permitting to be ignited, allowing, or maintaining an open outdoor fire. The Control Officer may impose any permit conditions that are necessary to ensure compliance with all Federal laws, State laws, or local rules. Burn Permit conditions(s) may include, but are not limited to, burning hours, notification of intent to burn, and Burn Permit posting.

A Federal consistency determination has been prepared for the proposed alternatives (see Section 5.5). The proposed alternatives are consistent with the State of Arizona SIP and local State Implementation Plan and would not have any significant, un-mitigable impacts to air quality. The proposed project will need to obtain a Rule 310 dust control permit from the County, which will have dust-control

stipulations. The construction contractor is responsible for obtaining this permit. No fire-burning will occur during construction or operation of the restoration project; therefore, a Rule 314 prescribed fire-burning permit will not be required.

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APPENDICES

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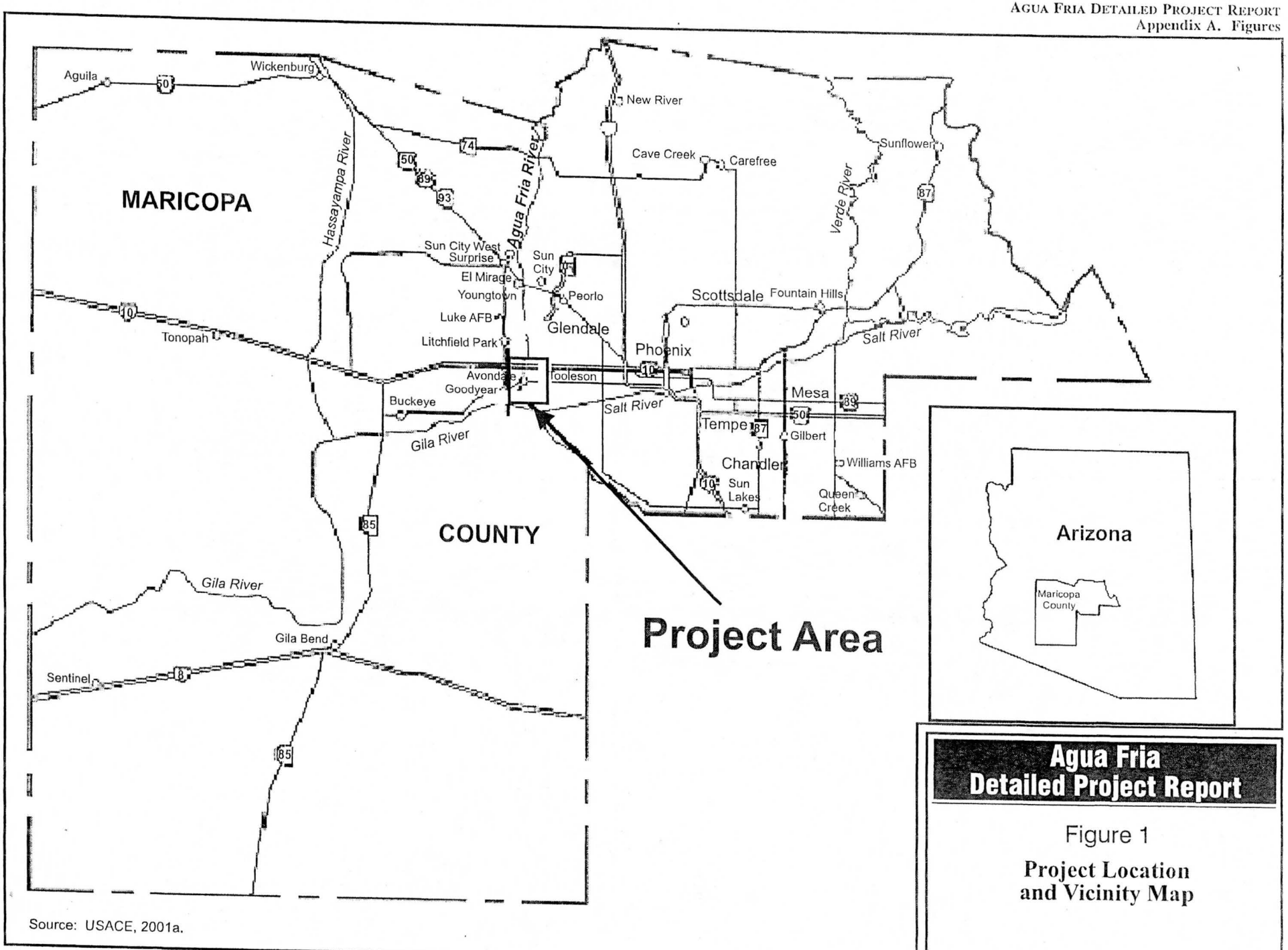
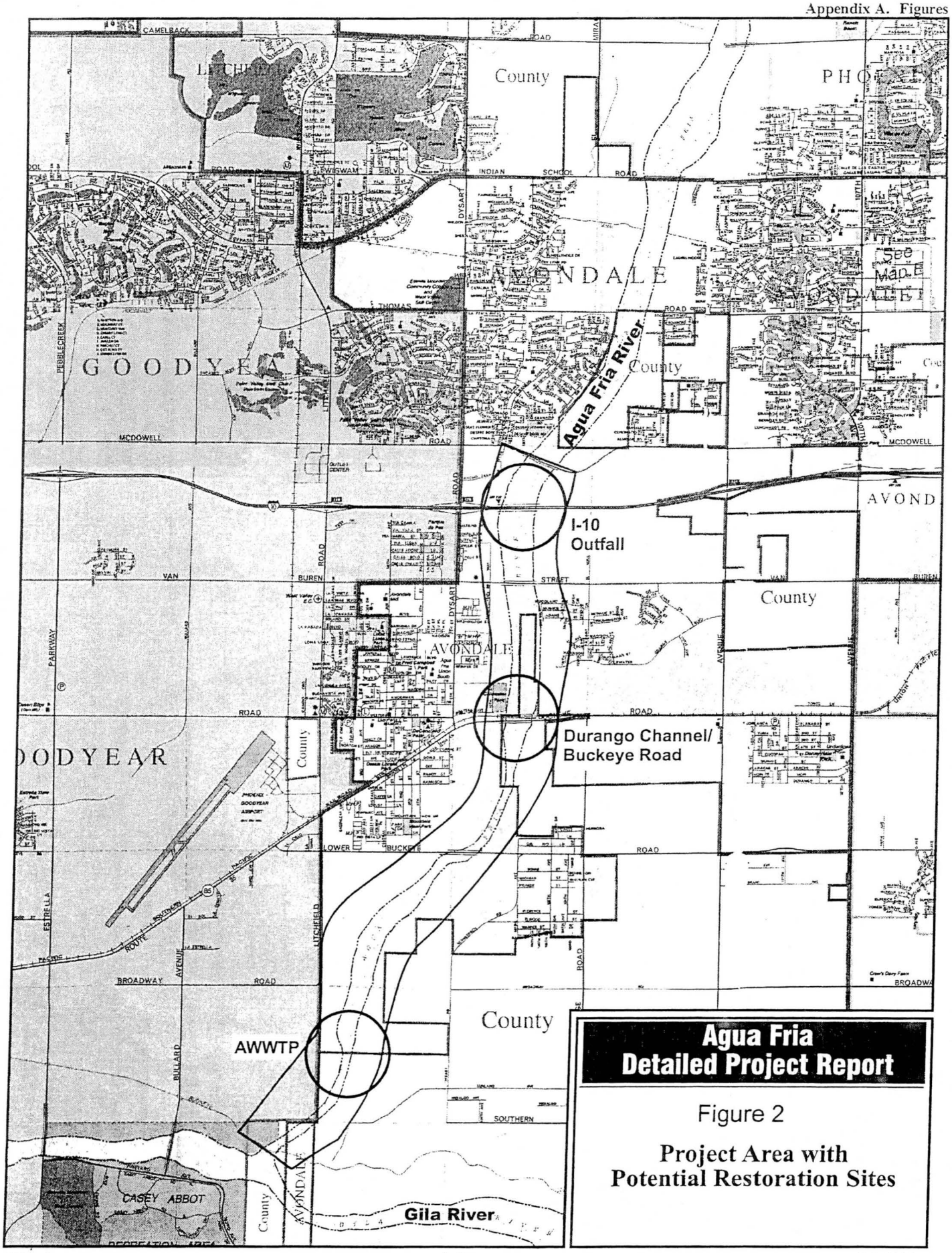


Source: USACE, 2001a.

Agua Fria Detailed Project Report

Figure 1

Project Location and Vicinity Map

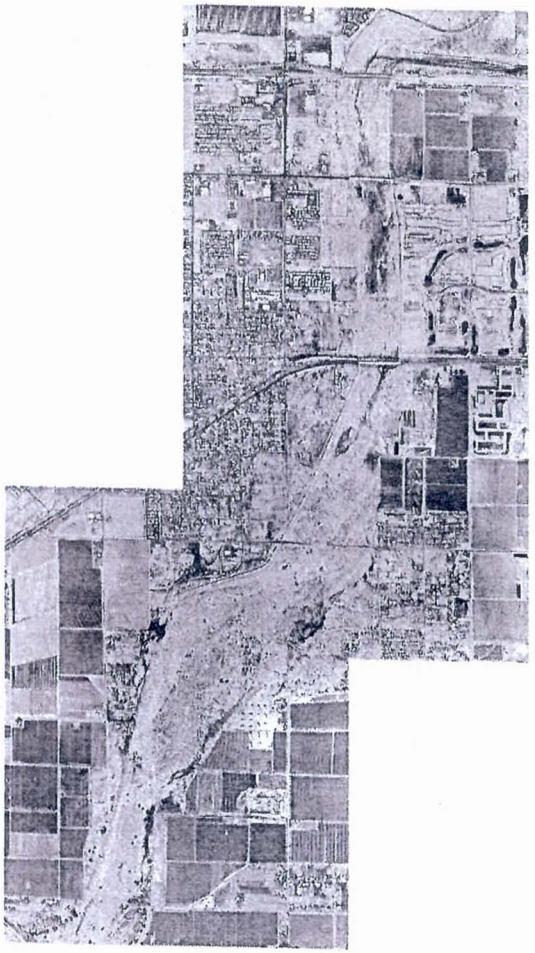


Agua Fria Detailed Project Report

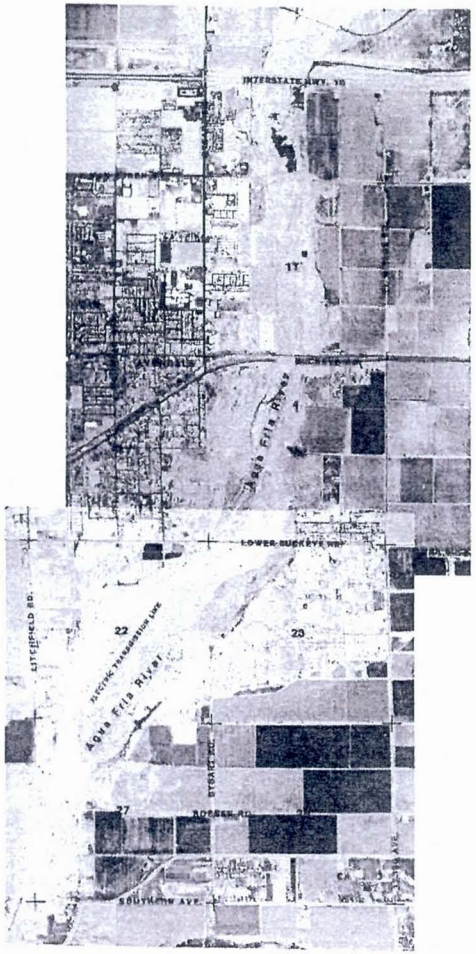
Figure 2

Project Area with Potential Restoration Sites

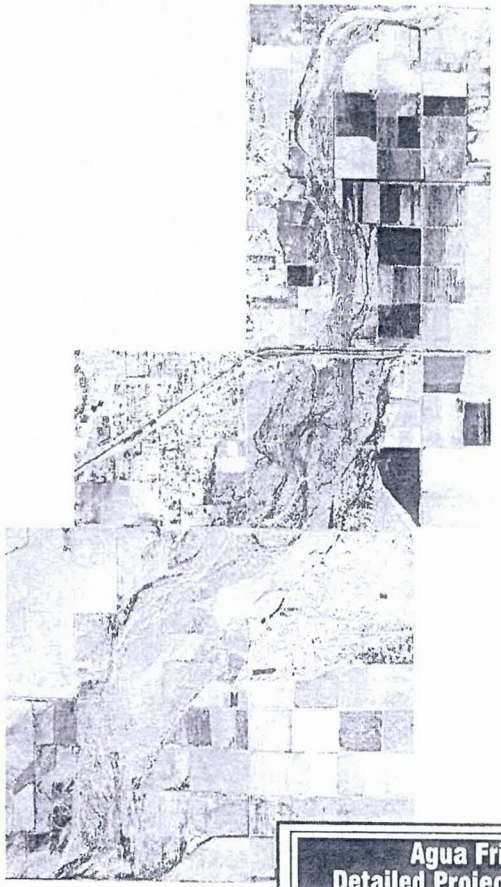
AGUA FRIA RIVER 2001



AGUA FRIA RIVER 1984



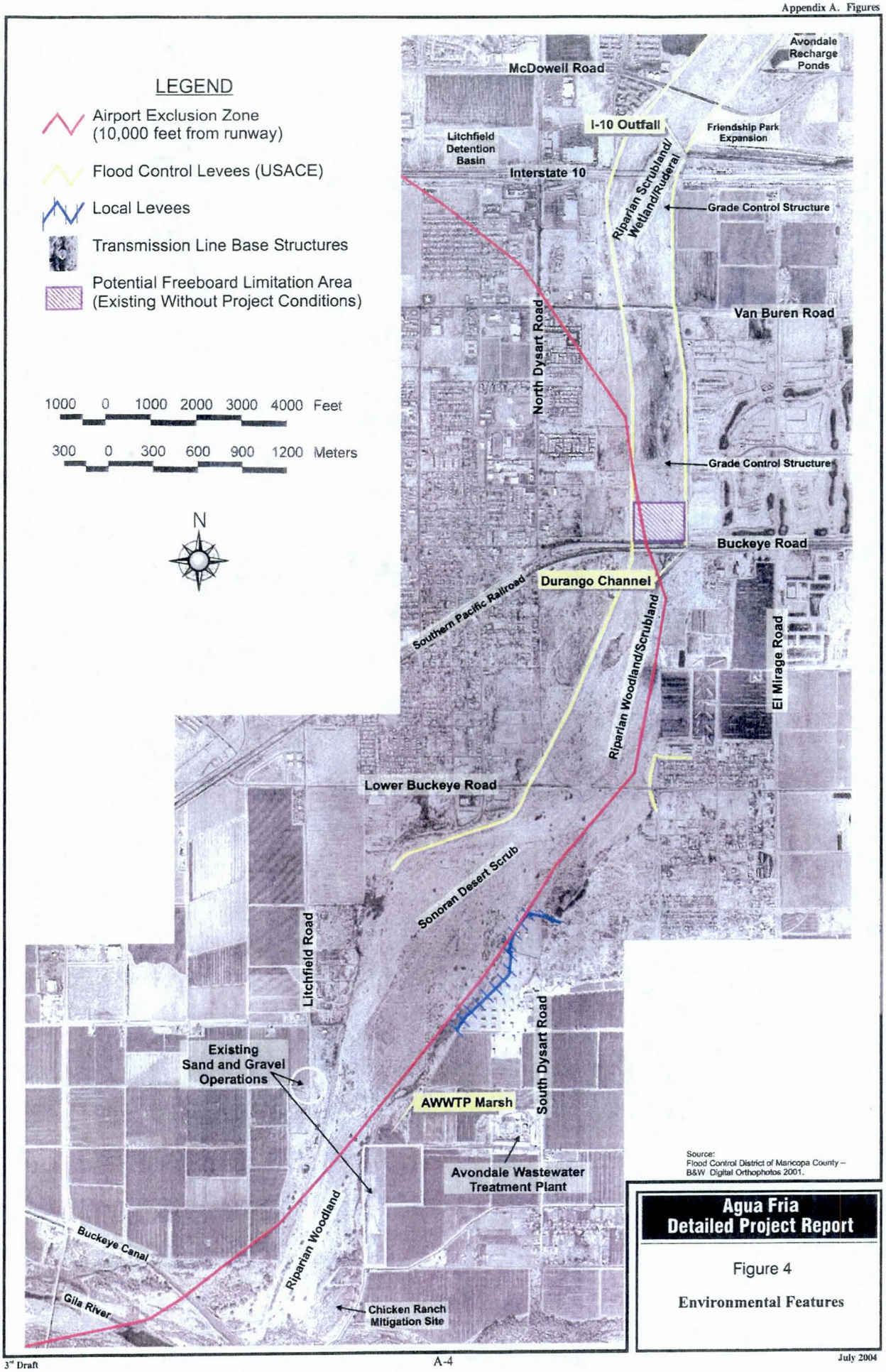
AGUA FRIA RIVER 1959

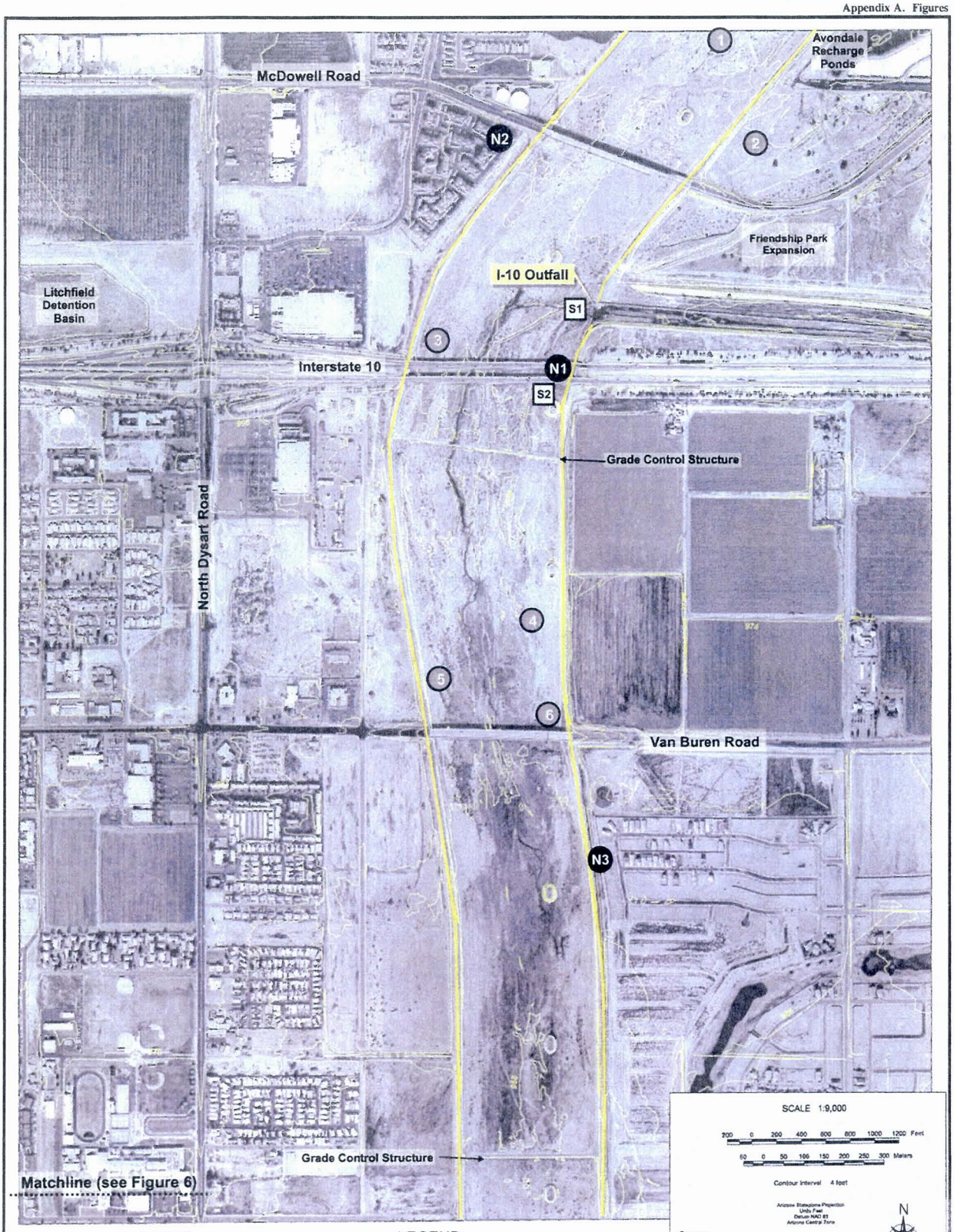


Agua Fria Detailed Project Report

Figure 3

1959 - 2001 Aerials


LEGEND
Airport Exclusion Zone (10,000 feet from runway)
Flood Control Levees (USACE)
Local Levees
Transmission Line Base Structures
Potential Freeboard Limitation Area (Existing Without Project Conditions)
1000 0 1000 2000 3000 4000 Feet
300 0 300 600 900 1200 Meters
N
McDowell Road
Avondale Recharge Ponds
I-10 Outfall
Friendship Park Expansion
Litchfield Detention Basin
Interstate 10
Riparian Scrubland/ Wetland/Ruderal
Grade Control Structure
North Dysart Road
Van Buren Road
Grade Control Structure
Buckeye Road
Durango Channel
Southern Pacific Railroad
Riparian Woodland/Scrubland
El Mirage Road
Lower Buckeye Road
Sonoran Desert Scrub
Litchfield Road
South Dysart Road
Existing Sand and Gravel Operations
AWWTP Marsh
Avondale Wastewater Treatment Plant
Buckeye Canal
Gila River
Riparian Woodland
Chicken Ranch Mitigation Site
Source: Flood Control District of Maricopa County – B&W Digital Orthophotos 2001.
Agua Fria Detailed Project Report
Figure 4
Environmental Features



Agua Fria Detailed Project Report

Figure 5

Environmental Features Sheet 1 of 4

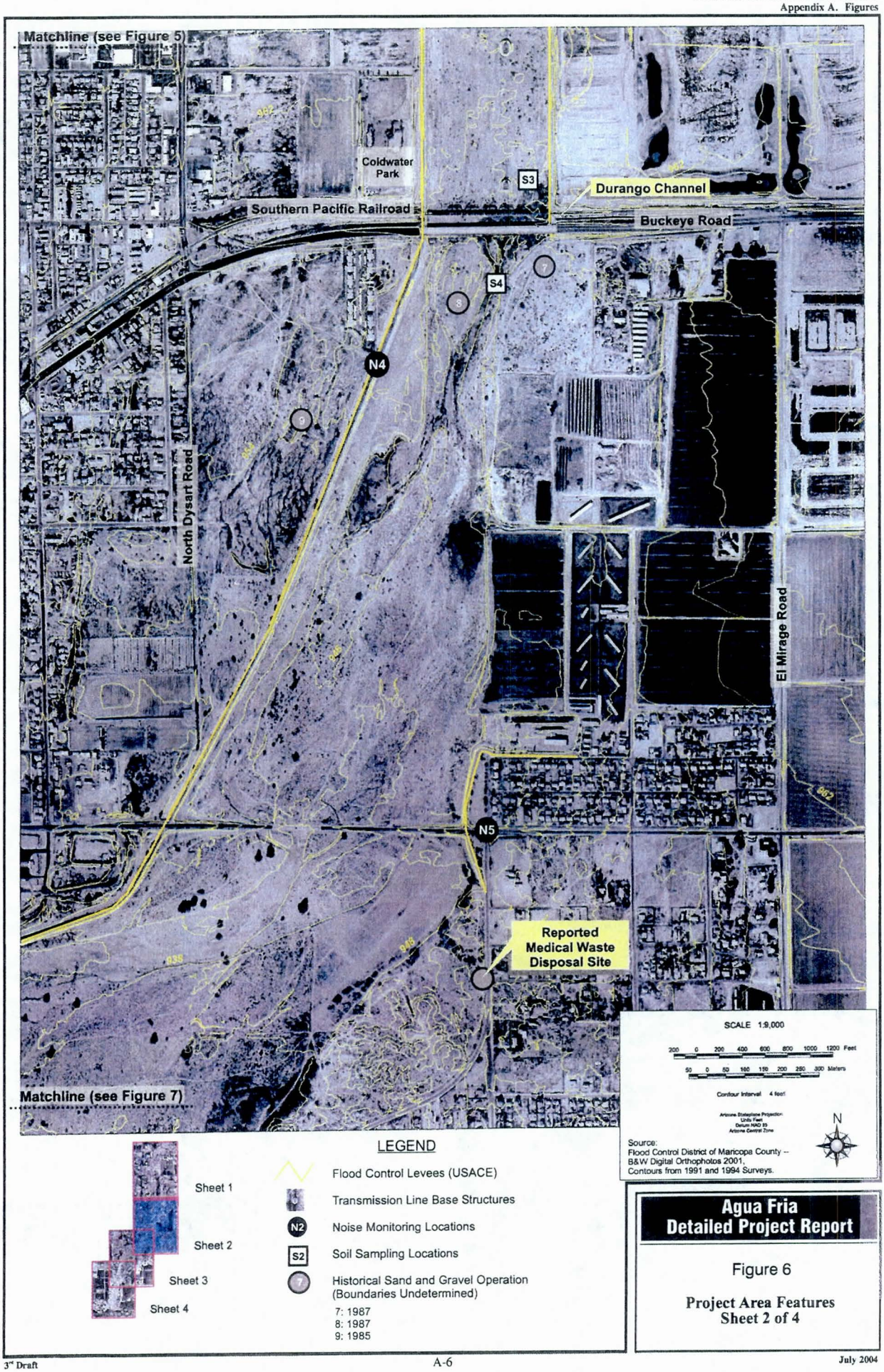


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Figure 6

Project Area Features Sheet 2 of 4

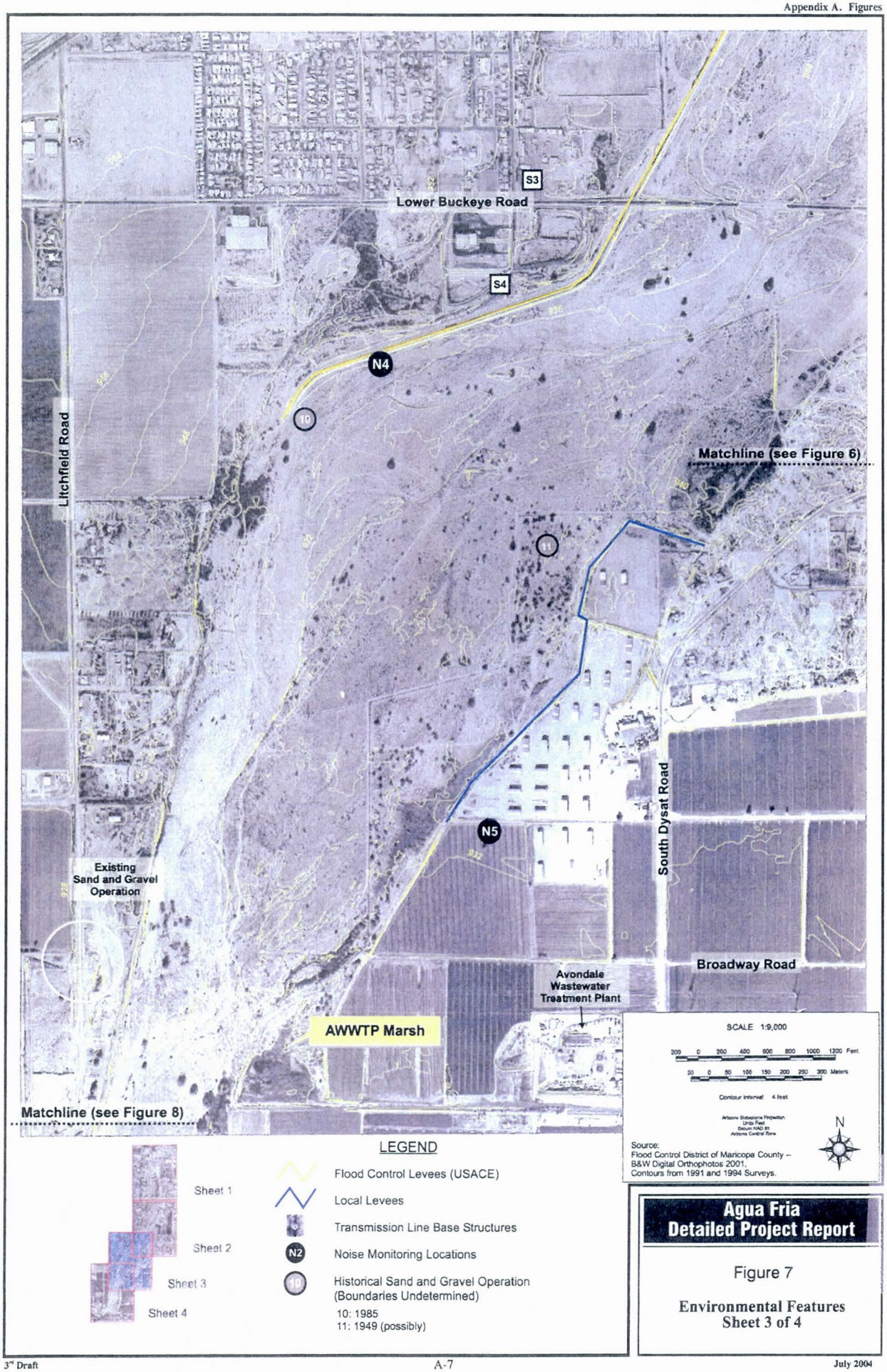

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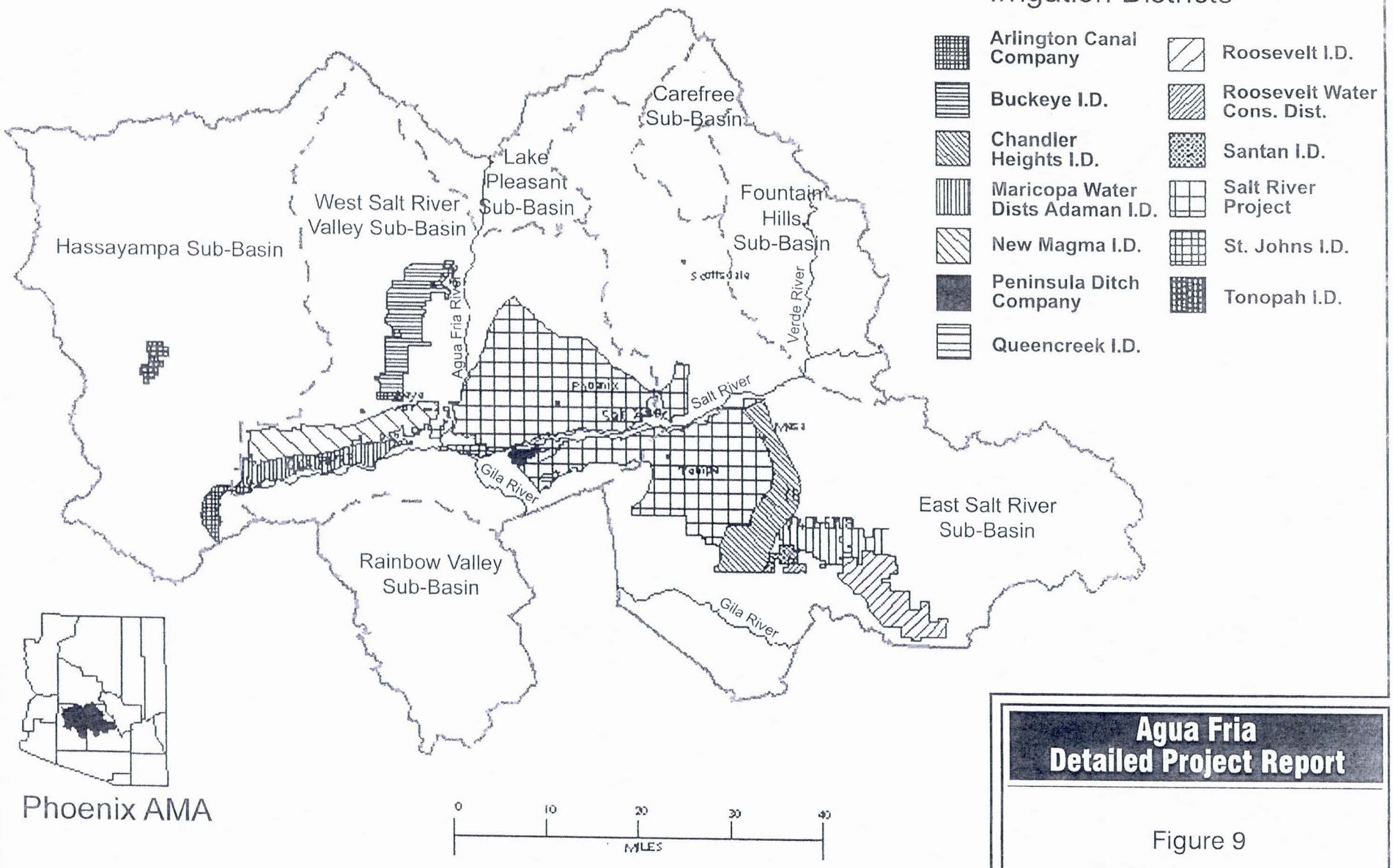
Figure 7

Environmental Features
Sheet 3 of 4

Agua Fria Detailed Project Report

Figure 8

Environmental Features
Sheet 4 of 4



Source: ADWR http://www.water.az.gov/azwaterinfo/InsideAMAs/amaphoenix.html

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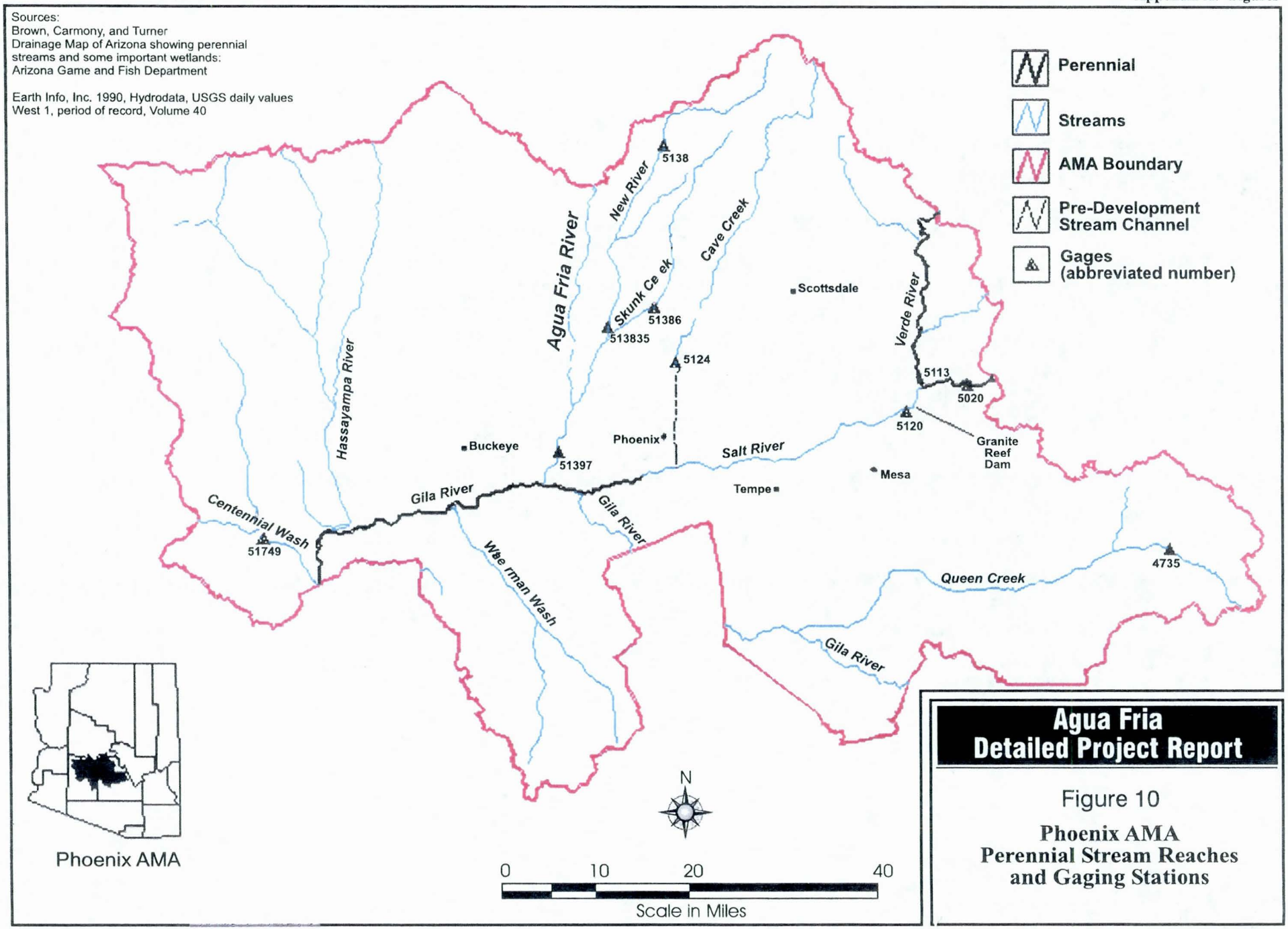
Figure 9
Irrigation Districts


Sources:
Brown, Carmony, and Turner
Drainage Map of Arizona showing perennial streams and some important wetlands:
Arizona Game and Fish Department
Earth Info, Inc. 1990, Hydrodata, USGS daily values
West 1, period of record, Volume 40
Perennial
Streams
AMA Boundary
Pre-Development Stream Channel
Gages (abbreviated number)
Agua Fria River
New River
Cave Creek
Skunk Creek
Hassayampa River
Verde River
Salt River
Gila River
Centennial Wash
Wickenburg Wash
Queen Creek
5138
51386
513835
5124
5113
5020
5120
51397
51749
4735
Scottsdale
Buckeye
Phoenix
Tempe
Mesa
Granite Reef Dam
Phoenix AMA
N
0 10 20 40
Scale in Miles
Agua Fria Detailed Project Report
Figure 10
Phoenix AMA
Perennial Stream Reaches and Gaging Stations

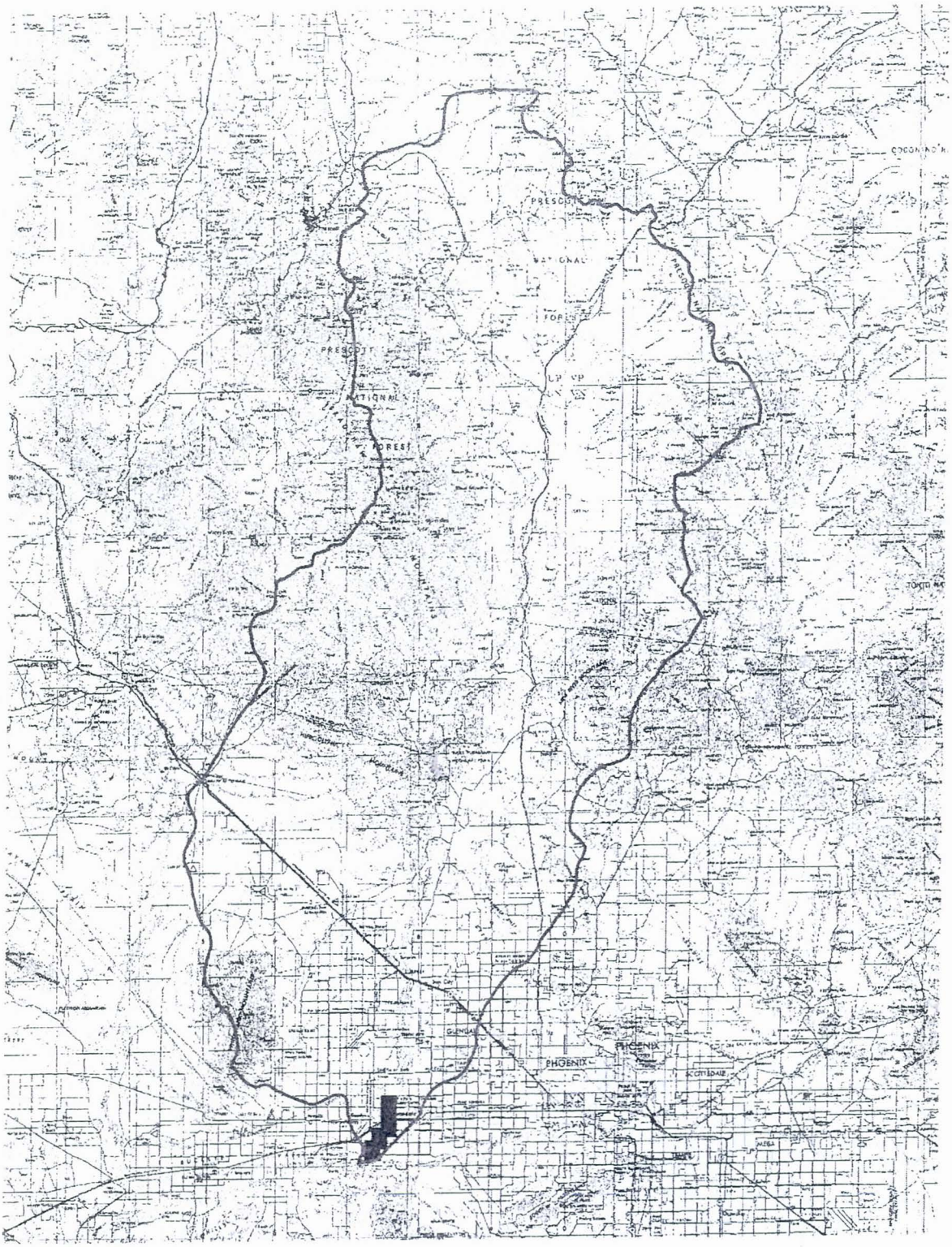


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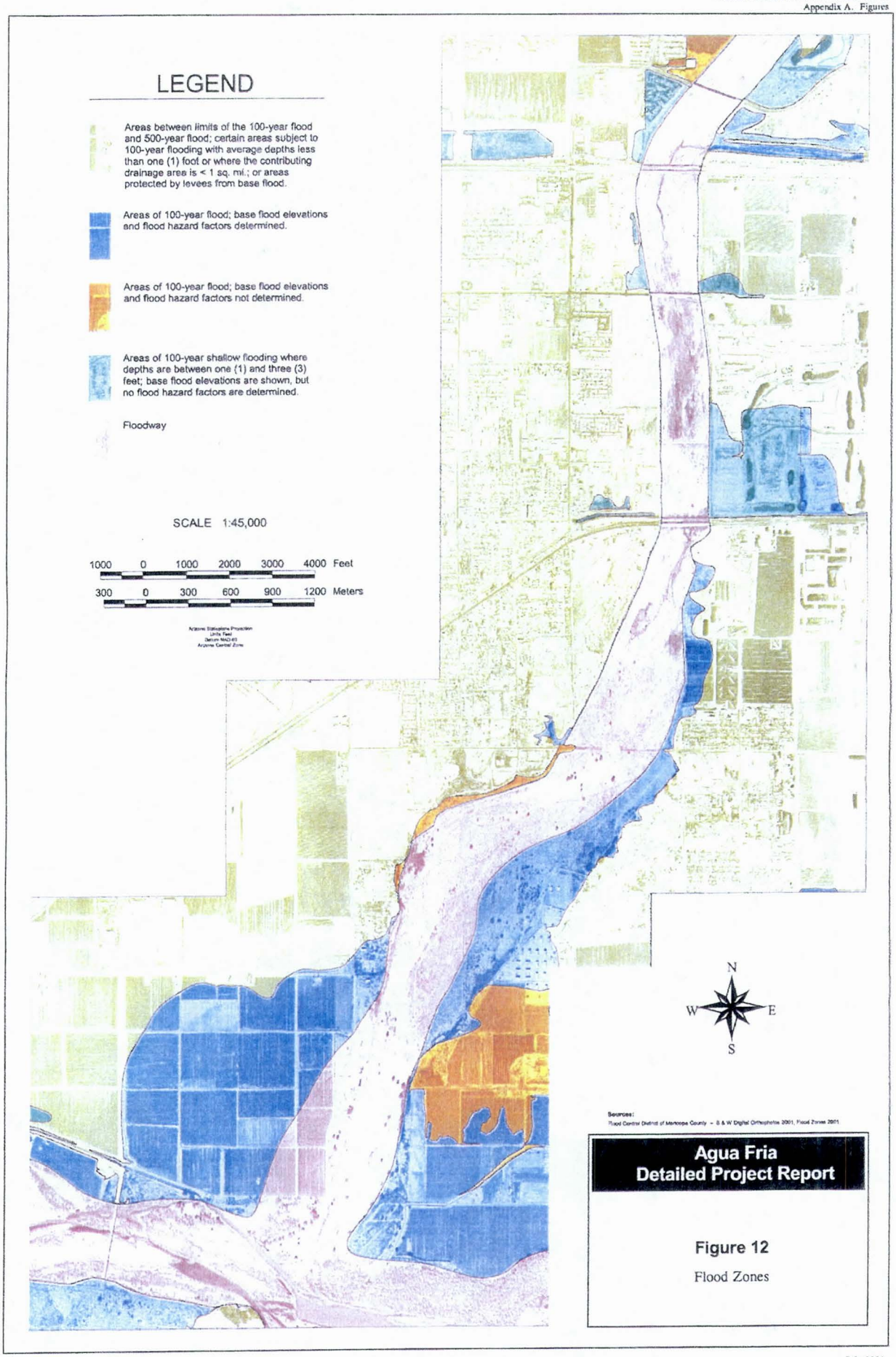
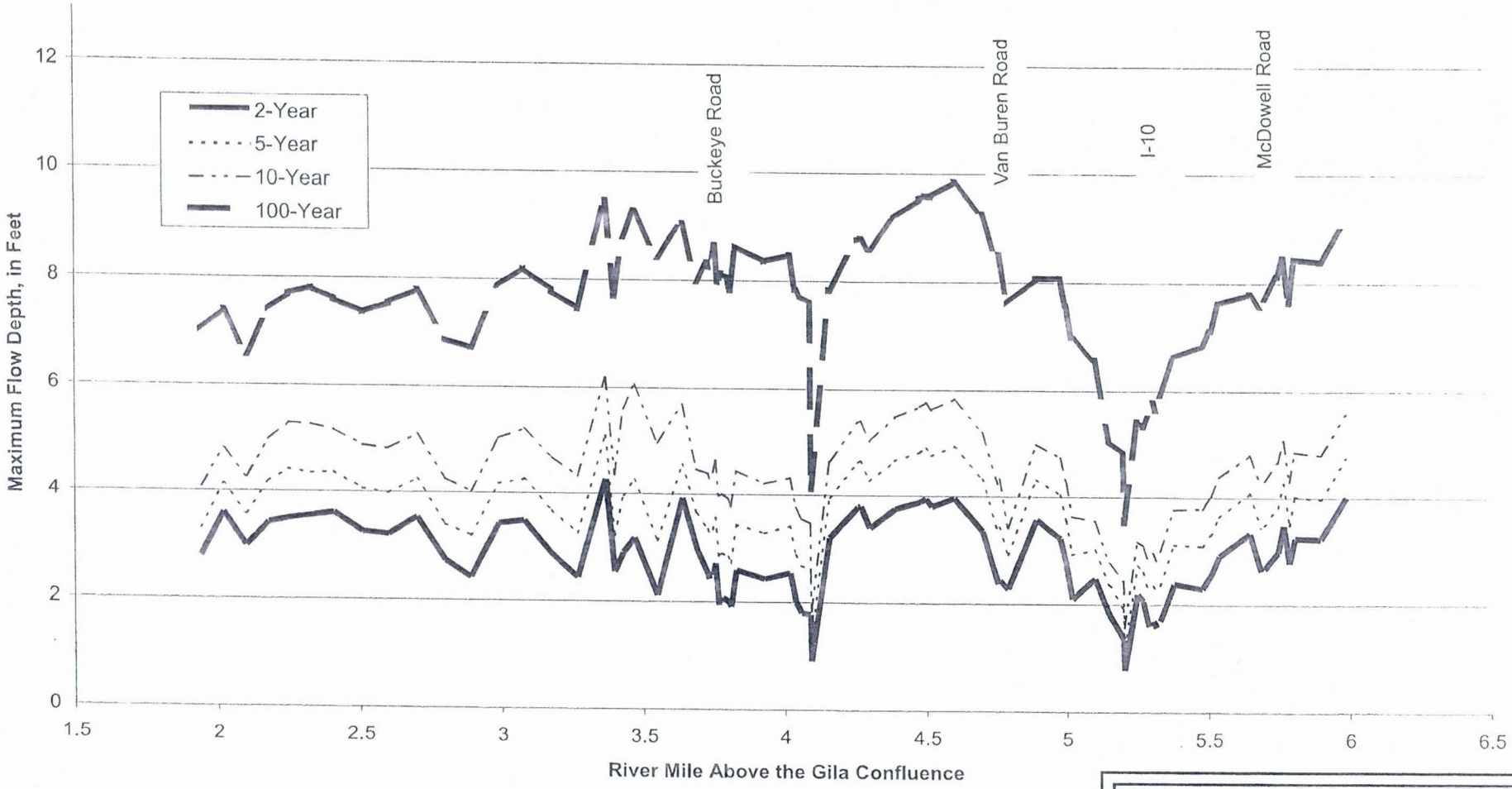
Figure 11

ApproximateBoundaries of the Agua Fria Watershed Area


LEGEND
Areas between limits of the 100-year flood and 500-year flood; certain areas subject to 100-year flooding with average depths less than one (1) foot or where the contributing drainage area is < 1 sq. mi.; or areas protected by levees from base flood.
Areas of 100-year flood; base flood elevations and flood hazard factors determined.
Areas of 100-year flood; base flood elevations and flood hazard factors not determined.
Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; base flood elevations are shown, but no flood hazard factors are determined.
Floodway
SCALE 1:45,000
1000 0 1000 2000 3000 4000 Feet
300 0 300 600 900 1200 Meters
N
W
E
S
Sources:
Agua Fria
Detailed Project Report
Figure 12
Flood Zones

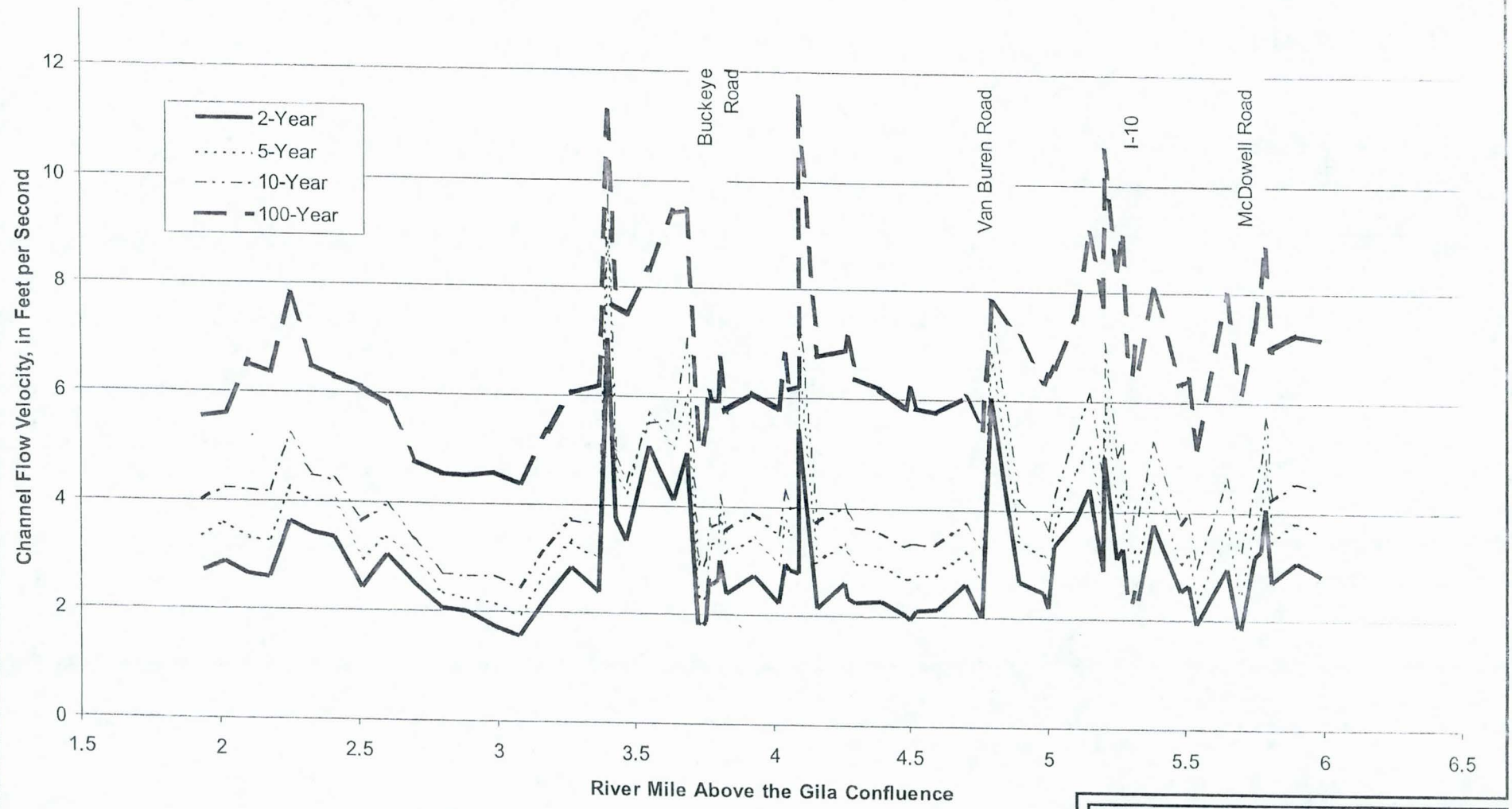


Source:
Adapted from a HEC-RAS computer model prepared for the Agua Fria Watercourse Master Plan by LTM Engineering

Agua Fria Detailed Project Report

Figure 13

Agua Fria Flow Depths Post New Waddell Dam Condition

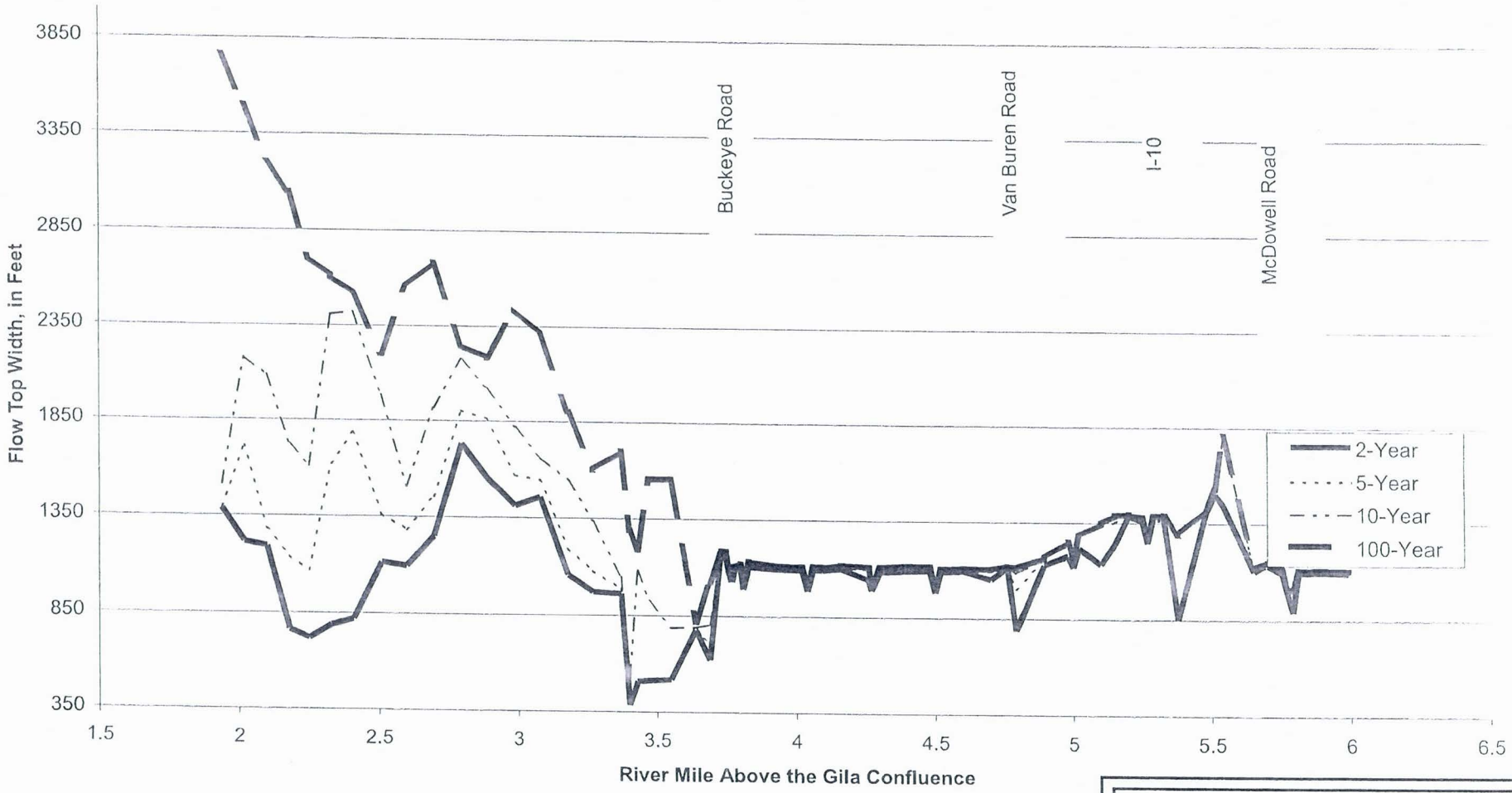


Source:
Adapted from a HEC-RAS computer model prepared for the Agua Fria Watercourse Master Plan by LTM Engineering

Agua Fria Detailed Project Report

Figure 14

Agua Fria Flow Velocities Post-New Waddell Dam Condition

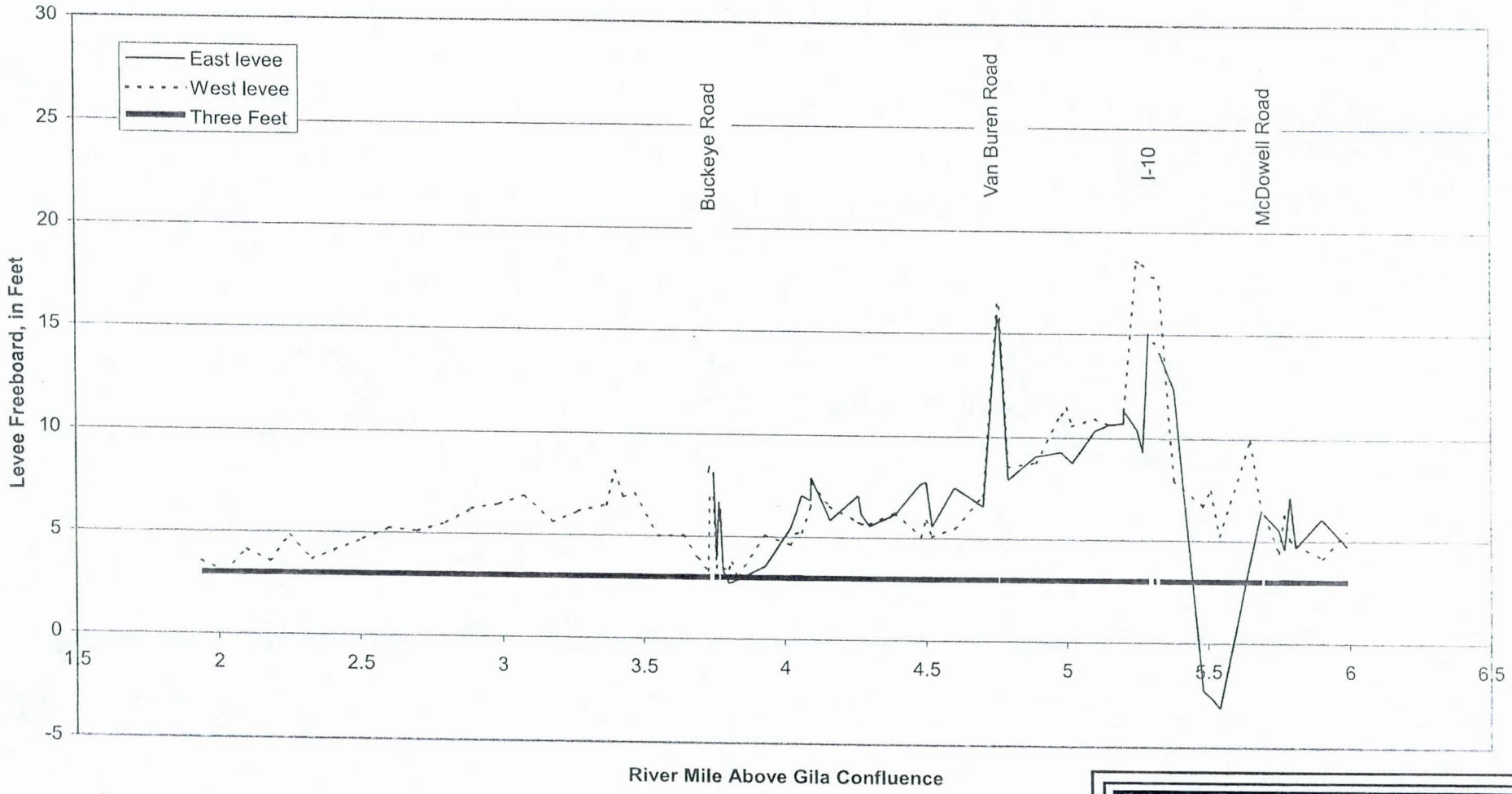


Source:
Adapted from a HEC-RAS computer model prepared for
the Agua Fria Watercourse Master Plan by LTM Engineering

Agua Fria Detailed Project Report

Figure 15

Agua Fria Flow Top Width Post-New Waddell Dam Condition

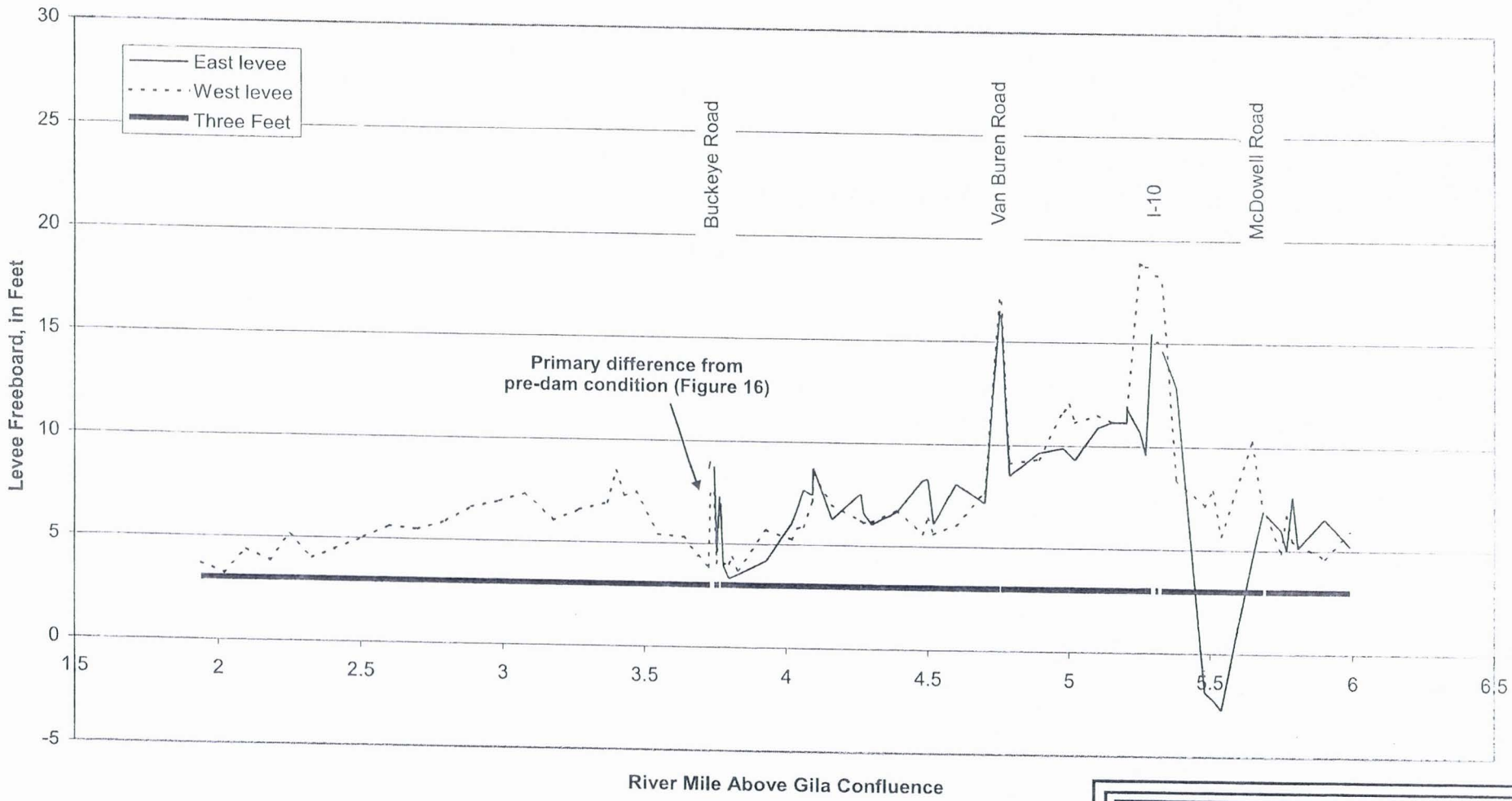


Source:
Adapted from a HEC-RAS computer model prepared for the Agua Fria Watercourse Master Plan by LTM Engineering

Agua Fria Detailed Project Report

Figure 16

Agua Fria Levee Freeboard Pre-New Waddell Dam SPF



Source:
Adapted from a HEC-RAS computer model prepared for
the Agua Fria Watercourse Master Plan by LTM Engineering

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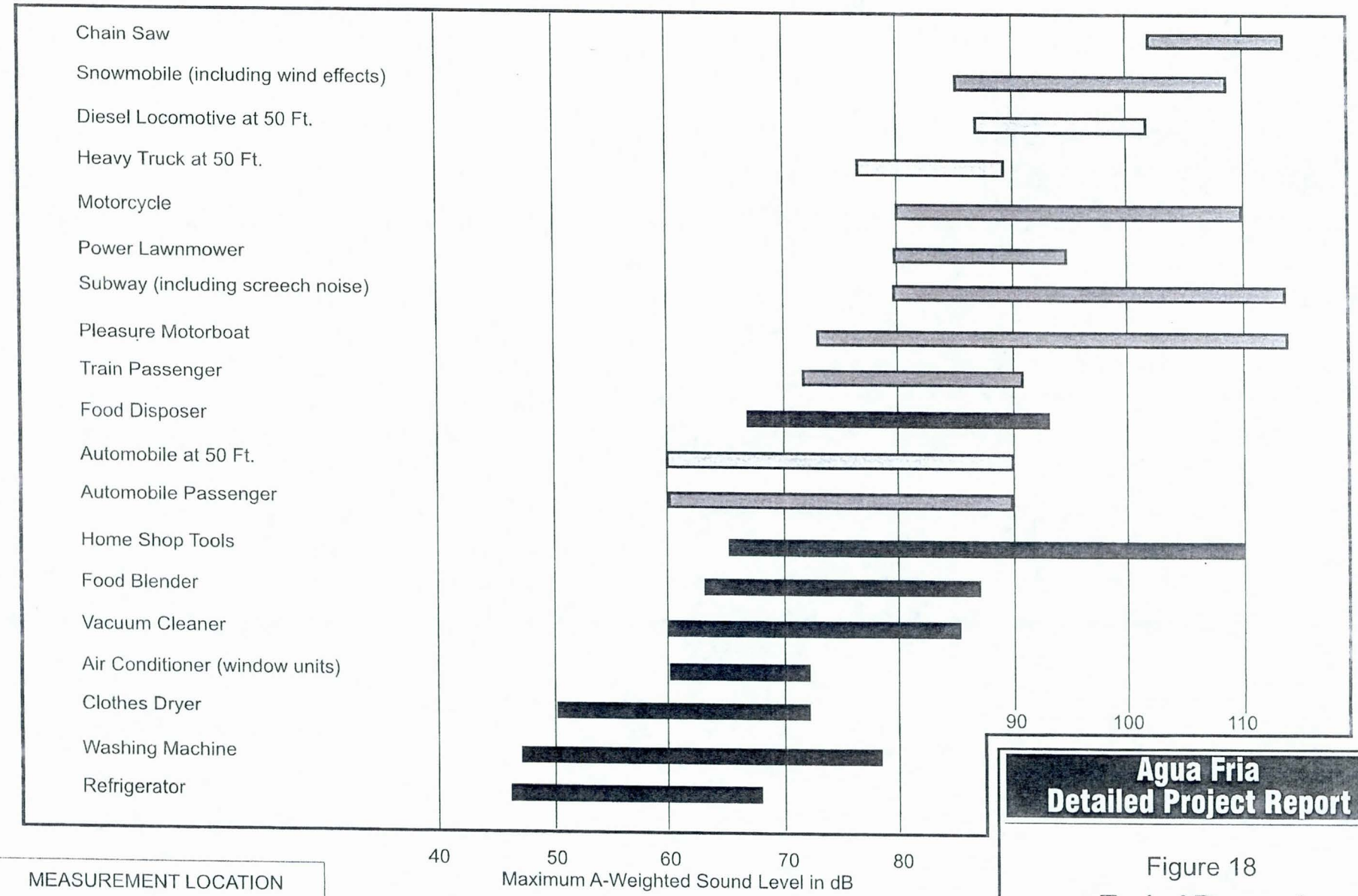
Figure 17

Agua Fria Levee Freeboard Post-New Waddell Dam SPF

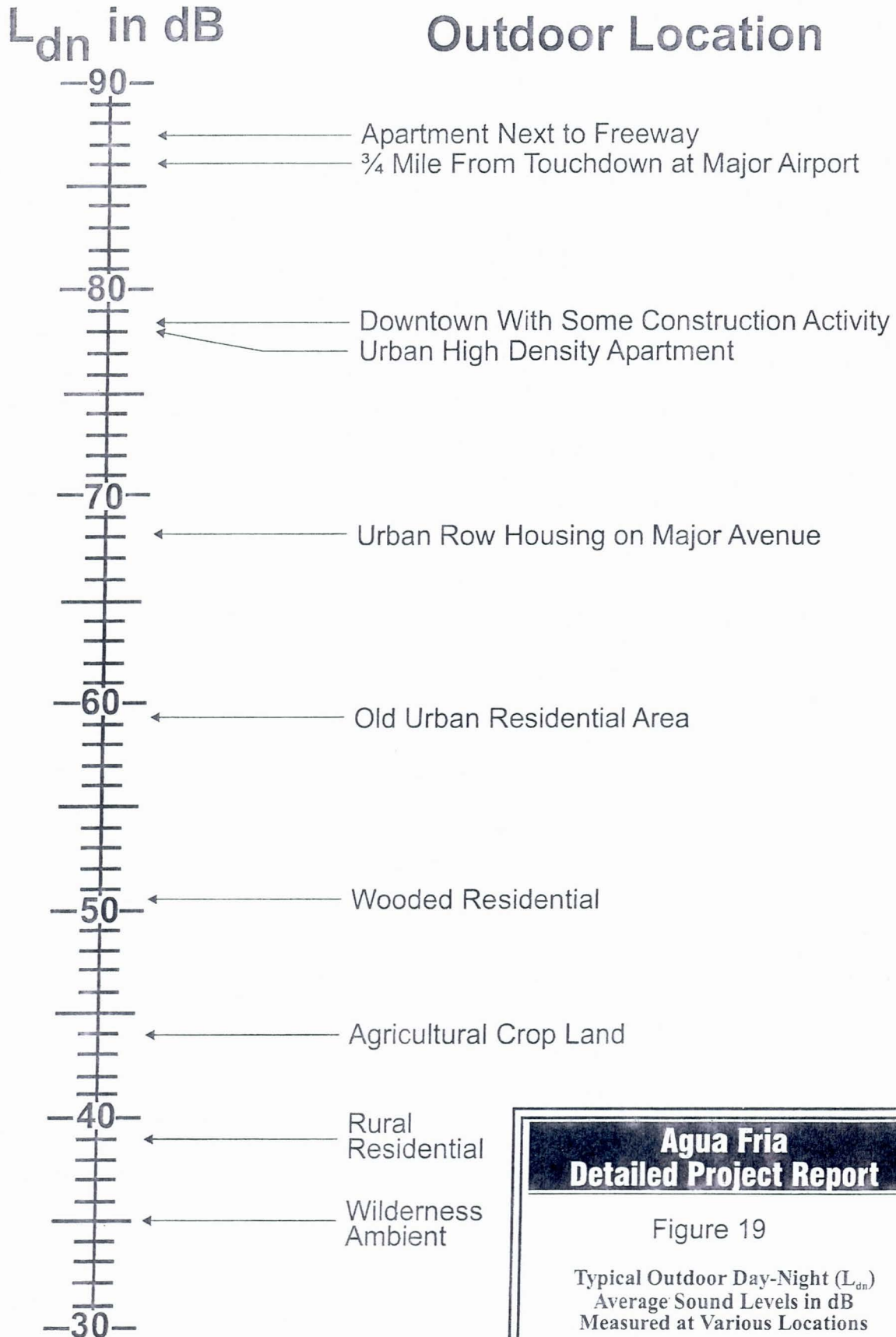


Source: USEPA, 1978. Protective Noise Levels
Condensed Version of EPA Levels Document

Agua Fria Detailed Project Report

Figure 18

Typical Range of Common Sounds

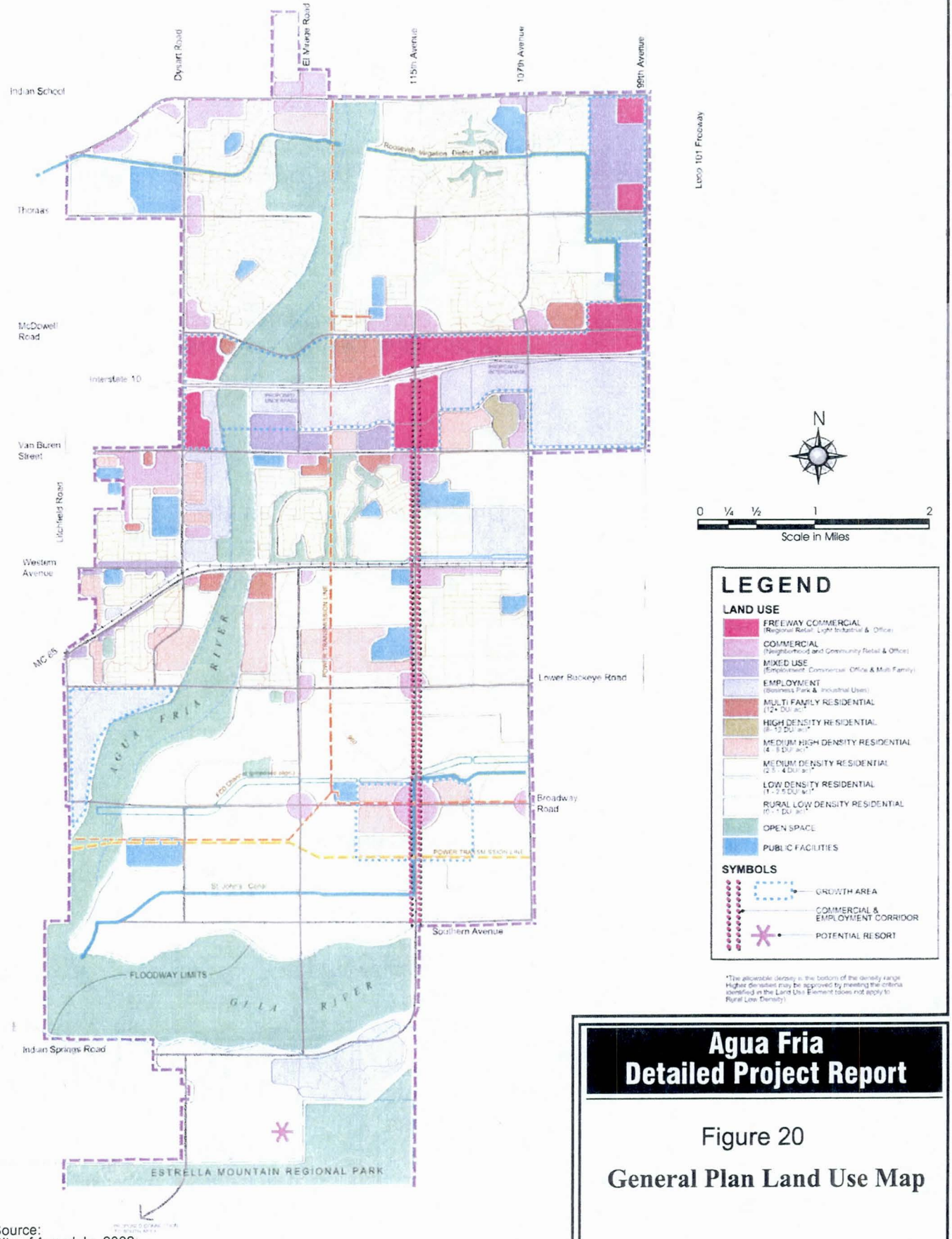


Source: USEPA, 1978. Protective Noise Levels Condensed Version of EPA Levels Document

Agua Fria Detailed Project Report

Figure 19

Typical Outdoor Day-Night (L_{dn}) Average Sound Levels in dB Measured at Various Locations

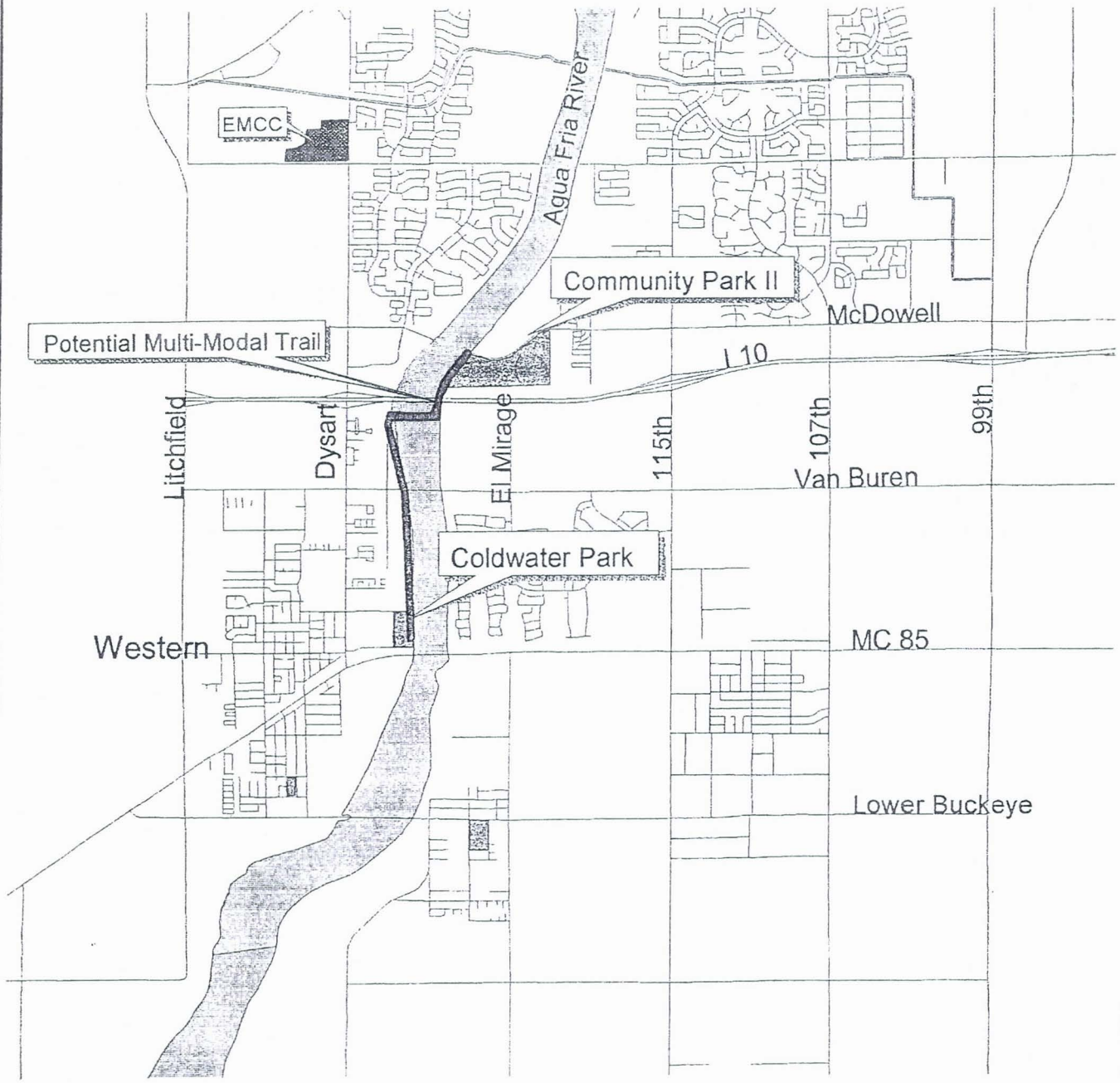


Source:
City of Avondale, 2002

Agua Fria Detailed Project Report

Figure 20

General Plan Land Use Map



* As of 7/1/04 the Friendship Park Expansion (Community Park II) was 90% complete; other phases of the recreation plan have not yet been implemented.

N

0 1½ 3

Scale in Miles

Source: City of Avondale, 2002

Agua Fria Detailed Project Report

Figure 21
Planned Recreation Facilities Adjacent to the Restoration Project

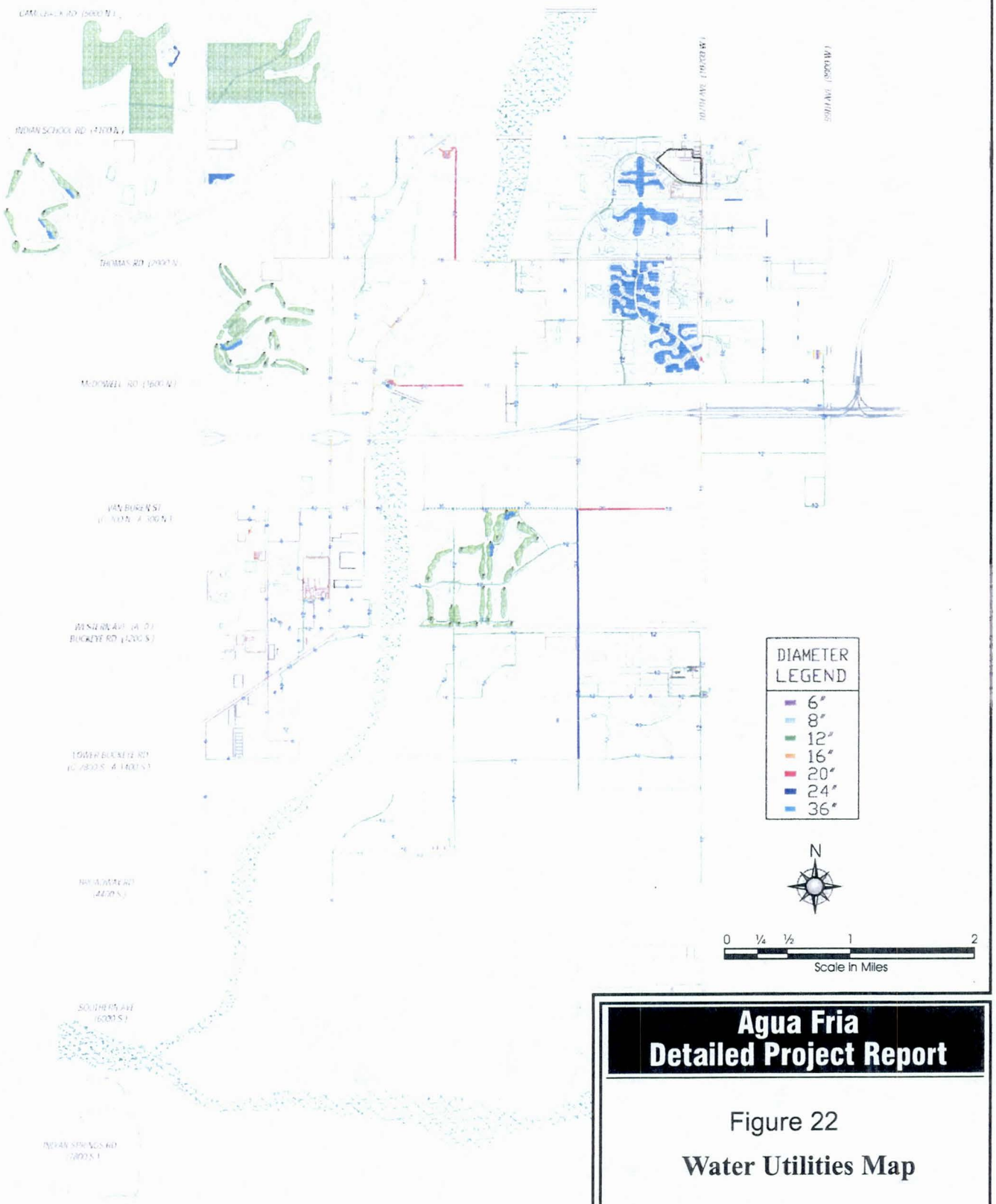


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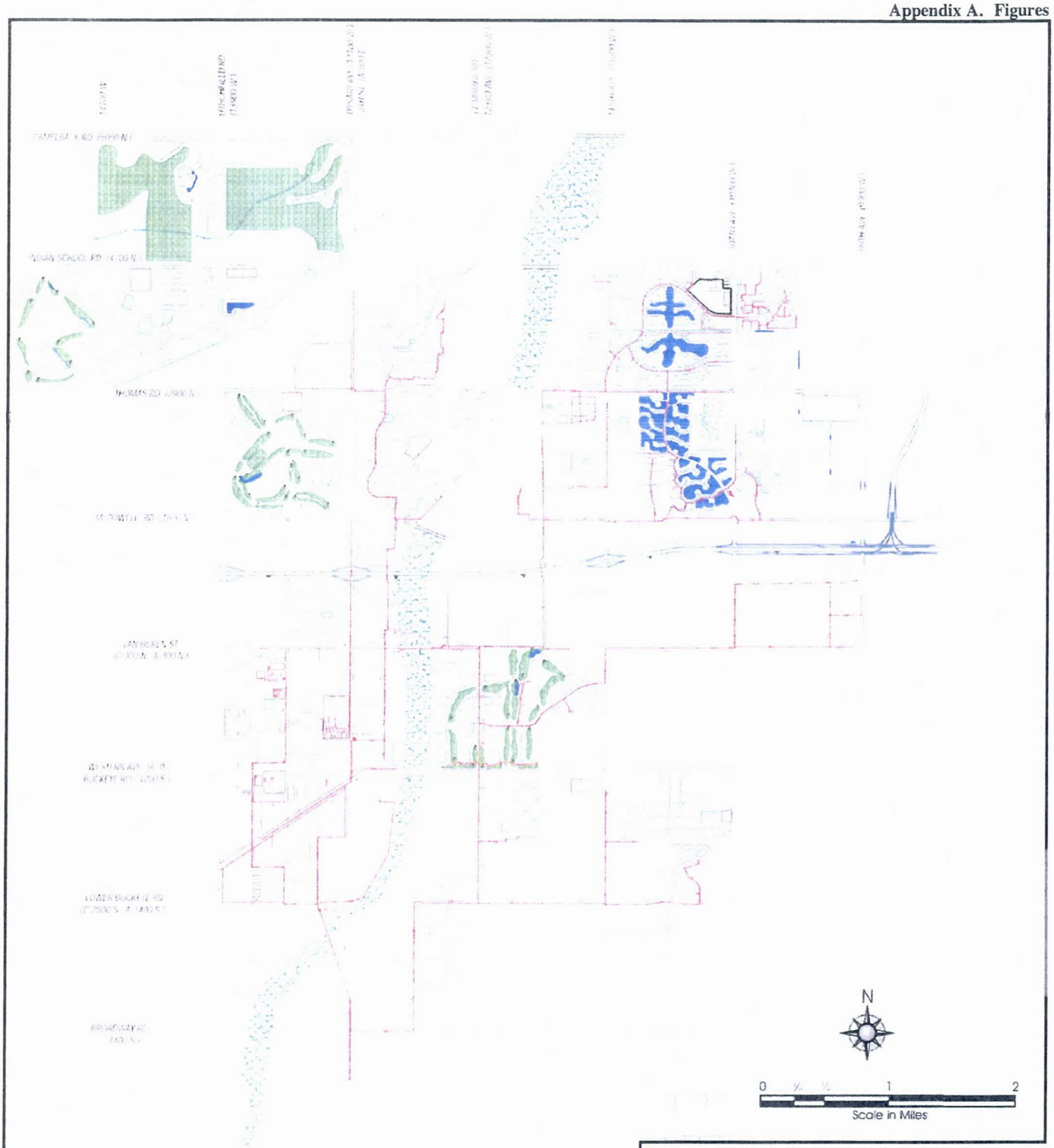
Figure 22

Water Utilities Map

Source:
City of Avondale, 2002



Source:
City of Avondale, 2002

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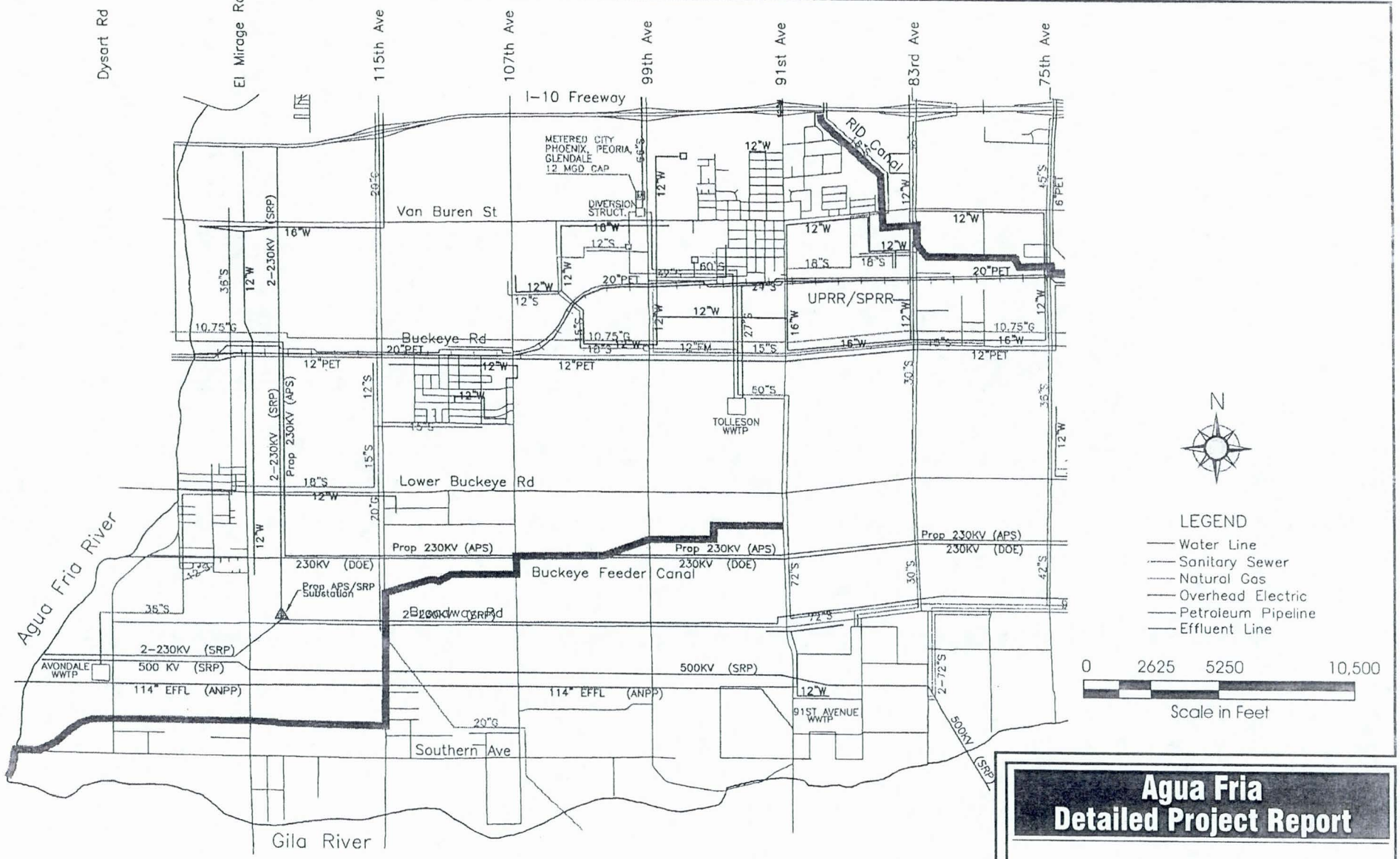
Figure 23

Wastewater Utilities Map

Aspen Environmental Group



Source: Durango Area Drainage Master Plan Data Collection Report, 2000; FCD#99-41, FCDMC.

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Figure 24

Existing and Planned Utilities

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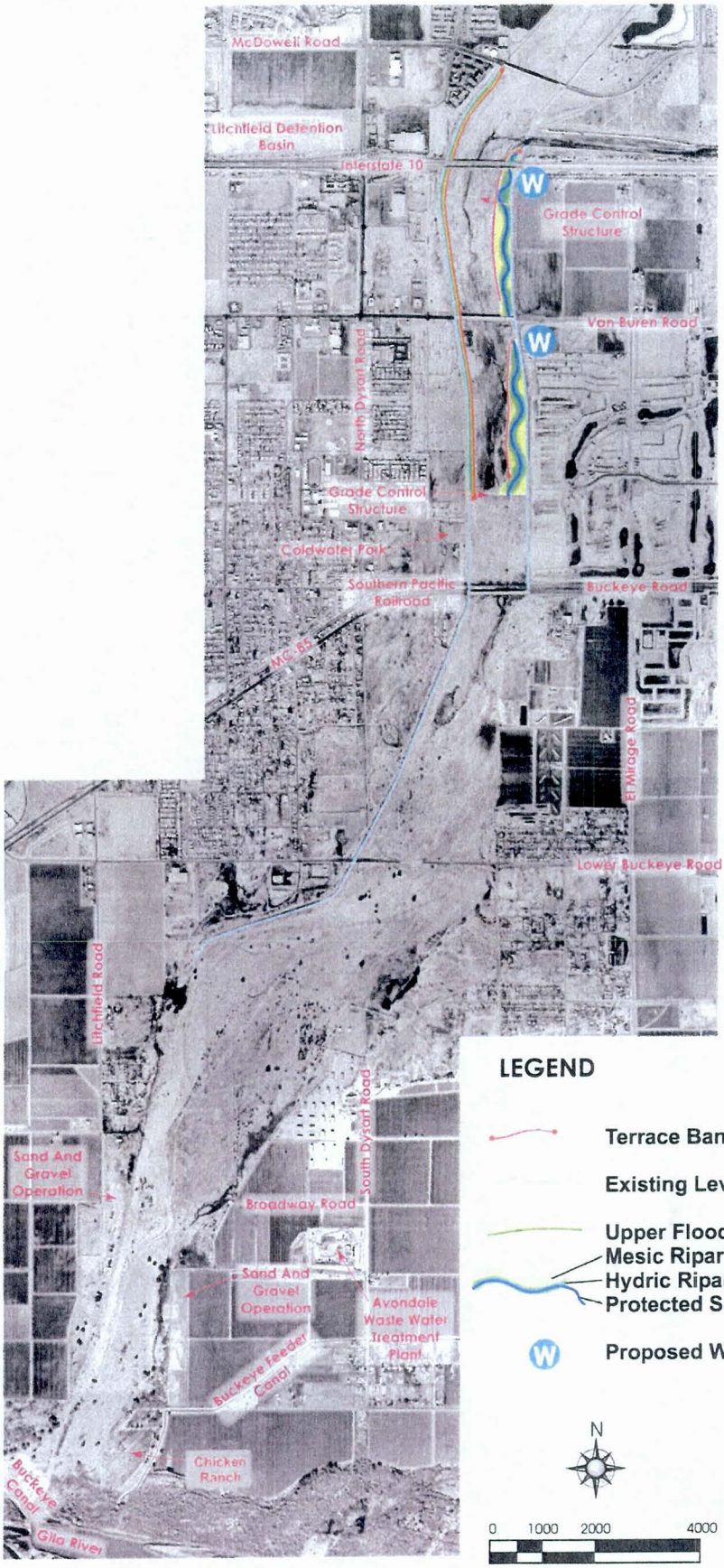
Figure 25

Street Map of the Project Area



Source: TetraTech, Inc., Tucson, AZ, 2002

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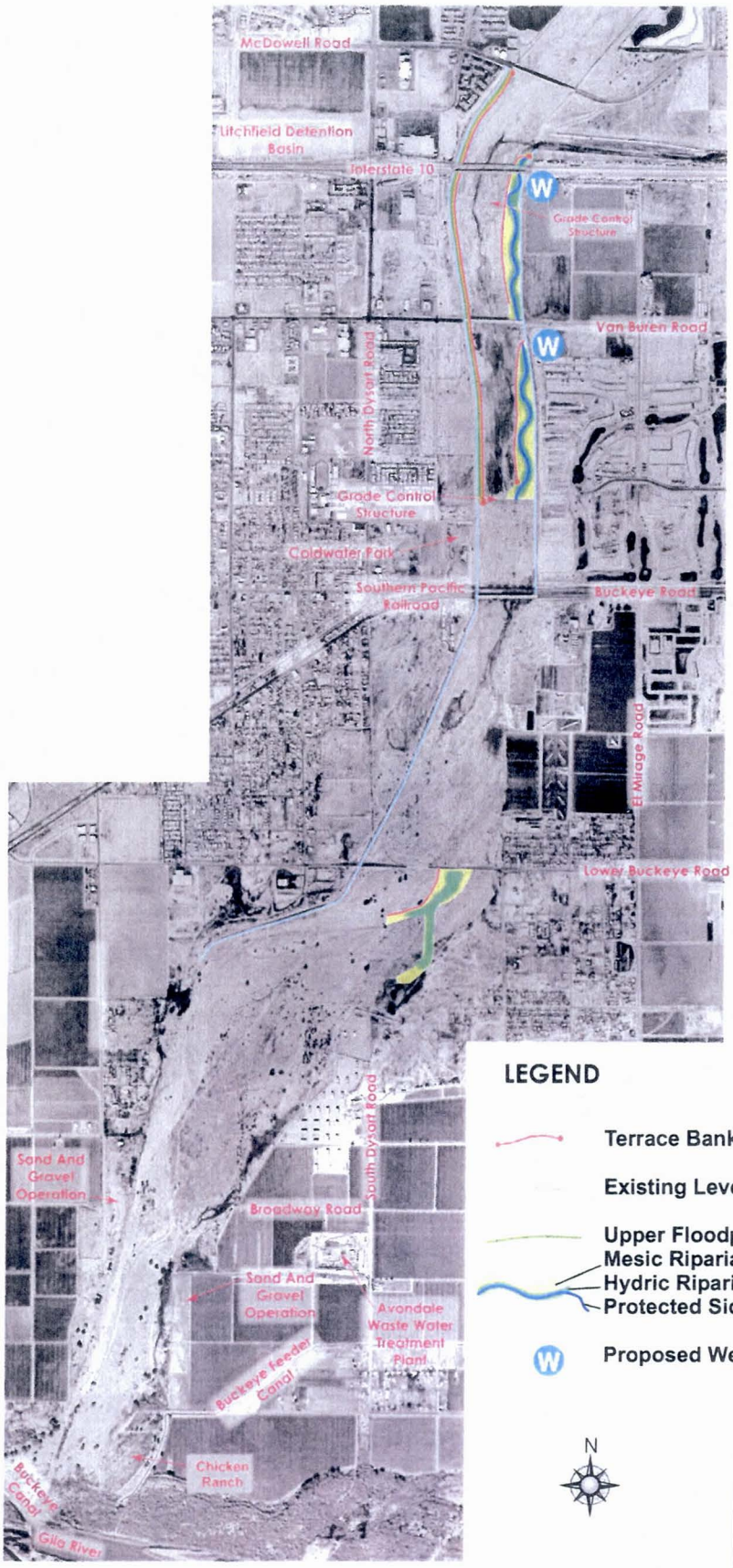
Figure 26

Alternative 2 Low Water Use

July 2004



Source: TetraTech, Inc., Tucson, AZ, 2002

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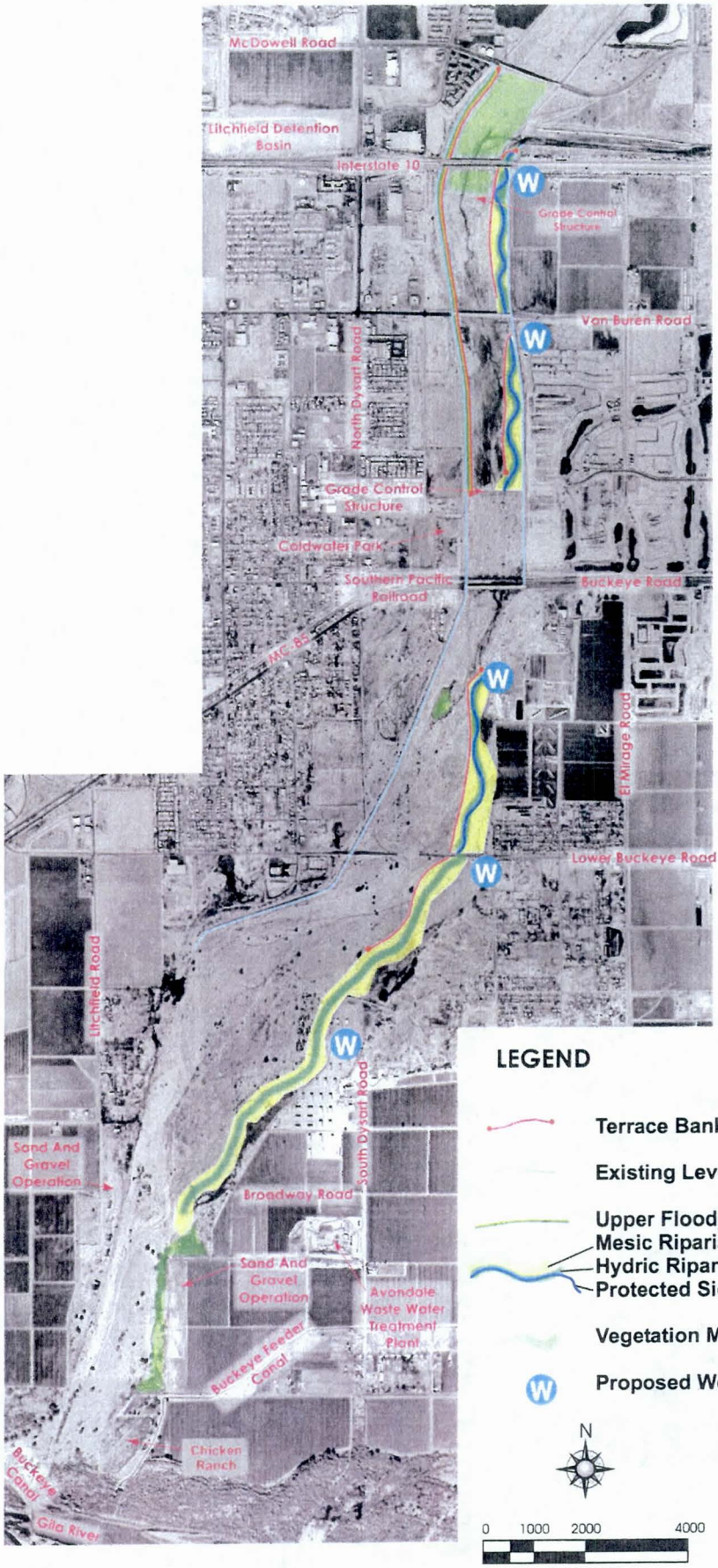
Figure 27

Alternative 3
Moderate Water Use



Source: TetraTech, Inc., Tucson, AZ, 2002

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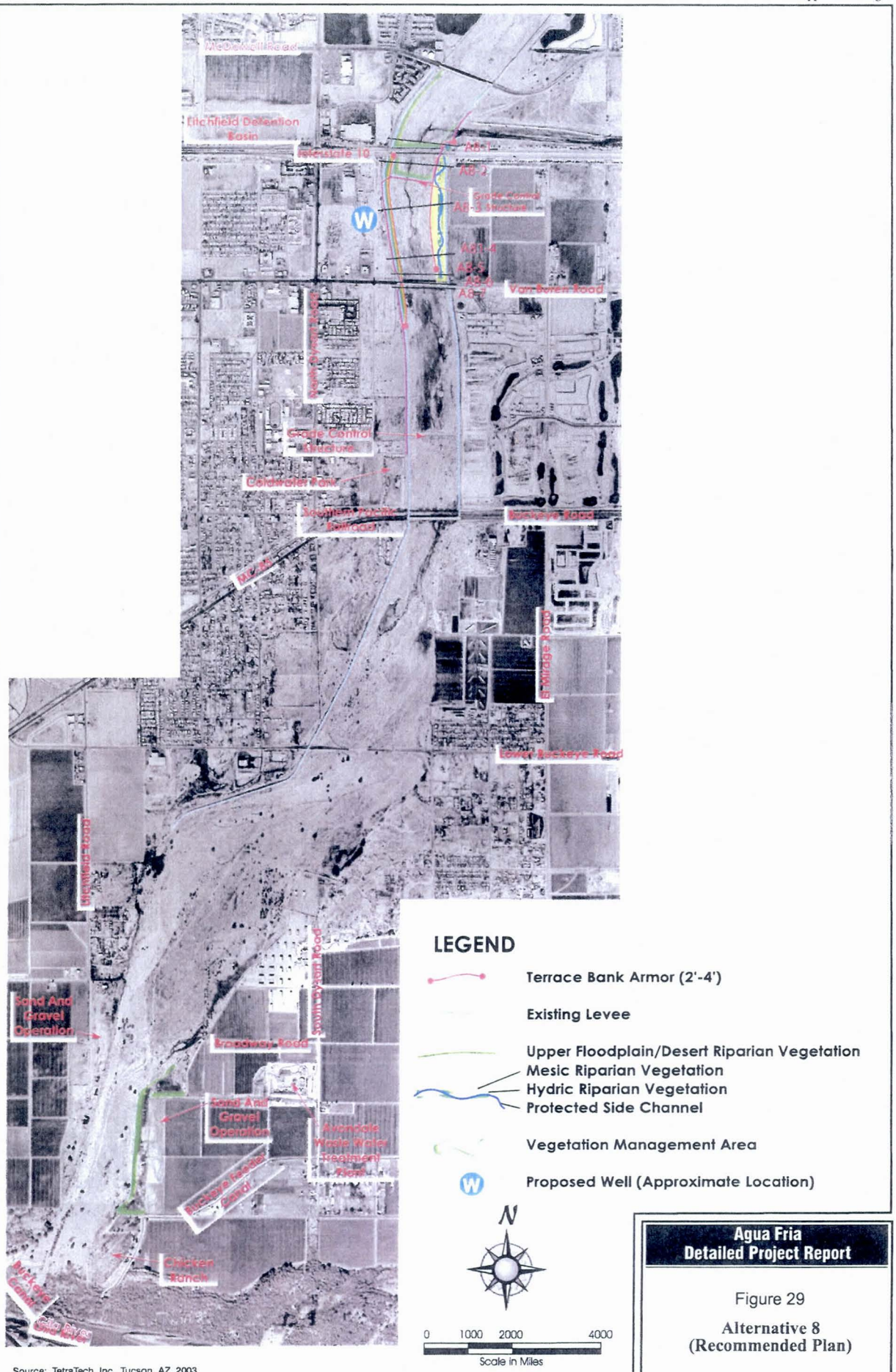
Figure 28

Alternative 4
High Water Use

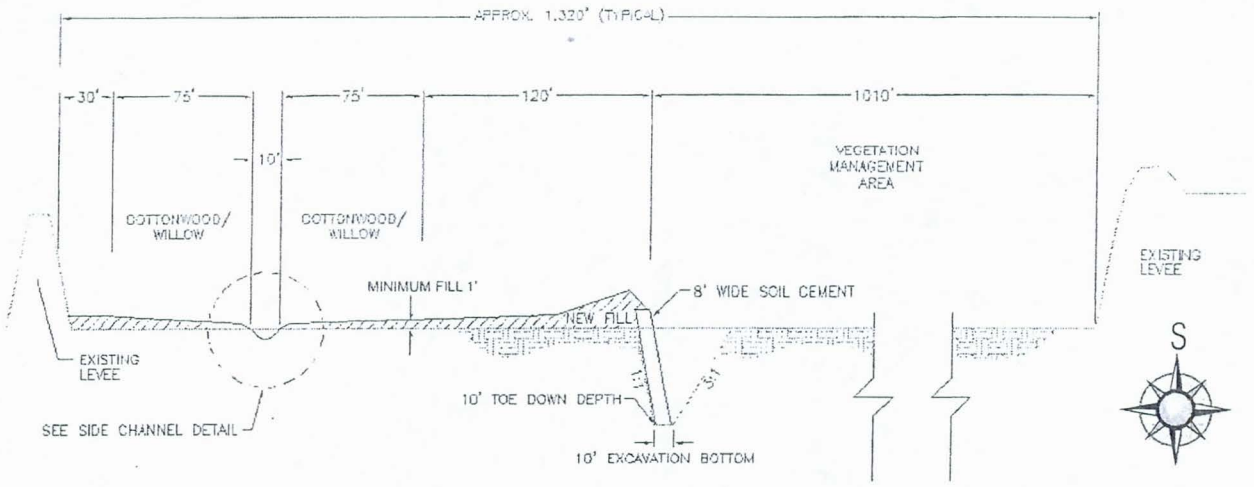


Source: TetraTech, Inc., Tucson, AZ, 2003

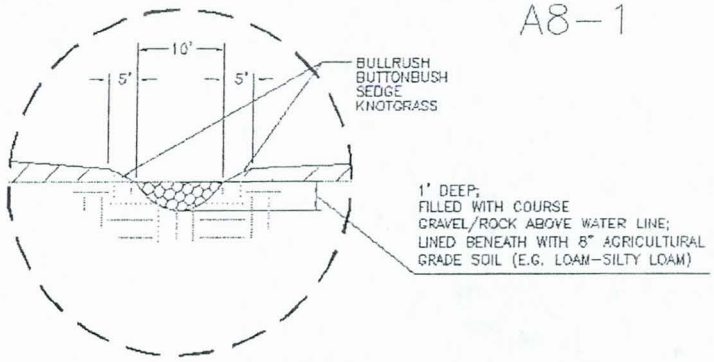
Agua Fria Detailed Project Report

Figure 29

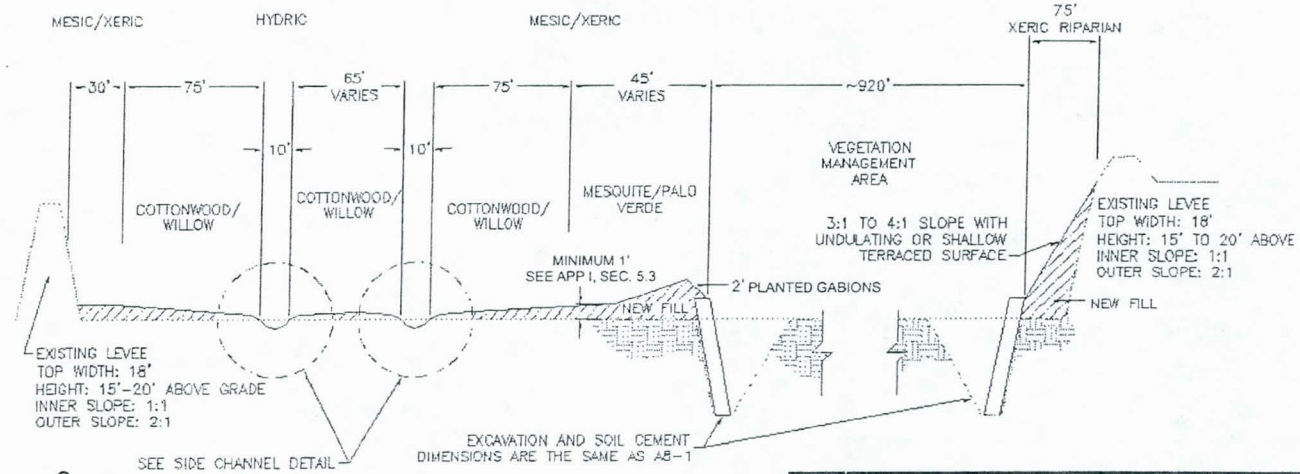
Alternative 8 (Recommended Plan)



A8-1



SIDE CHANNEL DETAIL



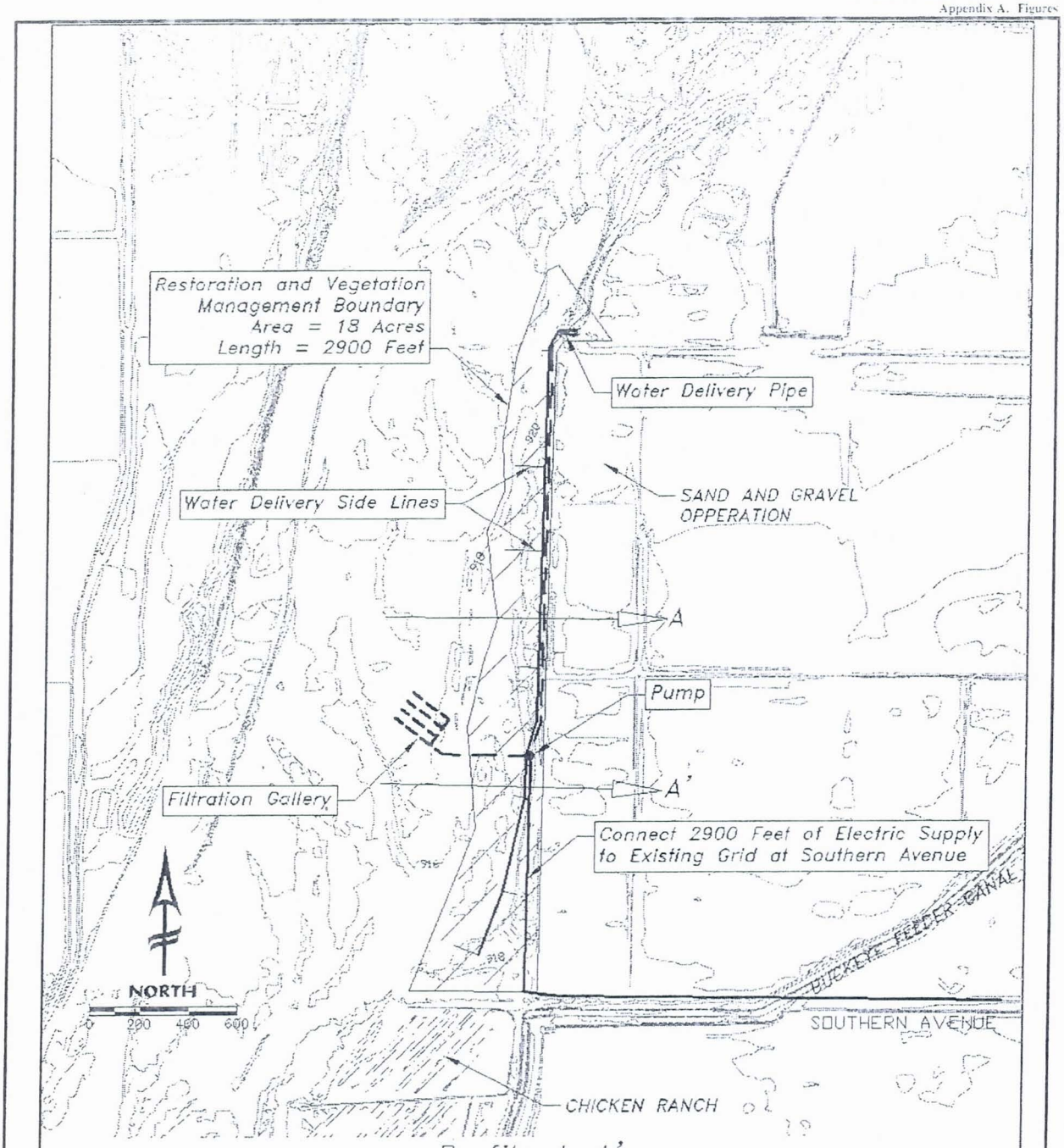
A8-2

* SEE SEC. 3.6 OF APPENDIX I FOR WELL INFORMATION
* VIEW IS FACING SOUTH, DOWNSTREAM
* NOT TO SCALE

Agua Fria Detailed Project Report

Figure 30a

Alternative 8 (Recommended Plan) I-10 Site Cross Sections



Profile A–A'

Not to Scale

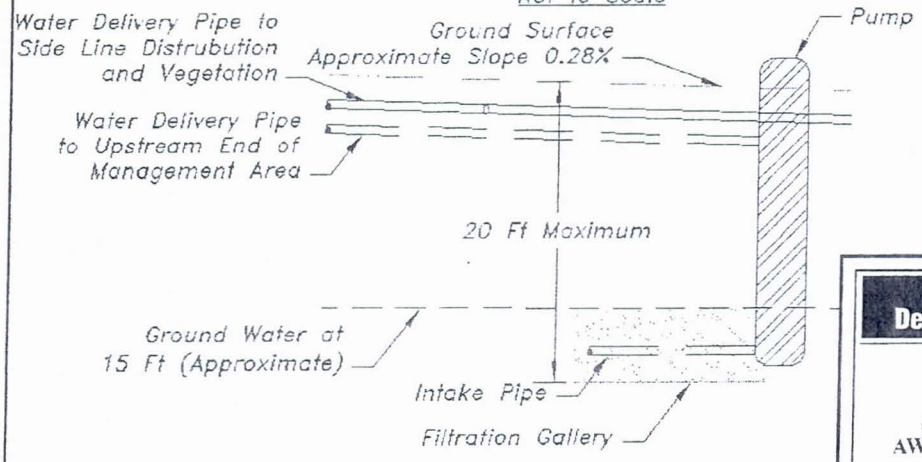


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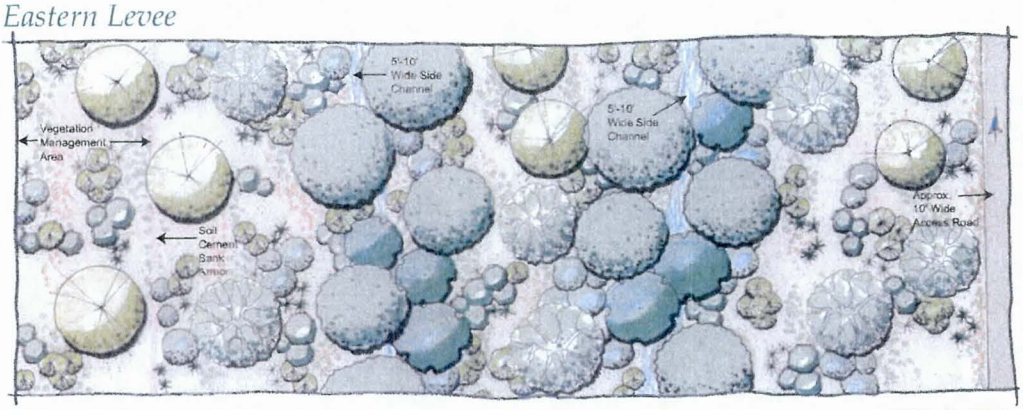
Figure 30b

Alternative 8 (Recommended Plan) AWWTP Site Cross Section and Plan View

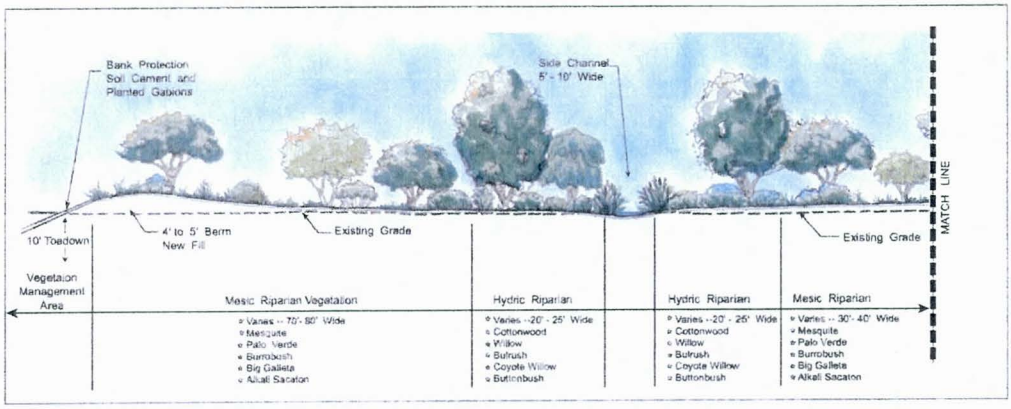
Proposed Concept Interstate - 10 Restoration Site

Eastern Levee

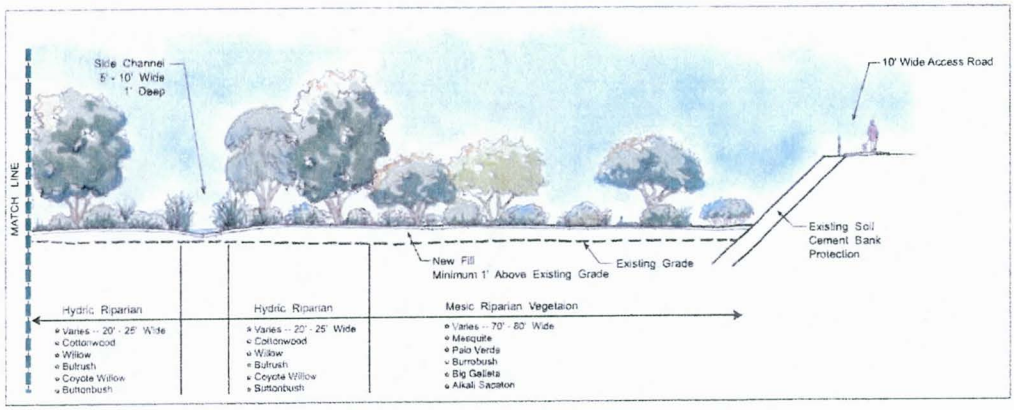


Not to scale

Plan View - Eastern Riparian Strip
3,130' long from north of I-10 to Van Buren Road
Planting density: Hydric Riparian - Trees 20' - 30' on center; Shrubs 10' - 20' on center
Mesic Riparian - Trees 40'-60' on center; Shrubs 10' - 20' on center



Cross Section



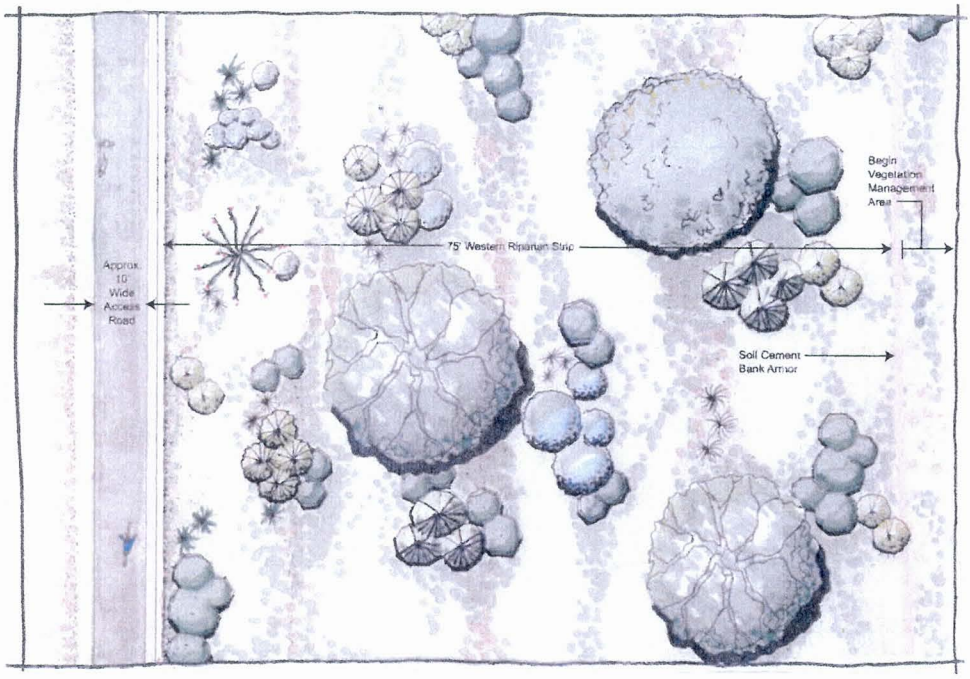
Cross Section

Agua Fria Detailed Project Report

Figure 31a
Alternative 8 (Recommended Plan)
Landscape Cross Section

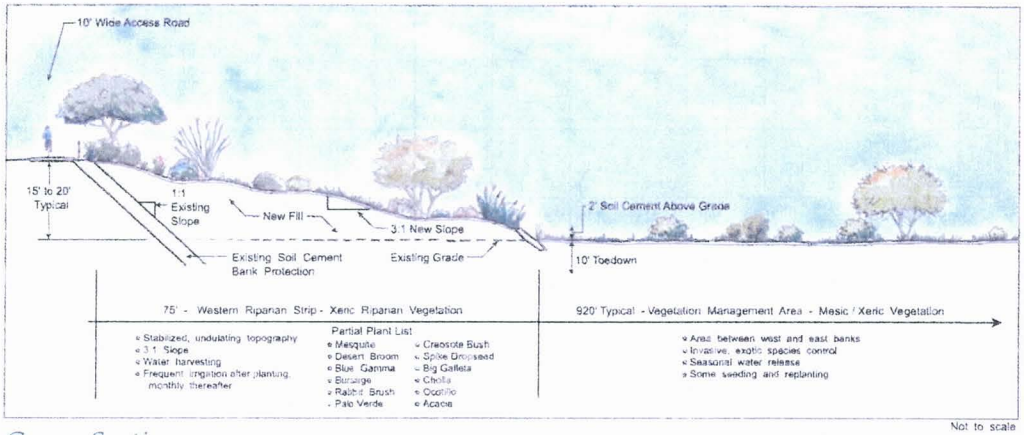
Proposed Concept Interstate-10 Restoration Site

Western Levee



Plan View - 75' Western Riparian Strip - Xeric Riparian Vegetation Zone
3,885' from I-10 to 800' south of Van Buren Road
Planting density: Trees 50' - 60' on center; Shrubs 10' - 20' on center

Not to scale



Not to scale

Cross Section

Agua Fria Detailed Project Report

Figure 31b

Alternative 8 (Recommended Plan) Landscape Cross Section

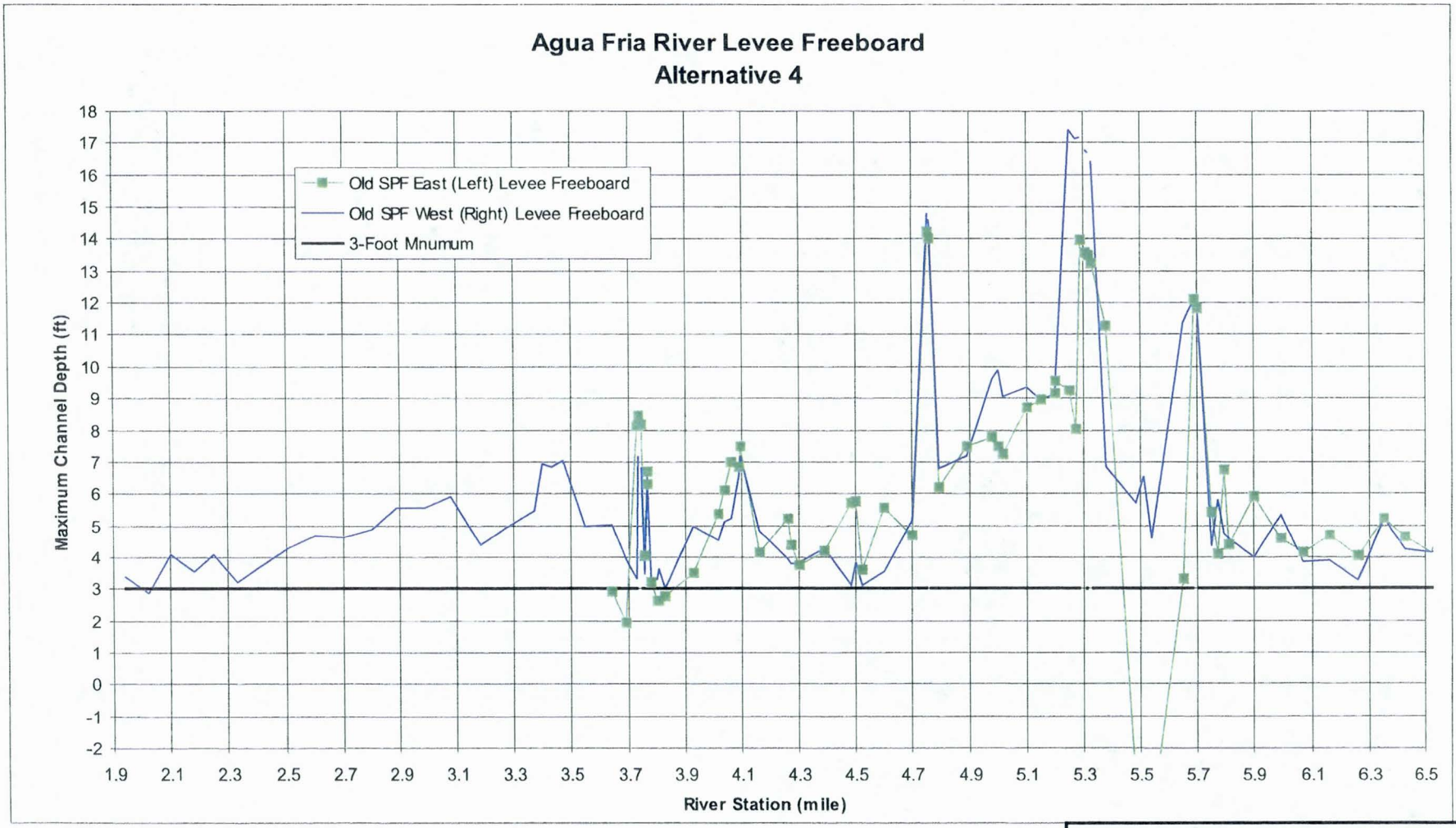


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Figure 32

Alternative 4- Levee Freeboard for Pre-New Waddell SPF

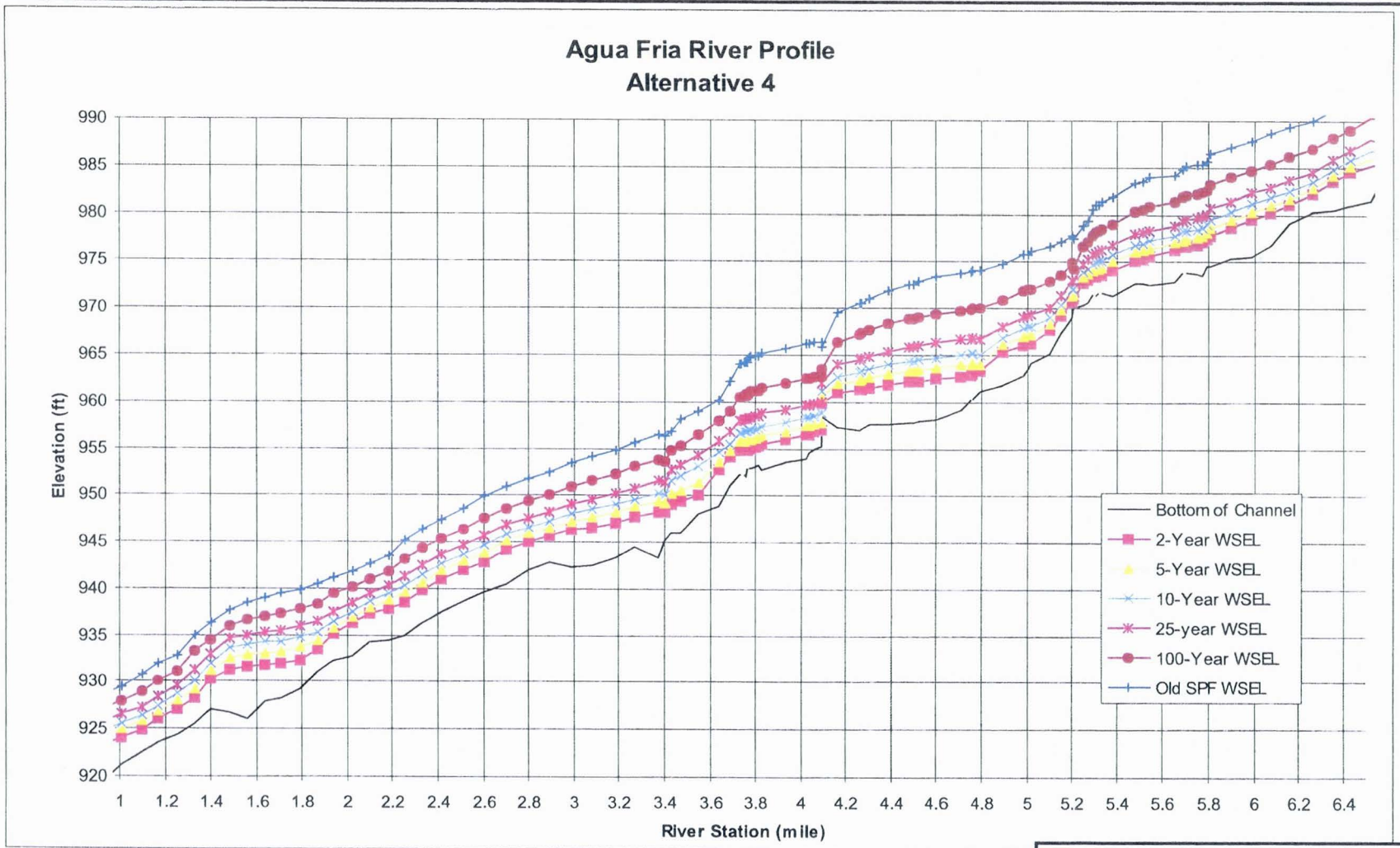

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Figure 33

**Alternative 4-
Water Surface Elevations (WSEL)
for Various Discharge Frequencies**

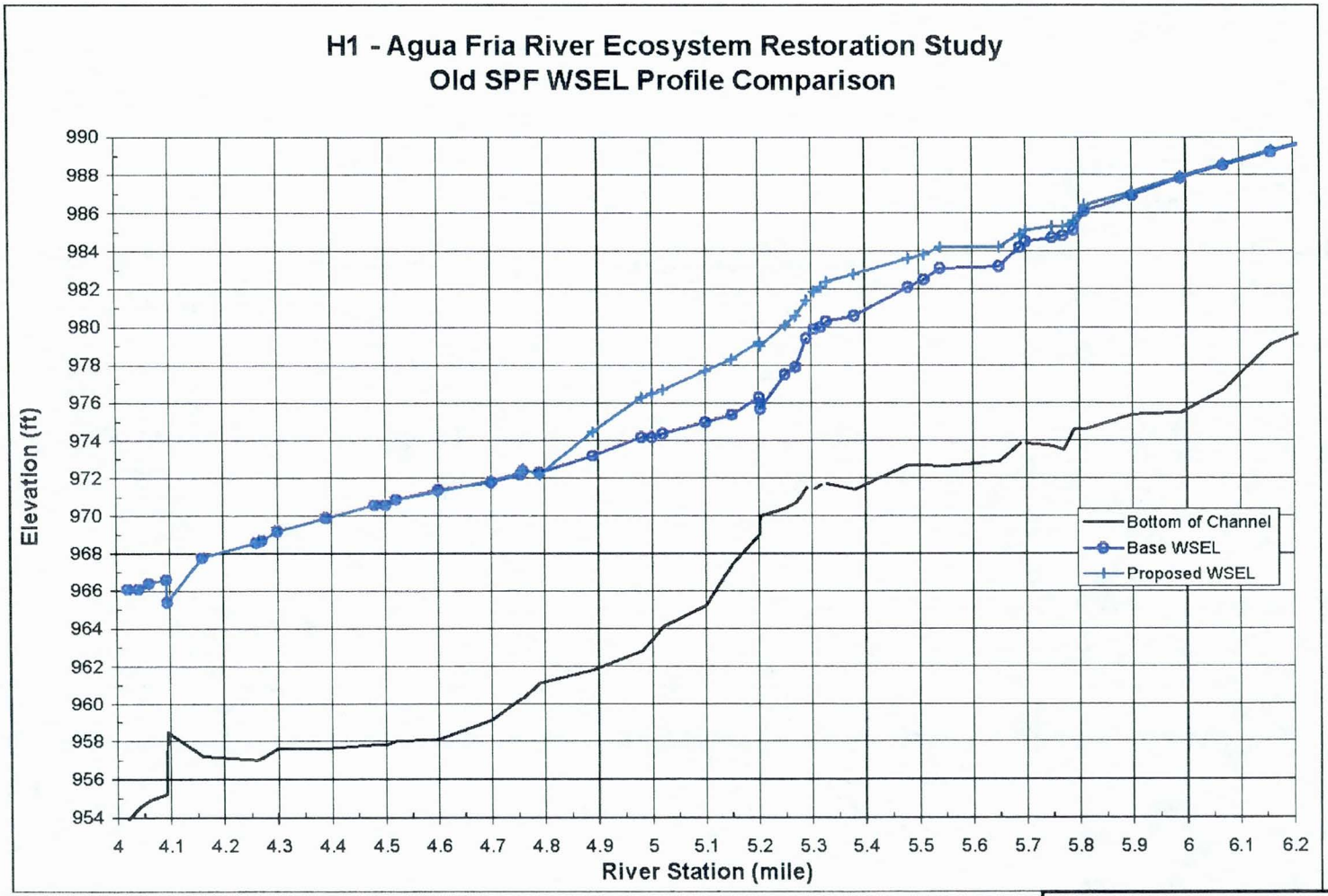

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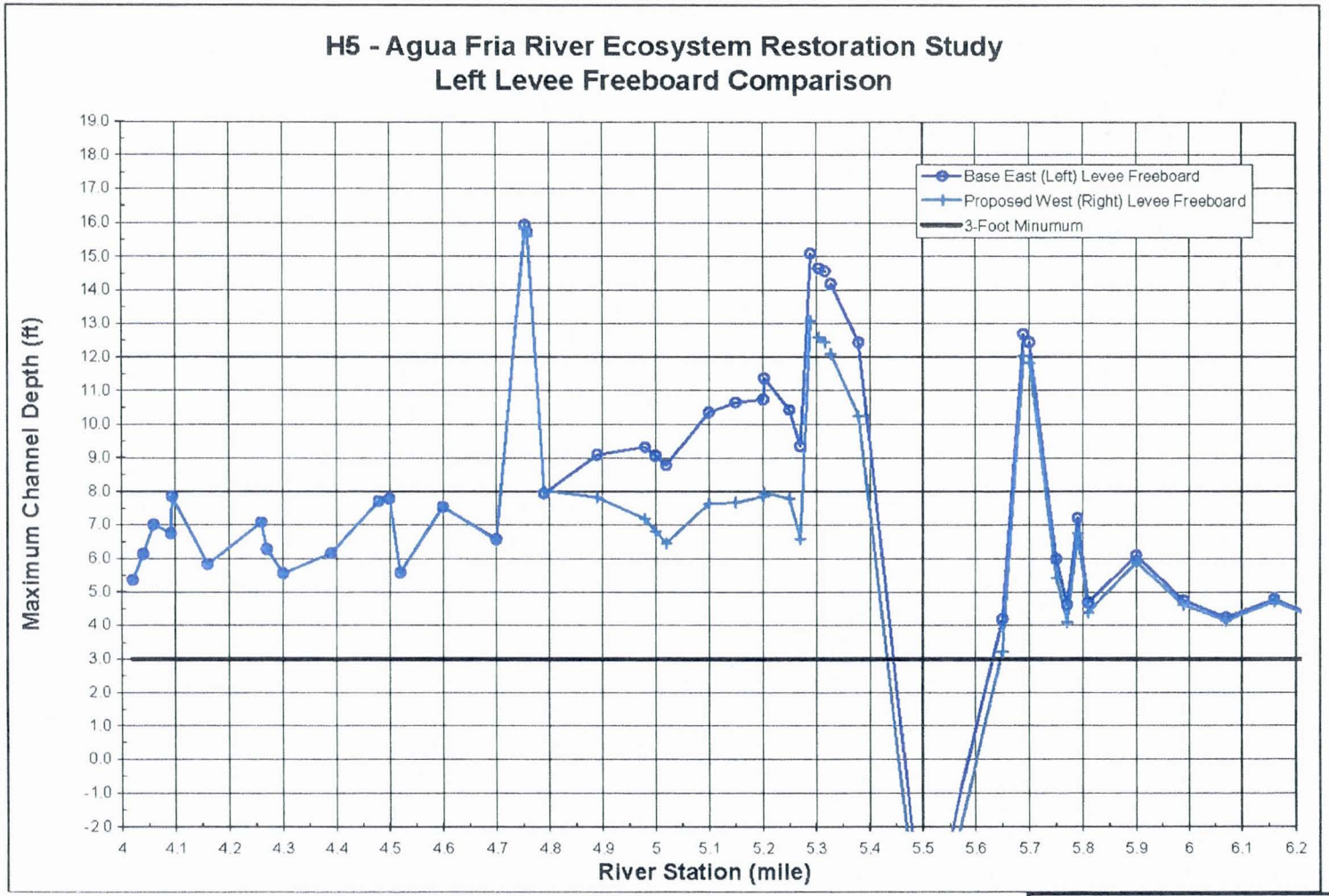
Figure 34

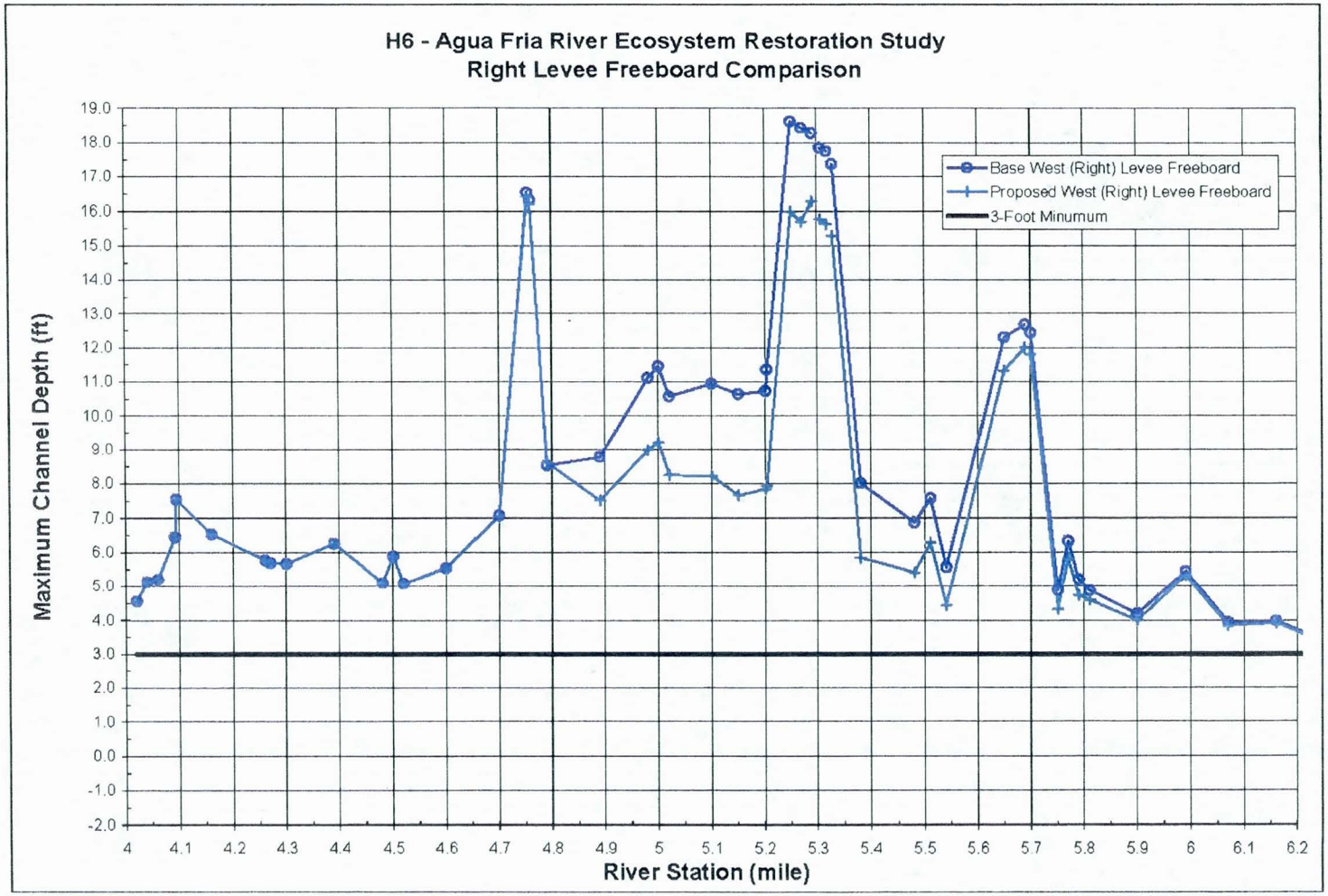
Alternative 8 (Recommended Plan)- Pre-New Waddell SPF WSEL Comparison



Agua Fria Detailed Project Report

Figure 35

Alternative 8 (Recommended Plan)- Pre-New Waddell SPF Left Levee Freeboard Comparison



Agua Fria Detailed Project Report

Figure 36

Alternative 8 (Recommended Plan)- Pre-New Waddell SPF Right Levee Freeboard Comparison

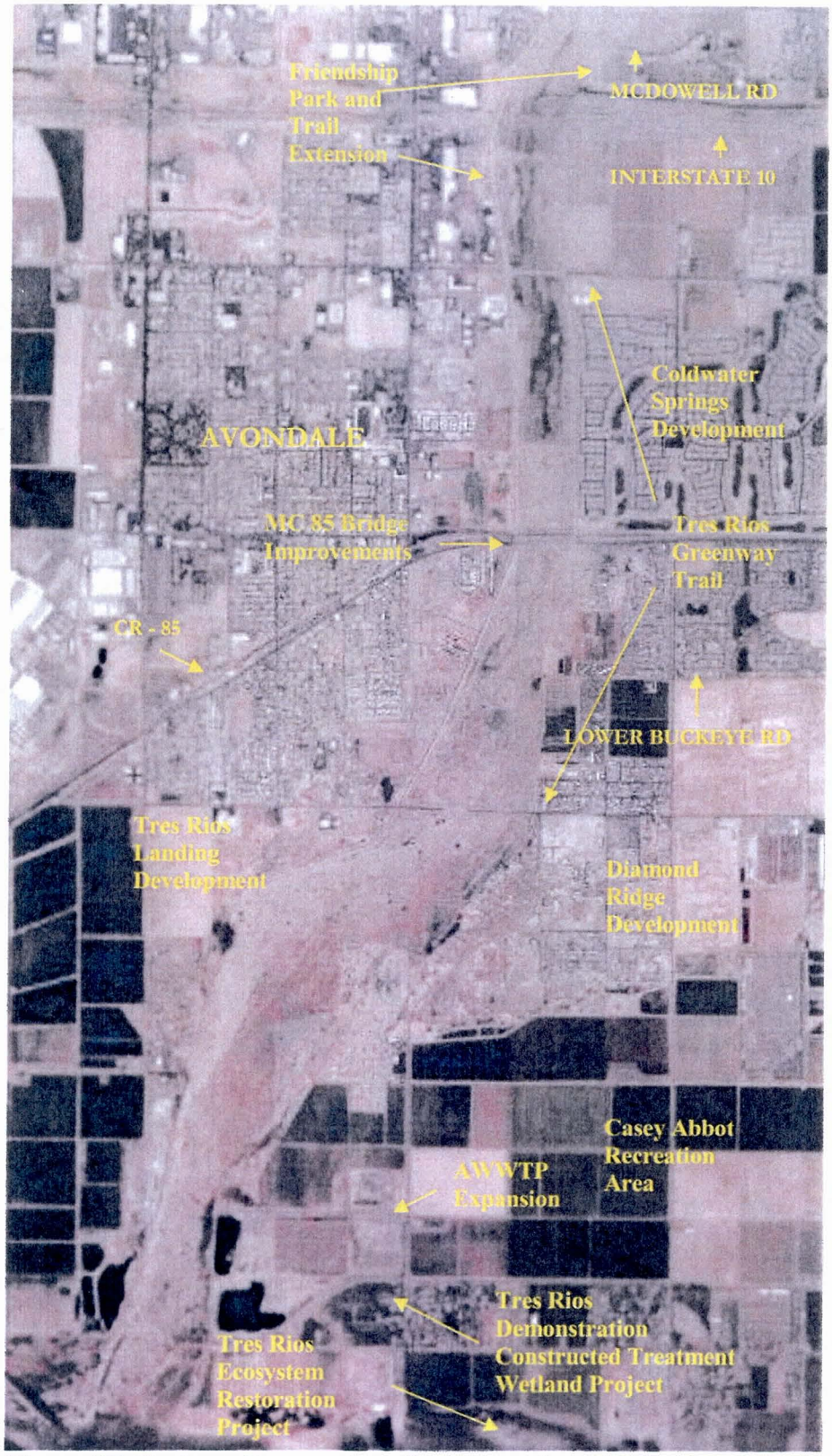


Figure 37. Projects Proposed or Constructed within Project Reach

APPENDIX B.

PRELIMINARY PLANT PALETTES

B.1 FCDMC

B.2 PROPOSED PLANT PALETTE FROM THE WEST VALLEY TRANSPORTATION CORRIDOR MASTER PLAN

APPENDIX B.1

FCDMC

Hydric Riparian (Riparian Vegetation) Hydric/mesic mid-level successional to climax riparian community		**Attributes**					
Common Name	**Botanical Name**	**Hydrologic Component** [1]	**Water Quality** [2]	**Moisture Regime** [3]	**Wildlife Value**		**General Comment**
					Species [4]	**Type** [5]	
Big galleta	*Hilaria rigida*	Low	Moderate	Upland	Ground Birds Small Mammals	Cover, Forage, Nesting	Bunchgrass up to 1 meter tall. Withstands high temperatures w/o dormancy.
Blue paloverde	*Cercidium floridum*	High	Low	Upland	Songbirds Raptors Small Mammals	Cover, Forage Nesting	Small Tree
Bulrush	*Scirpus acutus* Varied other species	Moderate	Excellent	Aquatic, Shoreline Low Upland	Waterfowl Songbirds Shorebirds Small Mammals	Cover, Nesting	Persistent emergent (2-4 meters tall). Dense monotypic stands. Rhizomes
Button-bush	*Cephalanthus occidentalis*	Moderate	Good	Aquatic, Shoreline Low Upland	Songbirds Small Mammals	Cover, Forage, Nesting	Shrub (< 3 meters tall). Wet soils
Sedge species	*Carex spp.* *Cyperus spp.*	Low	Moderate	Aquatic, Shoreline	Shorebirds Songbirds Small Mammals	Cover, Forage, Nesting	Hydric to mesic grass-like species
Coyote willow Other willows	*Salix exigua*	High	Moderate	Shoreline Low Upland	Songbirds Ground Birds Small Mammals	Cover, Nesting	Shrub (can exceed 3 meters). Very pliable stems. Other species such as S. gooddingii are tree-sized
Cottonwood	*Populus fermontii*	Extreme	Low, High Transporation	Low Upland Upland	Songbirds Raptors Small Mammals	Cover, Forage, Nesting	Large tree. Potential for large snags
Ironwood	*Olneya tesota*	High	Low	Upland	Songbirds Raptors Small Mammals	Cover, Forage, Nesting	Moderate height tree w/branches to surface.
Knotgrass	*Paspalum distichum*	Low	Low	Shoreline	Waterfowl Songbirds Shorebirds Small Mammals	Cover, Forage, Nesting	Low-growth grass along banks
Reed	*Phragmites communis*	Moderate to High	Excellent	Aquatic, Shoreline	Waterfowl Songbirds Shorebirds Small Mammals	Cover, Forage, Nesting	Persistent emergent (2-4 meters). Very invasive w/ dense monotypic stands. Rhizomes
Sycamore	*Plantus wrightii*	Extreme	Low, High Transporation	Upland Ground	Songbirds Raptors Small Mammals	Cover, Forage, Nesting	Large tree. Potential for large snags.

NOTES:

1 Hydrologic Component is a measure of the vegetations contribution to resistance to channel flows. It is a combination of the N-Value (a friction coefficent) and the species flexability and propensity for creating channel clogging snag material

2 Water quality is a measure of the vegetations ability to retain sediment, stabilize shorelines or uptake constituents. See accompaning text.

3 Aquatic mositure regime areas are normally inundated. **Shoreline** moisture regime is normally saturated or barely inundated. **Low Upland** moisture regime is occasionally inundated but is mostly dry. **Upland** mositure regime is normally dry, with occasional short duration wet periods. The upland moisture regime includes the Xeric-ripraian areas found along desert washes..

4 **Waterfowl** are species that normally float or swim. **Shorebirds** are normally wading birds and do not swim. **Songbirds** are primairly passerine migratory speices. **Raptors** are upland birds of prey, that will utilize all of the vegetation communities for hunting. **Small Mammals** are normally upland species coyote sized or smaller.

5 Habitat Types include **Cover**, which supplies wildlife with hiding areas and protected travel corridors; **Forage** which supplies wildife with vegetative food (predation is not included in forage) and **Nesting** which includes the location of the nest and material necessary to build the nest.

APPENDIX B.2

PROPOSED PLANT PALETTE FROM THE WEST VALLEY TRANSPORTATION CORRIDOR MASTER PLAN

APPENDIX B.2 PROPOSED PLANT PALETTE

Categories of Plant Materials Proposed for the West Valley Multi-Modal Transportation Corridor Master Plan

Scientific Species Name	Common Name
TREES	
Cercidium sp.	Palo Verde
Olneya tesota	Ironwood
Prosopis velutina	Native Mesquite
SHRUBS	
Ambrosia deltoidea	Bur-sage
Celtia pallida	Desert Hackberry
Encelia farinose	Brittlebush
Ericameria laricifolia	Turpentine Bush
Larrea tridentate	Creosote Bush
Simmondsia chinensis	Jojoba
CACTI & SUCCULENTS	
Carnegiea gigantean	Saguaro
Ecinocereus sp.	Hedgehog
Ferocactus sp.	Barrel Cactus
Fouquieria splendens	Ocotillo
Opuntia sp.	Prickly-Pear, Cholla
Yucca baccata	Banana Yucca
Yucca elata	Soaptree Yucca

Source: West Valley Mulit-Modal Transportation Corridor Master Plan, July 30, 2001. Funded by the Arizona Department of Transportation Enhancement Program

These plants are proposed for use along the trail system defined in the plan, including the Agua Fria river ecosystem restoration study area.

APPENDIX C.

AGENCY CORRESPONDENCE INCLUDING USFWS COORDINATION ACT REPORT, SHPO RESPONSE, AND NRCS EXEMPTION

AESO/FA
22410-2006-FA-0041

August 8, 2006

Ms. Ruth Villalobos
Chief, Planning Division
U.S. Army Corps of Engineers, Los Angeles District
P.O. Box 532711
Los Angeles, California 90053-2352

Dear Ms. Villalobos:

Thank you for providing the proposed Agua Fria River Section 1135 Ecosystem Restoration Project, Maricopa County, Arizona. These comments are provided pursuant to the Fish and Wildlife Coordination Act (FWCA) (48 stat. 401, as amended; 16 U.S.C. 661 et seq.), and constitute the U.S. Fish and Wildlife Service report under Section 2(B) of the FWCA. This report is based on coordination with the Arizona Game and Fish Department (AGFD), field investigations, literature research, file reviews, and information provided by the Los Angeles District of the U.S. Army Corps of Engineers (Corps) including the Preliminary Restoration Plan (Corps 2001) and Preliminary Draft Baseline Conditions and Alternatives Array Report (Corps 2002).

GENERAL PROJECT DESCRIPTION

Section 1135(b) of the Water Resources Development Act (WRDA) of 1986, as amended (P.L. 99-662) authorizes the Secretary of the Army to review the operation of water resource projects to determine the need for structural or operational modifications for the purpose of improving the quality of the environment in the public interest. The Flood Control District of Maricopa County (FCDMC) is the non-Federal co-sponsor of the Agua Fria River Ecosystem Restoration Project.

The project includes Skunk Creek, the New, and Agua Fria rivers (Arizona Canal Diversion Channel to the Gila River). The portion of the Agua Fria River proposed for restoration is located within the city limits of Avondale (southwestern region of the Phoenix metropolitan area) within Maricopa County, and is approximately five miles beginning at McDowell Road on the north end, extending southward to the confluence of the Gila River (refer to Figures 1.2-2 and 1.2-2 *in* Corps 2002). Within this reach of the river, the width varies from approximately 1200 feet at its narrowest areas at the northern end of the project site, to roughly 2500 ft. at its widest reaches at the southern portion.

The proposed project would restore up to 125 acres of riparian habitat along the Agua Fria River, include the removal of exotic plant species (palm trees, salt cedar, etc.), and reestablish native vegetation to provide an environment that more closely mimics historical conditions. Three restoration sites within the study area have been identified: 1) I-10 site, 2) Durango Channel site, and 3) Avondale Wastewater Treatment Plant (AWTP) site (refer to Figure 2.2-1 *in* Corps 2002). Specific proposed alternatives are discussed below.

Wildlife viewing platforms with environmental interpretive signage could also be included in the overall design. Such features, if developed, are considered recreational and would be formulated separately from the restoration proposal.

EXISTING ENVIRONMENT

Vegetation in the study area is characteristic of Sonoran desertscrub and Sonoran riparian deciduous forest. Riparian plants such as desert broom (*Baccharis sarothroides)*, salt cedar (*Tamarix pentandra)*, blue palo verde (*Cercidium floridum*), cottonwood (*Populus fremontii)*, and athel tamarisk (*Tamarix aphylla*), occur in and along the river channel. Buffel grass (*Pennisetum ciliare*), Russian thistle (*Salsola iberica*), Johnson grass (*Sorghum halapense*), and desert broom dominate the disturbed washes in the area. The channel broadens and vegetation shifts to species such as mesquite (*Prosopis juliflora)*, greasewood (*Sarcobatus vermiculatus)*, palo verde, four-winged saltbush (*Atriplex cohescens*), desert willow (*Chilopsis linearis*), and catclaw acacia (*Acacia greggii)* in lower reaches. Isolated water in the study area supports minimal hydric vegetation such as cattails (*Typha* sp.) and bulrush (*Scirpus* sp.). Outside the channel banks the landscape is dominated by agriculture and urbanization.

Wildlife species documented in the study area include coyote (*Canis latrans*), raccoon (*Procyon lotor*), black-tailed jackrabbit (*Lepus californicus*), desert cottontail (*Sylvilagus auduboni*), mourning dove (*Zenaida asiatica*), red-tailed hawk (*Buteo jamaicensis*), Swainson hawk (*Buteo swainsoni*), western meadowlark (*Sturnella neglecta*), pyrrhuloxia (*Cardinalis sinuatus*), western mockingbird (*Mimus polyglottos leucopterus*), sparrows (*Charadrius vociferus*), great blue heron (*Ardea herodias*), white-faced ibis (*Plegadis chihi*), western diamondback rattlesnake (*Crotalus atrox*), garter snake (*Thamnophis marcianus*), western banded gecko (*Coleonyx variegatus*), whiptail lizard (*Cnemidophorus* spp.), lowland leopard frog (*Rana yavapaiensis*), and bullfrog (*Rana catesbeinana*) (Corps, 2002). Other species likely to occur include greater roadrunner *(Geococcyx californianus*), cactus wren (*Campylorhynchus brunneicapillus*), Gambel's quail (*Callipepla gambelii*), turkey vulture (*Cathartes aura*), Gila woodpecker *(Melanerpes uropygialis*), myotis (*Myotis* sp.), deer mice (*Peromyscus* sp.), pocket mice (*Perognathus* sp.), javelina (*Tayasu tajacu*), bobcat *(Felis rufus*), and kangaroo rat (*Dipodomys* sp.).

No special status species are known to occur in the study area. However, habitats near the confluence of the Agua Fria River with the Gila River may provide nesting, roosting, or foraging opportunities for the endangered Yuma clapper rail (*Rallus longirostris yumanensis*), the endangered southwestern willow flycatcher (*Empidonax traillii extimus*), the recently delisted cactus ferruginous pygmy-owl (*Glaucidium brasilianum cactorum*), or the candidate yellow-billed cuckoo *(Coccyzus americanus occidentalis*).

PROPOSED ALTERNATIVE ACTIONS

The following alternatives are presented in the Baseline Conditions and Alternatives Array Report (Corps 2002). A complete description of the proposed alternative actions is found in Corps 2002.

Alternative 1, No-Action:

No restoration activities would be implemented by the Corps.

Alternative 2, Revegetation:

This alternative would reestablish and maintain native vegetation cover at the three sites. The primary elements would be revegetation and exotic species control. Additional measures would include nesting boxes, artificial burrows, and debris piles. The precise location of these features would be related to the final vegetation plan. The total project area would be 118.7 acres as follows: 64.2 acres at the I-10 site, 22.3 acres at the Durango Channel site, and 32.2 acres at the AWTP site (see Figures 2.2-1a to 2.2-1e *in* Corps 2002). This alternative would consist of two options, depending on existing conditions and hydraulic impacts: 2a; Riparian Woodland/Scrubland Dominated (high hydrologic component), and 2b; Wetland Dominated (low hydrologic component).

Alternative 2a would emphasize woody species representative of riparian woodlands. Woody species are generally inflexible and result in a higher roughness coefficient in the hydraulic analysis. However, infrequent large flood events would presumably wash out some of this vegetation. Alternative 2b would emphasize herbaceous species that are identified as having a low hydrologic component, typically species associated with wetlands and marshes. For these two alternatives, the core vegetation type would be riparian woodland/scrubland or wetland. In both cases there would be a gradient from hydric/mesic areas where water availability is greatest to more xeric/upland conditions with increasing distance from the water source.

Native plant communities would be established by a variety of methods, including container stock planting, cutting planting, seeding, pole planting, and wattle planting. A survey would be conducted prior to construction to evaluate the health and potential for salvage and preservation of native species at the site to conform to native plant laws.

Plant communities would be irrigated until established, especially along the levees. Harvested rainwater would sustain plant communities along the low-flow channel. It is expected that ground water would sustain woody plants once roots are established in the southern end of the project area, though the quality of the groundwater may limit productivity. Additional groundwater monitoring is needed to understand local conditions in restoration areas. There are few consistent sources of water flowing into the Agua Fria River to sustain plant communities. These include: (1) the outlet channel from Interstate-10; (2) the surface runoff from Buckeye Road, and (3) the outflow from the AWTP. However, these sources are uncommitted to the restoration project.

Revegetation would be preceded by chemical and mechanical control of non-natives which may be carried out over two seasons. A native species survey would be completed to assess the health of existing native species and opportunities for preservation and salvage.

The major elements of project operation and maintenance would include an exotic control program, revegetation or reseeding after flood damage, minimization of in-channel disturbance, redistribution of woody and other plant debris, control of foreign litter and debris, control of non-authorized use by pedestrians and off-road vehicles, public awareness campaign, and third-party mitigation for in-channel disturbance in restoration sites as a result of recreation, maintenance of in-channel structures, etc.

Alternative 3, Revegetation + Hydraulic Enhancement:

This alternative would include all elements of Alternative 2 and options for improving water availability and other ecosystem functions related to hydraulic and hydrologic processes. Additional water sources may be available to the three restoration sites in addition to the existing sources cited above. Amending the materials in the channel bed or the topography may reduce the loss of moisture through infiltration or evaporation.

Additional sources of water for improving the retention of water in the soil from existing sources will increase the opportunity to use a wider range of plant species or may allow the area of vegetation to be extended. The I-10 restoration site could extend downstream to the Durango Channel restoration site, resulting in a larger continuous habitat area.

At the I-10 and Durango Channel sites, this alternative involves excavation of a single low flow channel to direct drainage and frequent flood events into vegetated areas. This channel design would end in a shallow depression (see Figure 5.3-1 *in* Corps 2002) and reinforce the existing drainage below the Durango Channel in which two primary low flow channels converge in a depression (see Figures 2.2-1b to 2.2-1e *in* Corps 2002).

At the I-10 site, a shallow detention basin would be created at the mouth of the outfall and an excavated low flow channel leading from it would end in a small, shallow depression to collect higher flows. However, groundwater at this end of the project area is generally beyond the depth of phreatophytes and vegetation is more dependent on intermittent flow from the outfall. Erosion protection along the excavated low flow channel may be required.

The AWTP site is currently occupied by a marsh that extends to a single low flow channel without the braided characteristics of the I-10 site. It is expected that discharges from the plant would eventually be diverted to recharge ponds and the open water and marsh habitat would be replaced by riparian woodland.

Specific options for hydraulic enhancement considered include moving water from the AWTP to upstream locations, pumping waterlogged areas at the lower end of the project reach or diverting from irrigation channels, installing clay liners or soil amendments to retain soil moisture, constructing dams or other surface and subsurface barriers to protect against local pumping and to retain surface flow, constructing small check dams from coarse materials and woody debris in the low flow channel to create microvariation in bed conditions, using sand bars or coarse

materials and woody debris to trap surface moisture after flood events and create microvariation in soil conditions and soil moisture, constructing a subsurface flow (impermeable materials overlain by coarse material) to limit surface evaporation, importing fine sand and silt sized material upstream to be redistributed by natural flood events and replenish scoured or degraded zones, and using rocks and vegetative debris to stabilize the low flow channel and sand bar areas for vegetation growth.

Additional pre-construction and construction considerations include hydraulic and hydrologic analysis of the sustainability of these enhancements, alternative water sources, effects of imported materials on flood capacity, and the source of fine materials for sediment replenishment. Additional operation and maintenance considerations include maintenance of low flow channel and shallow depressions after infrequent flood events (e.g., > 10 years), and additional operation for sediment replenishment.

Alternative 4, Revegetation + Hydraulic Enhancement + In-channel Hardscaping:

This alternative would include all elements of Alternative 3 plus hard-scaping, or modifications to the slope and microtopography of the levees. Variations of this alternative include: slopes on inside of levee, slopes on inside and outside of levee, and terracing along levee (see Figure 5.4-1 *in* Corps 2002):

The concept for this alternative would be to place material from the excavated low flow channel or other places within the channel along the inner and/or outer slope of the levee. Because bed materials are generally coarse and permeable and areas are elevated from surface or groundwater, vegetation in these areas is expected to be limited to Sonoran upland vegetation. A permanent irrigation source has not been identified. Where trail landscaping coincides with this alternative, the shallow slopes may encourage pedestrian access into the restoration areas. A suitable vegetative buffer or other barrier would be considered.

Additional pre-construction and construction considerations include analysis of the sustainability and stability of enhancements, effects of imported materials, additional temporary or permanent irrigation, and compatibility with trail system along levee. Additional operation and maintenance considerations include maintenance of hardscaping features after infrequent flood events (e.g., > 10 years), and maintenance of additional temporary or permanent irrigation system.

Alternative 5, Revegetation + Hydraulic Enhancement + In-channel Hardscaping + Out of Channel Habitat Opportunities:

This alternative includes all elements in Alternative 4 plus out of channel restoration. These potential areas include (see Figure 2.2-1a *in* Corps 2002): the City of Avondale's Litchfield recharge pond, off-channel overflow space near McDowell Road, and the Chicken Farm mitigation site.

FUTURE WITHOUT PROJECT

Historical changes to groundwater and surface water drainage and surrounding land development have significantly affected the Agua Fria River. Upstream impoundments and channelization

have substantially changed the distribution and abundance of native riparian and wetland resources along the entire river. Within the study area, ongoing channel maintenance near I-10 is a consistent source of disturbance to vegetation. Within the study area, existing riparian and wetland habitat is limited. Though vegetation may continue to persist, significant regeneration and/or recruitment of species like cottonwood, willow, and mesquite is unlikely. Without project implementation, riparian and wetland vegetation in the study area is not likely to improve.

FUTURE WITH PROJECT

The restoration project could improve riparian and wetland habitat in the study area, potentially providing a corridor of habitat down to the Gila River. This could provide habitat connectivity when considered in combination with other planned restoration projects along the Salt and Gila rivers. Ongoing maintenance at the I-10 channel in the study area could be implemented in a fashion that minimizes disturbance. Isolated habitats could be expanded and connected, potentially providing suitable habitat conditions for an array of native wildlife species, including migratory birds.

DISCUSSION

We believe the most important aspect of wetland and riparian restoration is the identification and attainment of a secure water source to ensure adequate hydrologic conditions to support the desired biotic communities. Mitsch and Gosselink (1993) contend that hydrology is the most important variable in wetland creation and restoration activities and if proper hydrologic conditions are developed, the biological and chemical conditions will respond accordingly. They offer several parameters that are useful to describe hydrologic conditions of restored wetlands, including hydroperiod, water depth, and seasonal flood pulses. Additionally, they conclude that most wetland creation and restoration activities fail due to a lack of proper hydrology. Opportunities to secure AWTP discharge as a source of surface water to sustain the resources in the Agua Fria study area should be explored.

Prior to committing to a restoration program, assessments should be conducted to ensure restoration sites will be suitable environments for the establishment, regeneration, and survival of native riparian plants. The majority of failed riparian restoration activities that include removal of non-natives with subsequent native revegetation failed because of attempts to establish desirable species on degraded sites, typically with incompatible soil moisture or salinity (Briggs *et al.* 1994, Barrows 1998). Therefore, consideration should be given to microhabitat conditions such as depth to water table, soil texture, and salinity. Consideration should also be given to large scale ecological processes, such as flood regime, which species such as cottonwood and willow depend upon for seed bed formation, seed dispersal, germination, seedling establishment, recruitment, and survival. Other considerations should include groundwater fluctuations, site preparation, protection of plantings from herbivory, necessity of irrigation, potential for competition from undesirable species, and long term management potential for the site.

The proposed project is expected to be compatible with future recreation and public use. However, amenities to support such use are currently not part of this planning process. Because public use of the project site could potentially have significant effects on restored habitats, we believe recreation planning should be an active part of this planning process.

The proposed project could eventually result in the establishment of habitats suitable for threatened or endangered species. We encourage the local non-Federal sponsor(s) to consider development of a Safe Harbor Agreement (SHA) for future operation and maintenance activities that may affect listed species. Such an effort would greatly facilitate operation and maintenance of the project while providing conservation benefits to listed species. For instance, to avoid potential disturbance to listed species nesting in the study area, certain portions of the restored habitats could be designed to limit access by recreationists.

RECOMMENDATIONS

1) Explore the feasibility of securing effluent as a source of water to support planned biological resources within the study area, particularly cottonwood, willow, and mesquite.

2) Conduct assessments to ensure site specific microhabitat conditions will be conducive to establishment and growth of native riparian plants especially cottonwood, willow, and mesquite.

3) Incorporate public use and recreation into the planning process to ensure compatibility.

4) Encourage the local non-federal sponsor to work with FWS in the development of a SHA.

5) Continue to coordinate with FWS during the design and construction phases.

We appreciate the opportunity to provide recommendations for the proposed project. If we can be of further assistance or you have questions, please contact Mike Martinez (x224) or Debra Bills (x239).

Sincerely,

/s/ Steven L Spangle
Field Supervisor

cc: Supervisor, Project Evaluation Program, Arizona Game and Fish Department, Phoenix, AZ

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United States Department of the Interior

U.S. Fish and Wildlife Service
Arizona Ecological Services Field Office
2321 West Royal Palm Road, Suite 103
Phoenix, Arizona 85021-4951
Telephone: (602) 242-0210 Fax: (602) 242-2513

In Reply Refer to:
AESO/FA

March 14, 2002

Ms. Ruth Villalobos
Chief, Planning Division
U.S. Army Corps of Engineers, Los Angeles District
Attn: Mr. William Butler, CESPL-PD-RL, Room 14022
P.O. Box 532711
Los Angeles, California 90053-2352

Dear Ms. Villalobos:

Enclosed is our draft Fish and Wildlife Coordination Act Report for the Agua Fria River Section 1135 Ecosystem Restoration Study, Maricopa County, Arizona. Please review and provide any comments you may have by April 12, 2002, so we may finalize the report.

Sincerely,

Debra T. Bills

for David L. Harlow
Field Supervisor

Enclosure

W:/MikeMartinez/Aguatrans.wpd:cgg

DRAFT

AESO/FA

March 13, 2002

Ms. Ruth Villalobos
Chief, Planning Division
U.S. Army Corps of Engineers, Los Angeles District
Attn: Mr. William Butler, CESPL-PD-RL, Room 14022
P.O. Box 532711
Los Angeles, California 90053-2352

Dear Ms. Villalobos:

The U.S. Fish and Wildlife Service (Service) has reviewed the proposed Agua Fria River Section 1135 Ecosystem Restoration Study, Maricopa County, Arizona. This report is provided pursuant to the Fish and Wildlife Coordination Act (FWCA) (48 stat. 401, as amended; 16 U.S.C. 661 et seq.) and constitutes the Service report under Section 2(B) of the FWCA. This report is based on coordination with the Arizona Game and Fish Department (AGFD), field investigations, literature research, file reviews, and information provided by the Los Angeles District of the U.S. Army Corps of Engineers (Corps) including the Preliminary Restoration Plan (Corps, 2001) and Preliminary Draft Baseline Conditions and Alternatives Array Report (Corps, 2002).

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The proposed project would restore approximately 125 acres of riparian habitat along the Agua Fria River. The plan would include the appropriate removal of exotic plant species (palm trees, salt cedar, etc.), and re-establishment of native vegetation to provide an ecologically sound environment that more closely mimics historical riparian features. Three restoration sites within the study area have been identified: 1) I-10 site, 2) Durango Channel site, and 3) Avondale Wastewater Treatment Plant (AWTP) site (refer to Figure 2.2-1 *in* Corps 2002).

Wildlife viewing platforms with environmental interpretive signage could also be included in the overall design. Such features, if developed, are considered recreational and would be formulated separately from the restoration proposal.

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palo verde, four-winged saltbush (*Atriplex cohescens*), desert willow (*Chilopsis linearis*), and catclaw acacia (*Acacia greggii)* in lower reaches. Isolated water in the study area supports minimal hydric vegetation such as cattails (*Typha* sp.) and bulrush (*Scirpus* sp.). Outside the channel banks the landscape is dominated by agriculture and urbanization.

Wildlife species documented in the study area include coyote (*Canis latrans*), raccoon (*Procyon lotor*), black-tailed jackrabbit (*Lepus californicus*), desert cottontail (*Sylvilagus auduboni*), mourning dove (*Zenaida asiatica*), red-tailed hawk (*Buteo jamaicensis*), Swainson hawk (*Buteo swainsoni*), western meadowlark (*Sturnella neglecta*), pyrrhuloxia (*Cardinalis sinuatus*), western mockingbird (*Mimus polyglottos leucopterus*), sparrows (*Charadrius vociferus*), great blue heron (*Ardea herodias*), white-faced ibis (*Plegadis chihi*), western diamondback rattlesnake (*Crotalus atrox*), garter snake (*Thamnophis marcianus*), western banded gecko (*Coleonyx variegatus*), whiptail lizard (*Cnemidophorus* spp.), lowland leopard frog (*Rana yavapaiensis*), and bullfrog (*Rana catesbeinana*) (Corps, 2002). Other species likely to occur include greater roadrunner *(Geococcyx californianus*), cactus wren (*Campylorhynchus brunneicapillus*), Gambel's quail (*Callipepla gambelii*), turkey vulture (*Cathartes aura*), Gila woodpecker *(Melanerpes uropygialis*), myotis (*Myotis* sp.), deer mice (*Peromyscus* sp.), pocket mice (*Perognathus* sp.), javelina (*Tayasu tajacu*), bobcat *(Felis rufus*), and kangaroo rat (*Dipodomys* sp.).

No special status species are known to occur in the study area. However, habitats near the confluence of the Agua Fria River with the Gila River may provide nesting, roosting, or foraging opportunities for the endangered Yuma clapper rail (*Rallus longirostris yumanensis*), southwestern willow flycatcher (*Empidonax traillii extimus*), and cactus ferruginous pygmy-owl (*Glaucidium brasilianum cactorum*), or the candidate yellow-billed cuckoo *(Coccyzus americanus occidentalis*).

ALTERNATIVES

Alternative 1, No-Action:

DRAFT

No restoration activities would be undertaken.

Alternative 2, Revegetation:

This alternative would reestablish and maintain native vegetation cover at the three sites. The primary elements would be revegetation and an exotic species control. Additional measures would include nesting boxes, artificial burrows, and debris piles. The precise location of these features would be related to the final vegetation plan. The total project area would be 118.8 acres as follows: 64.2 acres at the I-10 Restoration Site, 22.3 acres at the Durango Channel Restoration Site, and 32. 2 acres at the AWTP Restoration Site (see Figures 2.2-1a to 2.2-1e *in* Corps 2002). This alternative would consist of two options, depending on existing conditions and hydraulic impacts.

Alternative 2a: Riparian Woodland/Scrubland Dominated (high hydrologic component)

Alternative 2b: Wetland Dominated (low hydrologic component).

Alternative 2a would emphasize woody species representative of riparian woodlands. Woody species are generally inflexible and result in a higher roughness coefficient in the hydraulic analysis. However, infrequent large flood events would presumably wash out some of this vegetation. Alternative 2b would emphasize herbaceous species that are identified as having a low hydrologic component, typically species associated with wetlands and marshes. For these two alternatives, the core vegetation type would be riparian woodland/scrubland or wetland. In both cases there would be a gradient from hydric/mesic areas where water availability is greatest to more xeric/upland conditions with increasing distance from the water source.

Native plant communities would be established in the habitat areas by a variety of methods, including container stock planting, cutting planting, seeding, pole planting, and wattle planting.

DRAFT

A survey would be conducted prior to construction to evaluate the health and potential for salvage and preservation of native species at the site to conform to native plant laws.

Plant communities would be irrigated until established, especially along the levees. Harvested rainwater would sustain plant communities along the low-flow channel. It is expected that ground water would sustain woody plants once roots are established in the southern end of the project area, though the quality of the groundwater may limit productivity. Additional groundwater study is needed to understand local conditions in restoration areas. There are few consistent sources of water flowing into the Agua Fria River to sustain plant communities. These include: (1) the outlet channel from Interstate-10; (2) the surface runoff from Buckeye Road, and (3) the outflow from the AWTP. However, these sources are uncommitted to the restoration project.

Revegetation would be preceded by chemical and mechanical control of non-natives which may be carried out over two seasons. A native species survey would be completed to assess the health of existing native species and opportunities for preservation and salvage.

The major elements of project operation and maintenance would include and exotic control program, revegetation or reseeding after flood damage, minimization of in-channel disturbance, redistribution of woody and other plant debris, control of foreign litter and debris, control of non-authorized use by pedestrians and off-road vehicles, public awareness campaign, and third-party mitigation for in-channel disturbance in restoration sites as a result of recreation, maintenance of in-channel structures, etc.

Alternative 3, Revegetation + Hydraulic Enhancement:

This alternative would include all the elements of Alternative 2 and options for improving water availability and other ecosystem functions related to hydraulic and hydrologic processes. Additional water sources may be available to the three restoration sites in addition to the existing

DRAFT

sources cited above. Amending the materials in the channel bed or the topography may reduce the loss of moisture through infiltration or evaporation.

Additional sources of water for improving the retention of water in the soil from existing sources would increase the opportunity to use a wider range of plant species or may allow the area of vegetation to be extended. The I-10 restoration site could extend downstream to the Durango Channel restoration site, resulting in a larger continuous habitat area.

At the I-10 and Durango Channel sites, this alternative would involve excavation of a single low flow channel to direct drainage and frequent flood events into vegetated areas. This channel design would end in a shallow depression (see Figure 5.3-1 *in* Corps 2002) and reinforce the existing drainage below the Durango Channel in which two primary low flow channels converge in a depression (see Figures 2.2-1b to 2.2-1e *in* Corps 2002).

At the I-10 site a shallow detention basin would be created at the mouth of the outfall and an excavated low flow channel leading from it would end in a small, shallow depression to collect higher flows. However, ground water at this end of the project area is generally beyond the depth of phreatophytes and vegetation is more dependent on intermittent flow from the outfall. Erosion protection along the excavated low flow channel may be required.

The AWTP site is currently occupied by a marsh that extends to a single low flow channel without the braided characteristics of the I-10 site. It is expected that discharges from the plant would eventually be diverted to recharge ponds and the open water and marsh habitat would be replaced by riparian woodland.

Specific options for hydraulic enhancement considered include moving water from the AWTP to upstream locations, pumping waterlogged areas at the lower end of the project reach or diverting from irrigation channels, installing clay liners or soil amendments to retain soil moisture, constructing dams or other surface and subsurface barriers to protect against local pumping and

to retain surface flow, constructing small check dams created from coarse materials and woody debris in the low flow channel to create microvariation in bed conditions, using sand bars or coarse materials and woody debris to trap surface moisture after flood events and create microvariation in soil conditions and soil moisture, constructing a subsurface flow (impermeable materials overlain by coarse material) to limit surface evaporation, importing fine sand and silt sized material upstream to be redistributed by natural flood events and replenish scoured or degraded zones, and using rocks and vegetative debris to stabilize the low flow channel and sand bar areas for vegetation growth.

Additional pre-construction and construction considerations include hydraulic and hydrologic analysis of the sustainability of these enhancements, alternative water sources, effects of imported materials on flood capacity, and the source of fine materials for sediment replenishment. Additional operation and maintenance considerations include maintenance of low flow channel and shallow depressions after infrequent flood events (e.g., > 10 years), and additional operation for sediment replenishment.

Alternative 4, Revegetation + Hydraulic Enhancement + In-channel Hardscaping:

This alternative would include all the elements of Alternative 3 plus hard-scaping, or modifications to the slope and microtopography of the levees . Variations of this theme include 4a – slopes on inside of levee, 4b – slopes on inside and outside of levee, and 4c – terracing along levee (see Figure 5.4-1 *in* Corps 2002):

The concept for this alternative would be to place material from the excavated low flow channel or other places within the channel along the inner and/or outer slope of the levee. Because bed materials are generally coarse and permeable and areas are elevated from surface or ground water, vegetation in these areas is expected to be limited to Sonoran upland vegetation. A permanent irrigation source has not been identified. Where trail landscaping coincides with this

alternative, the shallow slopes may encourage pedestrian access into the restoration areas. A suitable vegetation buffer or other barrier would be considered.

Additional pre-construction and construction considerations include analysis of the sustainability and stability of enhancements, effects of imported materials, additional temporary or permanent irrigation, and compatibility with trail system along levee. Additional operation and maintenance considerations include maintenance of hardscaping features after infrequent flood events (e.g., > 10 years), and maintenance of additional temporary or permanent irrigation system.

Alternative 5, Revegetation + Hydraulic Enhancement + In-channel Hardscaping + Out of Channel Habitat Opportunities:

This alternative would include all of the elements in Alternative 4 plus out of channel restorations areas. These potential areas include (see Figure 2.2-1a *in* Corps 2002): the City of Avondale's Litchfield recharge pond, off-channel overflow space near McDowell Road, and the Chicken farm mitigation site.

FUTURE WITHOUT PROJECT

Historical changes to groundwater and surface water drainage and surrounding land development have significantly effected the Agua Fria River. Maintenance at the I-10 channel is a consistent source of disturbance to vegetation. Within the channel of the Agua Fria River, existing riparian habitat is limited to a few isolated areas. Though these habitats may continue to persist, it is unlikely they would substantially improve.

FUTURE WITH PROJECT

The restoration project could improve the riparian habitat at the site, potentially providing a corridor of habitat down to the Gila River. Maintenance at the I-10 channel could be

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implemented in a fashion that minimizes disturbance. Isolated habitats could be expanded and connected, potentially providing suitable habitat conditions for an array of native wildlife species, including migratory birds.

DISCUSSION

The Service believes the most important aspect of wetland and riparian restoration is the identification and attainment of a secure water source to ensure adequate hydrologic conditions to support the desired biotic communities. Mitsch and Gosselink (1993) contend that hydrology is the most important variable in wetland creation and restoration activities and if proper hydrologic conditions are developed, the biological and chemical conditions will respond accordingly. They offer several parameters that are useful to describe hydrologic conditions of restored wetlands, including hydroperiod, water depth, and seasonal flood pulses. Additionally, they conclude that most wetland creation and restoration activities fail due to a lack of proper hydrology. Opportunities to secure AWTP discharge as a source of surface water to sustain the resources in the Agua Fria study area should be explored.

Prior to committing to a restoration program, assessments should be conducted to ensure that proposed areas would be suitable environments for the establishment, regeneration, and survival of native riparian plants. The majority of failed riparian restoration activities that include removal of non-natives with subsequent native revegetation, failed because of attempts to establish desirable species on degraded sites, typically with incompatible soil moisture or salinity (Briggs *et al.* 1994, Barrows 1998). Therefore, consideration should be given to microhabitat conditions such as depth to water table, soil texture, and salinity. Consideration should also be given to large scale ecological processes such as flood regime which species such as cottonwood and willow depend upon for seed bed formation, seed dispersal, germination, seedling establishment, recruitment, and survival. Other considerations should include groundwater fluctuations, site preparation, protection of plantings from herbivory, necessity of irrigation,

DRAFT

potential for competition from undesirable species, and long term management potential for the site.

The proposed project is expected to be compatible with future recreation and public utilization. However, amenities to support such use are currently not part of this planning process. Because public use of the project site could potentially have significant effects on restored habitats, we believe recreation planning should be an active part of this planning process.

The proposed project could eventually result in the establishment of habitats suitable for endangered species. We encourage the local non-Federal sponsor(s) to consider development of a Safe Harbor Agreement (SHA) or Habitat Conservation Plan (HCP) for future operation and maintenance activities that may affect listed species. Such an effort would greatly facilitate operation and maintenance of the project while providing conservation benefits to listed species. For instance, to avoid potential disturbance to listed species nesting in the study area, certain portions of the restored habitats could be inaccessible to recreationists.

RECOMMENDATIONS

1) Efforts to secure effluent as a source of water to support the biological resources within the study area should be explored.

2) Assessments should be performed to ensure that site specific microhabitat conditions would be conducive to establishment and growth of native riparian plants especially cottonwood, willow, and mesquite.

3) Public use and recreation should be incorporated into the planning process to ensure compatibility.

DRAFT

4) The Corps should encourage the local non-federal sponsor to work with the Service in the development of a SHA or HCP.

We appreciate the opportunity to provide recommendations for the proposed project. If we can be of further assistance or you have questions, please contact Mike Martinez (x224).

Sincerely,

David L. Harlow
Field Supervisor

cc: Regional Director, Fish and Wildlife Service, Albuquerque, NM
Supervisor, Project Evaluation Program, Arizona Game and Fish Department, Phoenix, AZ

W:/MikeMartinez/Aguafria.wpd

DRAFT

LITERATURE CITED

Barrows, C. 1998. The debate over tamarisk: The case for wholesale removal. Restoration and Management Notes. 16:2. Winter 1998. Pages 135-138.

Briggs, M.K., B.A. Roundy, and W.W. Shaw. 1994. Trial and error: Assessing the effectiveness of riparian revegetation in Arizona. Restoration and Management Notes. 12:1. Winter 1998. Pages 160-167.

Mitsch, W.J. and J.G. Gosselink. 1993. Wetlands. Van Nostrand Reinhold, New York.

U.S. Army Corps of Engineers. 2001. Agua Fria River Riparian Restoration Section 1135 Preliminary Restoration Plan. South Pacific Division, Los Angeles District. October 2001. 19 p.

U.S. Army Corps of Engineers. 2002. Preliminary Draft. Baseline Conditions And Alternatives Array Report For The Agua Fria Ecosystem Restoration Study. Prepared by Aspen Environmental Group. February 2002.

S.H.P.O.- 2002 - 411 (10055)

DEPARTMENT OF THE ARMY
LOS ANGELES DISTRICT, CORPS OF ENGINEERS
P.O. BOX 532711
LOS ANGELES, CALIFORNIA 90053-2325

February 21, 2002

Office of the Chief
Environmental Resources Branch

Mr. James Garrison
State Historic Preservation Officer
Arizona State Parks
1300 West Washington
Phoenix, Arizona 85007

RECEIVED
APR - 5 2002
By

RECEIVED
FEB 27 2002
2/28/02
ARIZONA STATE PARKS/S.H.P.O.

Dear Mr. Garrison:

This letter is in regard to the Corps of Engineers, Los Angeles District's proposed Agua Fria River Riparian Restoration Project. The project is in partnership with the Flood Control District of Maricopa County, owner of all properties within the project boundary. The purpose of the proposed project is to restore riparian habitat to the degraded ecosystem along portions of a six-mile reach of the south-end of the Agua Fria River. The reach extends from McDowell Road in the north to the Agua Fria River's confluence with the Gila River in the south, and bank to bank of the existing riverbed (see Attachment 1).

The proposed project elements would include a meandering low-flow channel, riverine terraces, islands of riparian plantings and earthen embankments along the soil –cement levees. The earth excavated to create an approximately 300-foot wide low-flow channel would be used to create sections of terracing and embankments along the existing levees. The construction of the levees was accomplished by the Corps, and completed in 1987.

Over the last two years, investigations have been conducted for a watercourse master plan for the identification, development, and/or preservation of resources along the Agua Fria River between its confluence with the Gila River and Waddell Dam for the Flood Control District of Mariposa County, among others. The Corps' analysis of cultural resources within our proposed project has been based on the archeological investigations conducted for the master plan. That material is contained in the reports noted below, which were submitted to your office at an earlier date as part of the master plan project.

Rodgers, James B.
2000 *The Agua Fria River Watercourse Master Plan Archeological Assessment of Northern Maricopa County, Arizona: Prehistoric Resources.* Scientific Archeological Services for the Flood Control District of Maricopa County.

Jackman, Karolyn J.
2000 *Historic Cultural Resources Along the Agua Fria River Between the Gila River and Waddell Dam.* Archaeological Consulting Services for Kimley-Horn and Associates.

An aerial photograph of the project area (Attachment 2) illustrates the proposed environmental features of the project. Sites near the proposed actions have also been plotted on the photograph. There are six previously recorded sties, four historic, two prehistoric, near the project area. No recorded historic properties are within the proposed project Area of Potential

Effect (APE). We have included an illustration of examples of potential features of the project (Attachment 3). This illustrates the position of the low-flow channel, and variations on the use of fill with existing levees.

We sent a project description along with a request for comment to the Ak-Chin Indian Community, Hopi, Pascua Yaqui Tribe, Salt River Pima-Maricopa Indian Community, Gila River Indian Community, Tohono O'odham Nation, and the Zuni. We have not received any response.

Based on the above information the Corps of Engineers has determined, pursuant to 36 CFR § 800.4(d)(1), that no historic properties will be affected by the proposed project. We request that this submittal be considered as an expedited consultation under 36 CFR § 800.3(g). We look forward to your comments.

Correspondence may be sent to:
Ms. Ruth B. Villalobos
Chief, Planning Division
U.S. Army Corps of Engineers
Los Angeles District
Attention: Pamela Maxwell (CESPL-PD-RL)
P.O. Box 532711
Los Angeles, CA 90053-2325

Questions regarding this evaluation may be referred to Pamela Maxwell, Staff Archeologist, at (213) 452-3877, or via email at pamela.j.maxwell@usace.army.mil.

Sincerely,

Andrew Miller
for Ruth Bajza Villalobos
Chief, Planning Division

Attachments

Concur
No Historic Properties Affected
for Elaine Heding Miller
Arizona State Historic Preservation Officer
Arizona State Parks Board
March 28, 2002

THE STATE OF ARIZONA
GAME AND FISH DEPARTMENT
2221 WEST GREENWAY ROAD, PHOENIX, AZ 85023-4399
(602) 942-3000 • WWW.AZGFD.COM

GOVERNOR
JANE DEE HULL
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JOE CARTER, SAFFORD
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W. HAYS GILSTRAP, PHOENIX
JOE MELTON, YUMA
DIRECTOR
DUANE L. SHROUFE
DEPUTY DIRECTOR
STEVE K. FERRELL

OPTIONAL FORM 99 (7-90)

FAX TRANSMITTAL # of pages ▶ 1

To Bill Butler	From Mike Martinez
Dept./Agency Corps	Phone # (602) 242-0210
Fax # (213) 452-4204	Email Fish & Wildlife

NSN 7540-01-317-7368 5099-101 GENERAL SERVICES ADMINISTRATION

April 8, 2002

Mr. David Harlow
Arizona Ecological Services Field Office
U.S. Fish and Wildlife Service
2324 West Royal Palm Road, Suite 103
Phoenix, Arizona 85021-4951

Re: Draft Fish and Wildlife Coordination Act Report for the Agua Fria River (Section 1135) Ecosystem Restoration Study

Dear Mr. Harlow:

The Arizona Game and Fish Department (Department) has reviewed the draft Fish and Wildlife Coordination Act (FWCA) Report for the proposed Agua Fria River Section 1135 Ecosystem Restoration Study. This report was developed by the U.S. Fish and Wildlife Service (Service) pursuant to Section 2(b) of the FWCA, and provides the Service's recommendations for enhancing wildlife habitats as a result of the proposed project.

The Department agrees with the Service's analysis and recommendations, which include securing effluent as a source of water, conducting site-specific assessments to ensure that favorable conditions exist for the establishment of native vegetation, and considering public use and recreation in the project area during the planning process. The Department appreciates the opportunity to review this draft FWCA report. Please contact me at (602) 789-3605 if you have any questions regarding this letter.

Sincerely,

Bob Broscheid
Project Evaluation Program Supervisor
Habitat Branch

cc: Terry Johnson, Chief, Nongame Branch
Russ Haughey, Habitat Program Manager, Region VI, Mesa

AGFD# 3-18-02(01)

RECEIVED
APR 10 2002
U.S. FISH & WILDLIFE SERVICE
ES FIELD OFFICE-PHOENIX, AZ

DEPARTMENT OF THE ARMY
LOS ANGELES DISTRICT CORPS OF ENGINEERS
P.O. BOX 532711
LOS ANGELES, CALIFORNIA 90053-2325

REPLY TO
ATTENTION OF

July 16, 2002

Office of the Chief
Environmental Resources Branch

Mr. David L. Harlow, Field Supervisor
U.S. Fish and Wildlife Service
Division of Ecological Services
Arizona State Office
2321 West Royal Palm Road, Suite 103
Phoenix, Arizona 85021-4951

Dear Mr. Harlow:

Please provide a current list of endangered, threatened, candidate or otherwise sensitive plant and animal species that may be affected by the Agua Fria River Section 1135 Ecosystem Restoration Study, Maricopa County, Arizona. A project vicinity map is enclosed for your information.

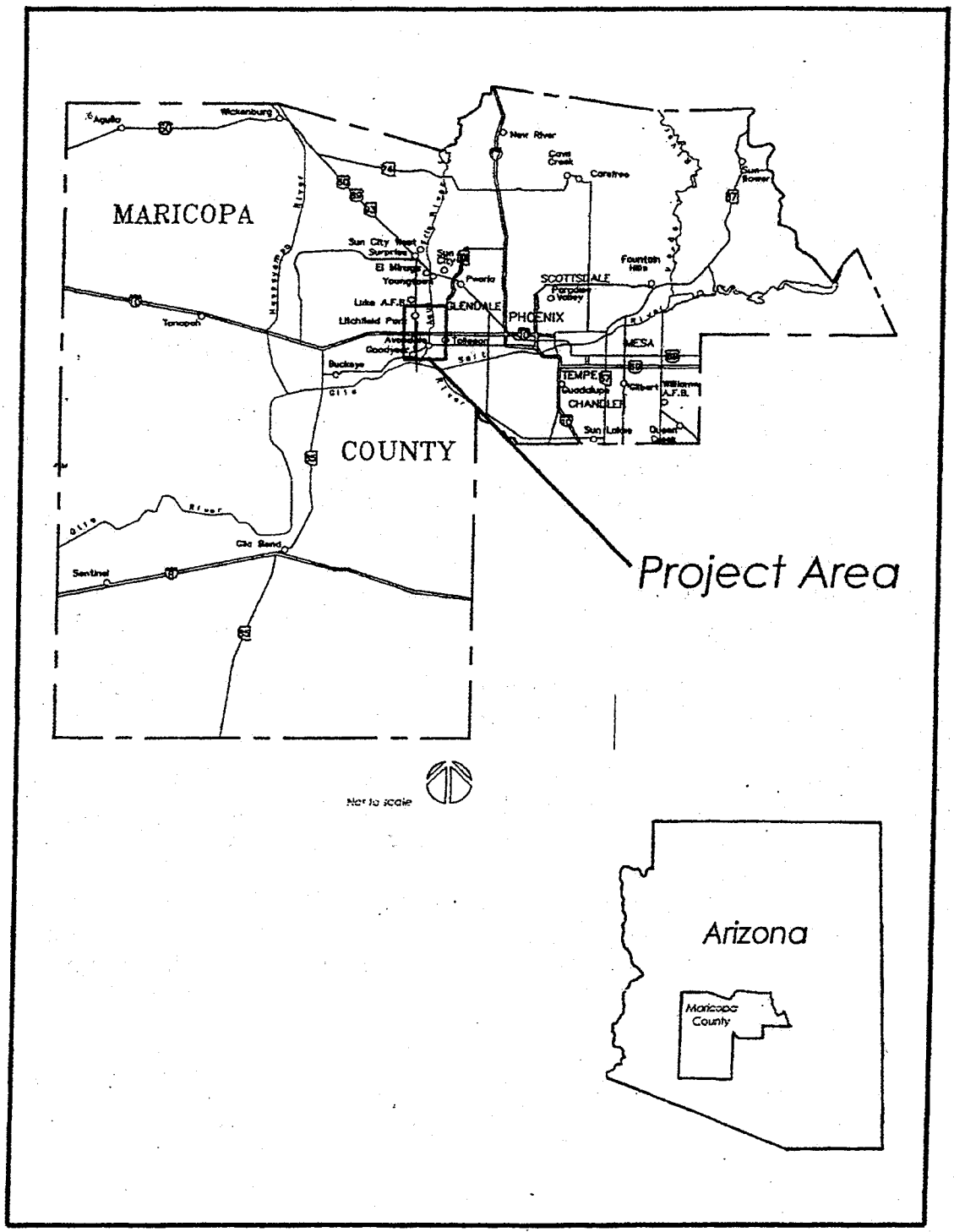
Please respond to this species list request within thirty (30) calendar days from receipt of this letter. Should you require additional information, or have any comments or questions regarding the proposed project, please contact Mr. William O. Butler, Environmental Science Manager, at (213) 452-3873. Thank you for your assistance in this matter.

Sincerely,

Andrew W Miller

Ruth Bajza Villalobos
Chief, Planning Division

Enclosure



Location Map
Figure 1

United States Department of the Interior
U.S. Fish and Wildlife Service
Arizona Ecological Services Field Office
2321 West Royal Palm Road, Suite 103
Phoenix, Arizona 85021-4951
Telephone: (602) 242-0210 Fax: (602) 242-2513

In Reply Refer to:

AESO/SE
02-21-02-I-0465

September 6, 2002

Ms. Ruth Baja Villalobos
Army Corps of Engineers
P.O. Box 532711
Los Angles, California 90053-2325

RE: Agua Fria Section 1135 Ecosystem Restoration Study in Maricopa County

Dear Ms. Villalobos:

This letter responds to your recent request for information on threatened or endangered species, or those that are proposed to be listed as such under the Endangered Species Act of 1973, as amended (Act), which may occur in your project area. The Arizona Ecological Service Field Office has posted lists of the endangered, threatened, proposed, and candidate species occurring in each of Arizona's 15 counties on the Internet. Please refer to the following web page for species information in the county where your project occurs: **http://arizonaes.fws.gov**

If you do not have access to the Internet or have difficulty obtaining a list, please contact our office and we will mail or fax you a list as soon as possible.

After opening the web page, find Arizona County/Species List on the main page. Then click on the county of interest. The arrows on the left will guide you through information on species that are listed, proposed, candidates, or have conservation agreements. Here you will find information on the species' status, a physical description, all counties where the species occurs, habitat, elevation, and some general comments. Additional information can be obtained by going back to the main page. On the left side of the screen, click on Document Library, then click on Documents by Species, then click on the name of the species of interest to obtain General Species Information, or other documents they may be available. Click on the "Cactus" icon to view the desired document.

Please note that your project area may not necessarily include all or any of these species. The information provided includes general descriptions, habitat requirements, and other information for each species on the list. Under the General Species Information, citations for the Federal Register (FR) are included for each listed and proposed species. The FR is available at most public libraries. This information should assist you in determining which species may or may not occur within your project area. Site-specific surveys could also be helpful and may be needed to verify the presence or absence of a species or its habitat as required for the evaluation of proposed project-related impacts.

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SEP 11 2002
PLANNING
DIVISION

Endangered and threatened species are protected by Federal law and must be considered prior to project development. If the action agency determines that listed species or critical habitat may be adversely affected by a federally funded, permitted, or authorized activity, the action agency will need to request formal consultation with us. If the action agency determines that the planned action may jeopardize a proposed species or destroy or adversely modify proposed critical habitat, the action agency will need to enter into a section 7 conference. The county list may also contain candidate species. Candidate species are those for which there is sufficient information to support a proposal for listing. Although candidate species have no legal protection under the Act, we recommend that they be considered in the planning process in the event that they become listed or proposed for listing prior to project completion.

If any proposed action occurs in or near areas with trees and shrubs growing along watercourses, known as riparian habitat, we recommend the protection of these areas. Riparian areas are critical to biological community diversity and provide linear corridors important to migratory species. In addition, if the project will result in the deposition of dredged or fill materials into waterways, we recommend you contact the Army Corps of Engineers which regulates these activities under Section 404 of the Clean Water Act.

The State of Arizona and some of the Native American Tribes protect some plant and animal species not protected by Federal law. We recommend you contact the Arizona Game and Fish Department and the Arizona Department of Agriculture for State-listed or sensitive species, or contact the appropriate Native American Tribe to determine if sensitive species are protected by Tribal governments in your project area.

Specific guidance information regarding the cactus ferruginous pygmy-owl on private land can also be found on our web page under Document Library. From there, click on Documents by Species, then click on cactus ferruginous pygmy-owl, then click on the document titled "Recommended Guidance for Private Landowners Concerning the Cactus Ferruginous Pygmy-owl."

For future projects, you do not need to contact our office to obtain a species list for a new project. However, for additional communications regarding this project, please refer to consultation number 02-21-02-I-0465. We appreciate your efforts to identify and avoid impacts to listed and sensitive species in your project area. If we may be of further assistance, please feel free to contact Tom Gatz for projects in northern Arizona or along the Colorado River (x240) or Sherry Barrett for projects in southern Arizona.

Sincerely,

Thomas A. Gatz
Acting Field Supervisor

cc: Regional Supervisor, Arizona Game and Fish Department, Tucson, AZ
Assistant Field Supervisor, Fish and Wildlife Service, Tucson, AZ

W:\Cathy Gordon\species list letters\army corps of engineers agua frairiver 1135 ecosystem restoration study.wpd:cgg

FLOOD CONTROL DISTRICT of Maricopa County

Gregory L. Jones, P.E.
Regional Planning Manager
Planning and Project Management Division

2801 West Durango Street
Phoenix, Arizona 85009
E-MAIL: glj@mail.maricopa.gov

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FAX: (602) 506-8561
TT: (602) 506-5897

FLOOD CONTROL DISTRICT of Maricopa County

Douglas A. Williams, AICP
Regional Planning Manager
Planning and Project Management Division

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FLOOD CONTROL DISTRICT of Maricopa County

Russell Miracle, P.E.
Planning Branch Manager

(602) 506-2961
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FAX: (602) 506-8561
TT: (602) 506-5897
2801 WEST DURANGO STREET
PHOENIX, ARIZONA 85009-6399

FLOOD CONTROL DISTRICT of Maricopa County

Michael S. Ellegood, P.E.
Chief Engineer and General Manager

(602) 506-4700
(602) 506-4601 FAX
e-mail: mse@mail.maricopa.gov

2801 WEST DURANGO STREET
PHOENIX, ARIZONA 85009-6399

Aspen
Environmental Group

January 29, 2003

NRCS
Attn: Jeff Schmidt
3003 N Central Ave., Suite 800
Phoenix, AZ 85012

SUBJECT: Agua Fria River Ecosystem Restoration Project

Dear Jeff:

Per our telephone conversation on January 28, 2003, I am sending you two plan views for the Agua Fria River Ecosystem Restoration Project that we are developing for the U.S. Corps of Engineers in cooperation with the Flood Control District of Maricopa County.

This phase of the project considers several alternatives with only one presented as a recommended plan. Figure 28, Alternative 4 represents the largest of these alternatives in terms of the affected area depicted in the plan legend as riparian strips and vegetation management areas. All other alternatives affect a subset of this area. Figure 29, Alternative 8 is the footprint of the plan we are presently recommending.

Please indicate to us whether this area overlaps with farmland and whether the FPPA would apply. If you have any questions, I can be reached at 818 597 3407 X 309 or skoslowsky@aspeneg.com.

Sincerely yours,
ASPEN ENVIRONMENTAL GROUP

Shari Koslowsky
Delivery Order Manager

cc: File (9238)

S:\projects\ongoing_prjcts\9200 USACE\9238-Agua Fria\Correspondence\NRCS farmland ltr.doc

30423 Canwood Street, Suite 215, Agoura Hills, CA 91301 • Phone (818) 597-3407 • Fax (818) 597-8001
E-mail: Aspen@AspenEG.com • http://www.AspenEG.com

United States Department of Agriculture

NRCS

Natural Resources Conservation Service
3003 N. Central Avenue, Suite 800
Phoenix, Arizona 85012-2946
(602) 280-8801
FAX (602) 280-8809

FEB 10 2003

February 6, 2003

Shari Koslowsky
Delivery Order Manager
30423 Canwood Street #215
Agoura Hills, California 91301

Dear Ms. Koslowsky:

I am in receipt of your letter dated January 29, 2003, regarding the Agua Fria River Ecosystem Restoration Project located in Maricopa County, Arizona.

The Natural Resources Conservation Service (NRCS) has general responsibility, nationwide, for implementing the Farmland Protection Policy Act (FPPA) and to review projects that may affect prime farmland and/or wetlands associated with agriculture. After reviewing the information provided, the following is noted:

1- The proposed new projects if implemented as planned, are exempt from the requirements of the FPPA - as revised in 1994, that excludes land which is already in or is committed to urban development, currently used as water storage, or land that is not prime or unique farmland.

2- We do not see any immediate concerns or impacts that would directly affect wetland areas associated with agriculture.

We recommend that any future development projects receive a prime farmland determination prior to any construction activities. Should you have questions, please feel free to contact Jeff Schmidt, Community Assistance Coordinator at 602.280.8818. Thank you again for the chance to review the proposed project.

Sincerely,

JAMES A. BRIGGS
Assistant State Conservationist (T)

cc:
Kris Graham-Chavez, DC, Phoenix, AZ
Jeff Schmidt, Community Assistance Coordinator, NRCS, Phoenix, Arizona

NOTICE OF MEETING
OF THE
FLOOD CONTROL ADVISORY BOARD
September 24, 2003

Pursuant to A.R.S. 38-431.02, notice is hereby given to the general public that the Flood Control Advisory Board (FCAB) will hold a meeting open to the public on Wednesday, September 24, 2003 at 2:00 p.m. in the New River Conference Room of the Flood Control District located at 2801 West Durango Street in Phoenix. Matters on the agenda may be discussed in executive session for the purpose of obtaining advice thereon.

The agenda is as follows:

1) Recognition of the Flood Control District Employee of the Quarter. ***Presented by:*** Representative from the Employee of the Quarter Committee.

2) Approve the Minutes of the June 25, 2003 FCAB meeting as submitted.

3) Agua Fria River Ecosystem Restoration Project, Resolution FCD 2003R006. ***Staff recommends the following action:*** It is moved that the Flood Control Advisory Board endorse and recommend that the Board of Directors adopt Resolution FCD 2003R006. ***Presented by:*** Greg Jones, P.E., Regional Area Planning Manager.

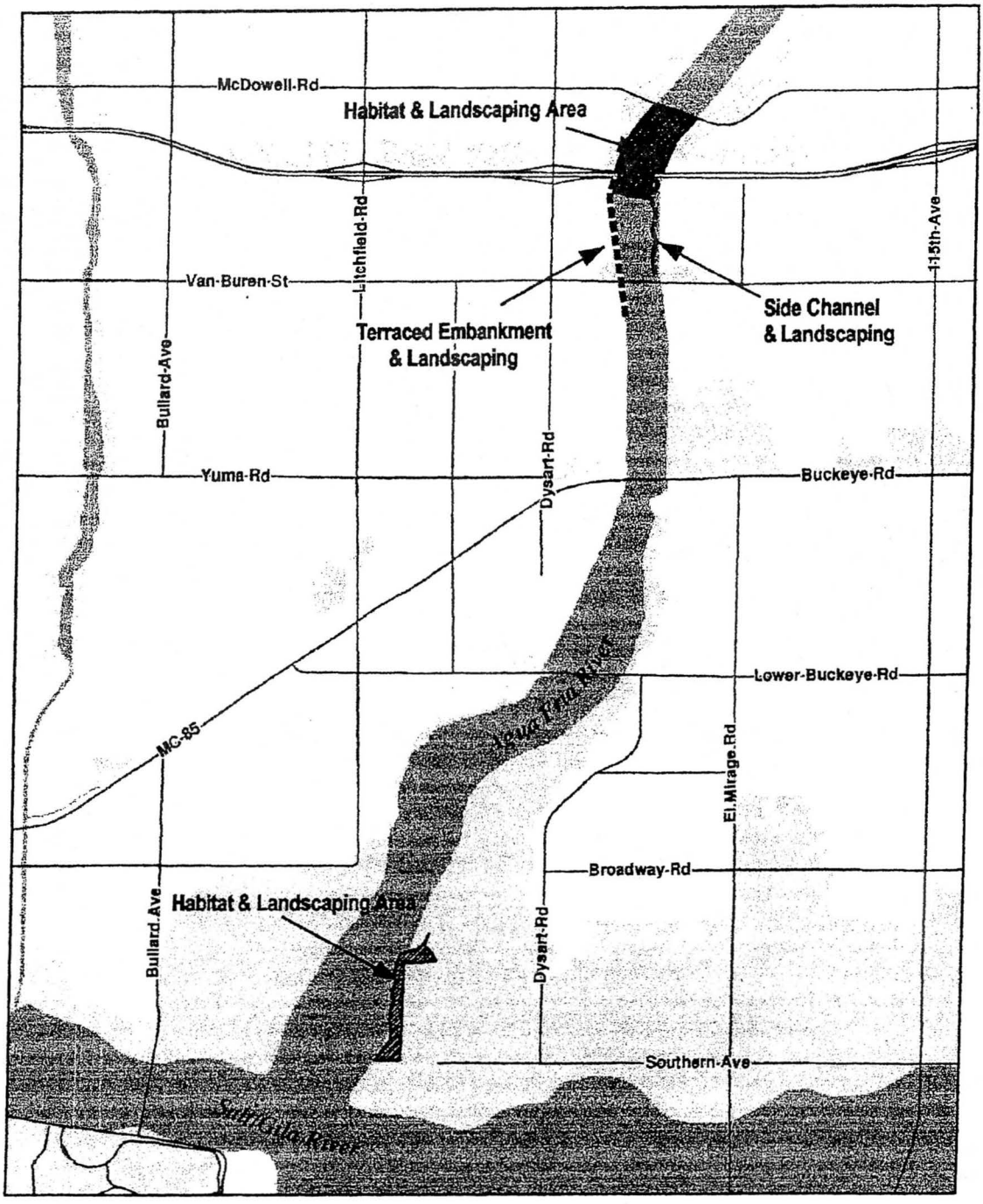
4) Results of the September 5, FCAB Special Meeting. ***Presented by:*** Tim Phillips, P.E., Deputy Chief Engineer and General Manager.

5) Fiscal Year 2003 Financial Results Comparative. This item is for information and discussion only. No action is required. ***Presented by:*** Michael Alexander, Financial Budget Analyst.

6) Comprehensive Plan and Hazard Mitigation Plan Status Update. This item is for information and discussion only. ***Presented by:*** Kelli Sertich, AICP, Regional Area Planning Manager.

7) McMicken Dam Fissure Zone Remediation Project Update. This item is for information and discussion only. No action is required. ***Presented by:*** Michael Greenslade, P.E., Dam Safety Engineer.

Exhibit A


McDowell-Rd
Habitat & Landscaping Area
Litchfield-Rd
115th-Ave
Van-Buren-St
Terraced Embankment
& Landscaping
Side Channel
& Landscaping
Bullard-Ave
Dysart-Rd
Yuma-Rd
Buckeye-Rd
Lower-Buckeye-Rd
Agua Fria River
MC-85
El Mirage Rd
Broadway-Rd
Habitat & Landscaping Area
Bullard Ave
Dysart-Rd
Southern-Ave
Salt River
N
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E
S
0
2,000
4,000
8,000
Feet

AGUA FRIA RIVER
ECOSYSTEM RESTORATION
PROJECT

RESOLUTION FCD 2003R006

WHEREAS, Arizona Revised Statutes Title 48, Chapter 21 allows the Board of Directors of the Flood Control District to contract and join with the United States, municipalities, political subdivisions, and others for the acquiring, constructing, maintaining and operating flood control works; and,

WHEREAS, the Resolution 93-03 adopted by the Board of Directors on May 3, 1993, established the District's Policy for the Aesthetic Treatment and Landscaping of Flood Control Projects; and,

WHEREAS, the Policy for the Aesthetic Treatment and Landscaping of Flood Control Projects allows the District to include aesthetic treatments to existing District flood control projects that did not include aesthetic features, at the discretion of the Chief Engineer and General Manager; and,

WHEREAS, the aesthetic treatment and landscaping were not incorporated in the Agua Fria River Channelization project when it was originally constructed due to the remote location at that time; and,

WHEREAS, the District has completed the Agua Fria River Water Course Master Plan; and,

WHEREAS, the U.S Army Corps of Engineers (COE) Feasibility Study, Agua Fria River Ecosystem Restoration Project features are consistent with the Agua Fria River Water Course Master Plan; and,

WHEREAS, the recommended plan of the Agua Fria River Ecosystem Restoration study includes 81 acres of river aesthetic enhancements at two locations, and the aesthetic enhancement of the exiting east and west levees from approximately I-10 to Van Buren Road, as shown on Exhibit A, attached hereto and made a part hereof; and,

WHEREAS, the District, in cooperation with the City of Avondale, COE, and others, will work to implement the proposed features identified in the Agua Fria River Ecosystem Restoration Study, subject to funding, priorities and future authorizations.

NOW, THEREFORE, BE IT RESOLVED that the Board of Directors of the Flood Control District of Maricopa County authorizes and directs the Chief Engineer and General Manager to negotiate and prepare intergovernmental agreements and/or agreements with the City of Avondale, COE, and/or other municipalities, agencies and others, as appropriate, for rights-of-way acquisition, design, construction, construction management and future operation and maintenance for the Agua Fria River Ecosystem Restoration Project that is consistent with the District's Policy for the Aesthetic Treatment and Landscaping of Flood Control Projects, subject to the ratification and approval of this Board; and,

BE IT FURTHER RESOLVED that the Chief Engineer and General Manager is hereby authorized and directed to negotiate with landowners and/or appropriate agencies to obtain the necessary rights-of-entry, property and/or easements and all other necessary land rights required for the Agua Fria River Ecosystem Restoration Project within the following sections:

T1N, R1W, Sections 2, 11, 27, 28, 33, 34

BE IT FURTHER RESOLVED that the Chief Engineer and General Manager retains the right to and is authorized and directed to hire, retain or otherwise utilize the professional services of the County Attorney's office or private counsel to initiate and prosecute actions and proceedings in the manner required by law to condemn any and all Rights-of-Entry, Property, and/or Easements required for the implementation of the Agua Fria River Ecosystem Restoration Project which cannot be obtained by donation or purchase in the following locations:

T1N, R1W, Sections 2, 11, 27, 28, 33, 34

Subject to the ratification and approval of this Board; and,

BE IT FURTHER RESOLVED that the Chief Engineer and General Manager is authorized and directed to include funds in the District's current and future Five-Year Capital Improvement Program (CIP) for the Agua Fria River Ecosystem Restoration Project, subject to prioritization by the District and subsequent approvals by this Board of future Five-Year CIP; and,

BE IT FURTHER RESOLVED that the Chief Engineer and General Manager is authorized and directed to advertise, select, negotiate and award a contract for engineering services for implementation of the Agua Fria River Ecosystem Restoration Project, subject to the ratification and approval of this Board.

Dated this _____ day of _____, 2003

_____
Chairman, Board of Directors

ATTEST:

_____
Clerk of the Board

Enclosure: Exhibit A, Resolution FCD 2003R006

AGREEMENT BETWEEN
THE UNITED STATES OF AMERICA
AND
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
FOR LOCAL COOPERATION AT
PHOENIX, ARIZONA AND VICINITY (INCLUDING NEW RIVER)
FLOOD CONTROL PROJECT, GILA RIVER BASIN, ARIZONA

THIS AGREEMENT entered into this 21st day of July, 1977, by and between the UNITED STATES OF AMERICA (hereinafter called the "Government"), represented by the Contracting Officer executing this agreement, and the FLOOD CONTROL DISTRICT OF MARICOPA COUNTY, a political subdivision of the State of Arizona (hereinafter called the "District"), WITNESSETH THAT:

WHEREAS, construction of the Phoenix, Arizona and Vicinity (including New River) Project (hereinafter called the "Project"), was authorized by the Flood Control Act of 1965, 79 Stat. 1073, (Public Law 89-298); and

WHEREAS, under Title 45, Chapter 10, Arizona Revised Statutes, a flood control district may cooperate with the United States in the construction of flood control projects for the benefit of lands within the District; and

WHEREAS, the District hereby represents that it has the authority and capability to furnish the non-Federal cooperation required by the Federal legislation authorizing the Project, other applicable law, and the General Design Memorandum (Phase I) for the Project; and

WHEREAS, the assurances given and the obligation undertaken by the District in this agreement shall apply to all aspects of the Project except for any recreational features, which will require additional assurances and undertakings by the non-Federal agency cooperating in such features.

NOW, THEREFORE, the parties agree as follows:

1. The District agrees that, if the Government shall commence construction of the Phoenix, Arizona and Vicinity (including New River) Flood

Control Project, in Maricopa County, Arizona, substantially in accordance with Federal legislation authorizing such Project (Section 204 of the Flood Control Act of 1965), and subsequent revisions as stated in the General Design Memorandum (Phase I) for the Project, approved by the Division Engineer, U. S. Army Engineer Division, South Pacific, on 8 July 1977, the District shall, in consideration of the Government commencing construction of such Project, fulfill the requirements of non-Federal cooperation specified in such legislation and memorandum and the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, 84 Stat. 1894 (Public Law 91-646), as to all aspects of the project except for any recreational features thereof, to wit:

a. Provide, without cost to the United States, all lands, easements, and rights-of-way, including spoil-disposal areas, necessary for the construction of the Project.

b. Perform, without cost to the United States, all necessary construction, alteration or relocation of highways, roads, highway bridges, utilities, irrigation and drainage works, and all necessary street modifications required in connection with the Project.

c. Hold and save the United States free from damages due to the construction works except those damages due to the fault or the negligence of the United States or its contractors.

d. Maintain and operate all the works after completion in accordance with regulations prescribed by the Secretary of the Army.

e. Prevent any encroachment upon the existing or improved channels or within the detention basin areas that would reduce their flood-conveying or storage capacities.

f. Hold and save the United States free from all damages arising from water-rights claims resulting from construction, maintenance, and operation of the Project.

g. Contribute in cash 2.3 percent of the total cost of construction of the Project, to be paid either in lump sum prior to commencement of construction or in installments prior to commencement of pertinent work items in accordance with construction schedules as required by the Chief of Engineers, the final allocation of costs to be made after the actual costs of construction have been determined.

h. In addition to the acquisition of lands, easements, and rights-of-way to be acquired by the District as deemed required for the Project by the Secretary of the Army, take whatever action is necessary to manage and maintain the designated floodways and floodway fringes in the affected watercourses and adjacent flood plains along Dreamy Draw from Dreamy Draw Dam to its confluence with the Arizona Canal diversion channel, along Cave Creek from Cave Buttes Dam to its confluence with the Arizona Canal diversion channel, along Skunk Creek from Adobe Dam to its confluence with the New River, along the New River from the New River Dam to its confluence with the Agua Fria River, and along the Agua Fria River from its confluence with the New River to its confluence with the Gila River, as delineated by

the Secretary of the Army so as to assure the unobstructed passage of floodwaters of 100-year floods, while providing for limited use and development of the lands within such areas deemed compatible therewith, in accordance with regulations to be prescribed by the Secretary of the Army. In connection therewith, the District shall, on a continuing basis, remove or cause to be removed excessive plant growth and sediments that would obstruct flows and/or appreciably increase the flood plain widths for 100-year floods.

i. Enter into an agreement with the Arizona Game and Fish Department providing for the operation and maintenance of mitigation lands.

j. At least annually notify interests affected that the Project will not provide complete flood protection.

k. Acquire such real estate interests downstream of the spillways of the Project as are deemed necessary by the Chief of Engineers to assure the carrying out of project purposes and to protect non-Federal interests from hazards created by spillway flows. Such acquisitions shall be without cost to the United States.

l. Comply with the requirements of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 applicable to State agencies. In connection therewith, the District hereby assures the Secretary of the Army that:

(1) Fair and reasonable relocation payments and assistance shall be provided to or for displaced persons, as are required to be provided by a Federal agency under Sections 202, 203, and 204 of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970.

(2) Relocation assistance programs offering the services described in Section 205 of said act shall be provided to such displaced persons.

(3) Within a reasonable period of time prior to displacement, decent, safe, and sanitary replacement dwellings will be available to displaced persons in accordance with Section 205 (c)(3) of said act.

(4) In acquiring lands, easements, and rights-of-way for the Project, it will be guided, to the greatest extent practicable under State law, by the land acquisition policies in Section 301 and the provisions of Section 302 of said act.

(5) Property owners will be paid or reimbursed for necessary expenses as specified in Sections 303 and 304 of said act.

(6) Affected persons will be adequately informed of the benefits, policies, and procedures concerning the matters set forth in subparagraphs (1) through (5) above.

2. The District hereby gives the Government a right to enter, at reasonable times and in a reasonable manner, upon lands which the District owns or controls, for access to the Project for the purpose of inspection, and for the purpose of repairing and maintaining the Project, if such inspection shows that the District for any reason is failing to repair and maintain the Project in accordance with the assurances hereunder and has persisted in such failure after a reasonable notice in writing by the Government delivered to the Chief Engineer and General Manager of the District or his successor, or in the event that no one is occupying such a position in the District, to the Chairman of the Board of Directors of the District. No repair and maintenance by the Government in such event shall operate to relieve the District of responsibility to meet its obligations as set forth in paragraph 1 of

this Agreement, or to preclude the Government from pursuing any other remedy at Law or equity.

3. This Agreement is subject to the approval of the Secretary of the Army.

IN WITNESS WHEREOF, the parties hereto have executed this contract as of the day and year first above written.

UNITED STATES OF AMERICA

By _____
Colonel, Corps of Engineers
District Engineer
U.S. Army Engineer District, L.A.
Contracting Officer

Date 21 JUL 1977

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

By _____
Chairman, Board of Directors

ATTEST:

_____
Clerk of the Board

The undersigned, having considered all of the provisions of the foregoing Agreement and the effect of Section 221 of the Flood Control Act of 1970, 84 Stat. 1818 (Public Law 91-611), approves the foregoing Agreement as to form, substance, and legality this 13 day of July, 19 77

_____
Chief Legal Officer, Flood Control
District of Maricopa County, Arizona

APPROVED:

_____
H. B. MUSSELL, Actg Dir/RE

For and on behalf of Secretary
of the Army

CERTIFICATE OF AUTHORITY

I, Larry J. Richmond, do hereby certify that I am the General Counsel of the Flood Control District of Maricopa County; that the Flood Control District of Maricopa County is a legally constituted public body with full authority and capability to perform the terms of the agreement between the United States of America and the Flood Control District of Maricopa County in connection with the Phoenix, Arizona and Vicinity (including New River) Flood Control Project, and to pay damages, if necessary, in the event of the failure to perform in accordance with Section 221 of the Flood Control Act of 1970, 84 Stat. 1818 (Public Law 91-611) and that the persons who have executed the contract on behalf of the Flood Control District of Maricopa County have acted within their statutory authority.

In Witness Whereof, I have made and executed this Certificate this 13 day of July, 1977.

Chief Legal Officer, Flood Control
District of Maricopa County, Arizona

APPENDIX D.

CLEAN WATER ACT 404(B)(1) REPORT

Appendix D
Clean Water Act, Section 404 (b) (1)
Compliance Evaluation

Agua Fria
Section 1135 CAP
Restoration Project

Maricopa County, Arizona

Clean Water Act
SECTION 404 (b) (1) COMPLIANCE EVALUATION

I. INTRODUCTION

This appendix evaluates compliance with the guidelines established under the Federal Pollution Control Act (Clean Water Act) Amendments of 1972 (Public Law 92-500), as amended by the Clean Water Act of 1977 (Public Law 95-217), legislation collectively referred to as the Clean Water Act, 33 U.S.C. 1251 et seq. Its intent is to succinctly state and evaluate information regarding the effects of discharge of dredged or fill material into the waters of the United States. As such, it is not meant to stand alone and relies heavily upon information provided in the attached Detailed Project Report (DPR). Use of the "Documentation" category is for expansion of discussions only when necessary or for references and citation.

The Clean Water Act sets national goals and policies to eliminate the discharge of water pollutants into waters of the U.S. Any discharge of dredged or fill material into waters of the U.S. by the Corps requires a written evaluation that demonstrates that a proposed action complies with the guidelines published at 40 CFR § 230. These guidelines, referred to as the Section 404(b)(1) Guidelines (the "Guidelines") are the substantive criteria used in evaluating discharges of dredged or fill material under Section 404 of the Clean Water Act.

The Agua Fria Riparian Restoration Project would require the discharge of dredged and fill material into the Agua Fria River. The Agua Fria River is a tributary to the Gila River. The Gila River is a tributary to the Colorado River, a navigable water of the United States, under 33 CFR §328.3(a)(1). The Agua Fria River is considered to be Waters of the U.S. as defined in 33 CFR § 328.3(a)(5) and, as such, is subject to regulation under Section 404. The lateral limit of jurisdiction in non-tidal waters such as the Agua Fria River is defined in 33 CFR § 328.4(c)(1) as the ordinary high water mark (OHWM), provided the jurisdiction is not extended by the presence of wetlands (see below). Title 33 CFR § 328.3(e) defines the OHWM as that line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas.

Wetlands are one of the Special Aquatic Sites identified in 40 CFR § 230 Subpart E. Wetlands are defined as, "areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (33 CFR § 328.3). The list of special aquatic sites also includes sanctuaries and refuges, mud flats, vegetated shallows, coral reefs, and riffle and pool complexes. Special aquatic sites are geographic areas, large or small, possessing special ecological characteristics of productivity, habitat, wildlife protection, or other important and easily disrupted ecological values. These areas are generally recognized as significantly influencing or positively contributing to the

general overall environmental health or vitality of the entire ecosystem of a region (40 CFR § 230.3[q-1]).

A Jurisdictional Determination report encompassing the project area was submitted to the USACE Arizona Field Office in June 2000 for the purpose of taking sediment samples as part of the Agua Fria River Watercourse Master Plan (Kimley Horn 2001a). Where a wetland area occurred within the confines of the otherwise dry river channel, its boundary was approximated and noted on the aerial photography. Seasonal or perennial wetlands were identified in three areas where there is significant surface water drainage, i.e., I-10 channel (Papago Diversion Channel), Durango Regional Outfall Channel at Buckeye Road , and AWWTP. These wetlands consist of small areas dependent upon stormwater, effluent and irrigation discharges, and a few larger areas associated with abandoned aggregate mining activities. These wetlands are transitional in nature, changing with fluctuations in the volume of stormwater flows, delivery of effluent, flood events, and management of active and abandoned aggregate mining operations. A follow-up planning level delineation was prepared by the Corps of Engineers in 2007 (Appendix R) that conforms with the preceding.
Where ephemeral hydrologic conditions were present, the field evaluation was concerned with establishing an OHWM as the boundary of the jurisdictional channel. The OHWM delineation is based on discernable field evidence such as erosion scars, bank definition, sediment deposition, debris flows, vegetation patterns and other field indicators. The aerial photography was utilized to determine overall trends and channel patterns that were combined with the field information to develop a likely OHWM boundary. Therefore, in some instances an "outer" defined bank was chosen as representing the OHWM for the channel reach. This approach may result in the inclusion of interfluvial areas within the jurisdictional boundary that otherwise might not be considered jurisdictional under the strictest of field interpretations. Where the Agua Fria River is confined within armored or stabilized banks, the armored bank was noted as the boundary.

With the exception of the "No-Action" Alternative, all alternatives receiving final consideration include restoration of the Agua Fria River channel through parts of the study area. This work would include modifications to the river channel, banks and terraces, installation of water harvesting features and irrigation infrastructure, planting of vegetation, and soil amendment/ restoration activities. All action alternatives would have a similar range of impacts to Waters of the U.S., both for initial construction work, and during future operation, maintenance, repair, replacement and rehabilitation (OMRR&R) activities completed by the non-federal sponsors (the Flood Control District of Maricopa County (FCDMC) and the City of Avondale (COA)).

Fundamental to the Guidelines is the precept that "dredged or fill material should not be discharged into the aquatic ecosystem, unless it can be demonstrated such a discharge would not have an unacceptable adverse impact either individually or in combination with known and/or probable impacts of other activities affecting the ecosystems of concern." The procedures for documenting compliance with the Guidelines include the following:

- Examining practicable alternatives to the proposed discharge that might have fewer adverse environmental impacts, including not discharging into a Water of the U.S. or discharging into an alternative aquatic site;

- Evaluating the potential short- and long-term effects, including cumulative effects, of a proposed discharge of dredged or fill material on the physical, chemical, and biological components of the aquatic environment;

- Identifying appropriate and practicable measures to mitigate the unavoidable adverse environmental impacts of the proposed discharge, and;

- Making and documenting the Findings of Compliance required by §230.12 of the Guidelines.

II. PROJECT DESCRIPTION

A. Project Location and Characteristics

The project modification boundaries are located in the Agua Fria River in the southwestern region of the Phoenix metropolitan area, within Maricopa County, Arizona, and in the City of Avondale. Within the city limits of Avondale, the project reach is bounded to the north (upstream) by McDowell Road and to the south by the confluence of the Gila River[1]. Within this reach of the river, the width varies from approximately 1,200 feet in the narrowest portions at the northern end of the project site, to roughly 2,500 feet at the widest portions at the southern sections; however, flowage easements extend beyond this width. The average elevation in the project area ranges from approximately 894 to 1,019 feet above sea level.

The Agua Fria River was once a perennial watercourse in the project area, characterized by meandering flows throughout the river system. The river once 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, coupled with construction of dams upstream, transformed the Agua Fria River to a dry river that flows only ephemerally in response to storm runoff and effluent discharge.

[1] The following boundaries have been used for the purpose of data research: (1) Latitude 33° 30' 00" and 33° 23' 30"; Longitude 112° 21 30 and 112° 18' 30"; and (2) T1N: R1W: Sections 02, 03, 10, 11, 14, 15, 16, 21, 22, 23, 26, 27, 28, 33, 34, and 35.

The Agua Fria River watershed covers approximately 2,250 mi^2, but 83 percent of it is controlled upstream by several manmade structures, including the New Waddell Dam, the Arizona Diversion Canal, and dams along the New River and Skunk Creek. The Agua Fria River flood control project was constructed for the pre-New Waddell Dam Standard Project Flood of 92,000 to 102,000 cubic feet (cfs) through the project reach. This discharge is approximately three percent to nine percent higher than the post-New Waddell Dam 100-year discharge. The New Waddell Dam, constructed in 1991, reduced the Standard Project Flood to approximately 83,000 to 94,000 cfs through the project reach. The 100-year discharge was reduced to approximately half the Standard Project Flood (SPF).

Average streamflow on the Agua Fria River is close to zero. There is generally no flow at all for the months of April, May, June, October, and November. Sporadic flows occur in the remaining months depending upon rainfall. Within the project reach there are several discharges or drainages, including the I-10 channel outflow (north of I-10), the Durango Regional Outfall Channel outflow (north of Buckeye Road), the Avondale Wastewater Treatment Plant (AWWTP), and several smaller irrigation and stormwater runoff drains (Figures 4 to 8, located in Appendix A).

Destruction of native riparian habitat has facilitated an increase in invasive plant species that are more tolerant of disturbed conditions. Invasive plants consume more water than native vegetation because of their ability to occupy a greater areal extent on the landscape, placing additional strains on the already limited water supply. Within the study area, the river is now a highly disturbed riverbed with minimal native vegetation.

Soil cement levees provide flood control protection along the east and west banks of the Agua Fria River, from approximately Indian School Road (north of McDowell Road) to Buckeye Road. The western levee extends further south to 1/4-mile south of Lower Buckeye Road for a total length of approximately 3-1/2 miles within the project area, while the eastern levee within the project area is approximately 2 miles, extending to Buckeye Road. There are other bank protection structures associated with private developments or bridge crossings (such as a 1/4-mile levee around a residential neighborhood on the east side of the river at Lower Buckeye Road).

Residential development is currently replacing much of the historically agricultural lands surrounding the project area. Sand and gravel mining within the lower reaches of the Agua Fria River still occurs from Indian School Road to Camelback Road and further downstream near lower Buckeye Road on both the east and west banks. Birders, hikers, equestrians and off-road vehicles also use the project area informally.

The regional climate is semi-arid, with mean monthly temperatures ranging from around 50°F in December and January to around 85-90°F between July and August. Scarce rainfall occurs in a bimodal pattern during the months of January and February and July and August. Vegetation within and adjacent to the restoration project area consists of disturbed/ruderal, early successional, riparian, upland and agricultural. The Agua Fria River at its confluence with the Gila River is within the Pacific Flyway and in general, provides resting, foraging and nesting habitat for a variety of migratory and non-migratory birds.

The Agua Fria River flood control project was constructed for the pre-New Waddell Dam Standard Project Flood of 92,000 to 102,000 cubic feet (cfs) through the project reach. The New Waddell Dam, constructed in 1991, reduced the Standard Project Flood to approximately 83,000 to 94,000 cfs through the project reach. The 100-year discharge was reduced to approximately half the Standard Project Flood.

Average streamflow on the Agua Fria River is close to zero. There is generally no flow at all for the months of April, May, June, October, and November. Sporadic flows occur in the remaining months depending upon rainfall. On average, there is no measurable flow on the Agua Fria River 99 days out of 100. There are several discharges or drainages to the Agua Fria River, including effluent from the Avondale Wastewater Treatment Plant (AWWTP), the I-10 channel outflow (north of I-10), the Durango Channel outflow (north of Buckeye Road), and smaller irrigation and stormwater runoff drains.

III. PROJECT ALTERNATIVES

A. Regulatory Considerations

Section 230.10 of the Guidelines dictates that, except as provided under §404(b)(2), "no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have significant adverse environmental considerations." A "practicable alternative" is defined as "available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes." The overall project purpose is to restore approximately 100 acres of habitat within this reach of the Agua Fria River. While the NEPA process, through the integrated DPR and EA, extensively examines alternatives and discloses all of their environmental impacts, the 404(b)(1) Evaluation focuses on the impacts of alternatives to the aquatic ecosystem.

The Guidelines also require that "where the activity associated with a discharge which is proposed for a special aquatic site does not require access or proximity to or siting within the special aquatic site in question to fulfill its basic purpose (i.e., is not "d"), practicable alternatives that do not involve special aquatic sites are presumed to be available, unless clearly demonstrated otherwise." The basic purpose of this project – ecosystem restoration- is water dependent, since the project purpose cannot be fulfilled without utilizing the river. The Guidelines further specify that where a discharge is proposed for a special aquatic site, all practicable alternatives to the proposed discharge that do not involve a discharge into a special aquatic site are presumed to have less adverse impact on the aquatic ecosystem, unless clearly demonstrated otherwise.

For the purpose of a 404(b)(1) alternatives analysis, practicable alternatives include:

- Offsite alternatives - i.e., discharges of dredged or fill material at other locations in waters of the United States, and;

- On-site alternatives - these include project designs that do not involve a discharge of dredged or fill material into Waters of the U.S., as well as project designs that have different impacts to Waters of the U.S.

B. Off-Site Alternatives

The Agua Fria River is one of three primary river corridors in the Phoenix area that have been subjected to significant development pressures. Within the channel of the Agua Fria River, existing riparian habitat is limited to a few isolated areas, which are determined by surface water discharges and shallow ground water. Overall, the habitats are of low value and declining because of chronic disturbance and alteration of basic ecosystem processes.

The location of this project was chosen based upon the availability of a contiguous segment of the river corridor, the support of a non-federal sponsor, the proximity and contiguity of other restoration projects, and the technical feasibility of constructing a project at this location.

The Agua Fria Riparian Restoration Project is one of several ecosystem restoration endeavors that are at various stages of development by the Corps and non-federal sponsors along the Agua Fria and adjacent Gila River. The FCDMC Agua Fria River Watercourse Master Plan outlines specific recommendations relative to floodplain management strategies, recreation opportunities, and habitat preservation for the corridor. Throughout this DPR, data from the Agua Fria River Watercourse Master Plan and its technical appendices were used because of its direct relevance to the restoration project site. The larger Tres Rios Aquatic Ecosystem Restoration project, just downstream from Agua Fria, is in the design stage.

The nearest other potential location for an Agua Fria restoration project would be upstream, but would not be near or contiguous with the Tres Rios restoration project, and does not currently have the support of a non-federal sponsor. In addition, because of the series of upstream dams and associated legal constraints to project design, it would be much more difficult to design a functioning habitat restoration project upstream of the subject project area. Off-site alternatives, therefore, do not meet the overall project purpose.

C. On-Site Alternatives

An array of 8 alternatives (including the No-Action Alternative) was formulated by the Corps, the City of Avondale and the Maricopa County Flood Control District during the alternative formulation process. These alternatives represented varying combinations of restoration treatments (e.g., vegetation types, channel modifications, water source, infrastructure). Alternatives were initially developed based on the Corps' federal planning objectives for water resource projects, specific planning objectives developed for the Agua Fria Riparian Restoration Project, and project-specific opportunities and constraints for implementing restoration activities. The specific planning objectives listed below reflect the problems and opportunities and represent desired positive changes along the Agua Fria River reach:

- Restore native riparian, wetland and floodplain habitats, and manage undesirable plant, fish, and wildlife species;

- Reduce flood damages to infrastructure and structures, and;

- Improve passive recreation and environmental-education opportunities.

The initial array of alternatives was ranked and screened based on associated habitat benefits and implementation costs. A modified Habitat Evaluation Procedure (HEP) was used by the planning team to identify and quantify the anticipated habitat benefits associated with the proposed restoration alternatives. The HEP protocols assess and quantify the values of existing habitat types, and evaluates and quantify future changes in these characteristics and associated habitat benefits resulting from implementation of the restoration alternatives (refer to the DPR, Appendix K for a discussion of the HEP evaluation and methodology). Results of the HEP assessment were incorporated into the Corps' standard cost evaluation analysis (ICA) to identify the alternatives that provided the highest habitat benefits per unit cost.

The construction alternatives are Alternative 2, Alternative 3, Alternative 4, Alternative 5, Alternative 6, Alternative 7 and Alternative 8. The following ecosystem restoration features are common to all construction alternatives:

- Develop riparian strips, with no structural changes, to facilitate growth of native vegetation (vegetation management areas)

- Within riparian strips, excavate meandering side channels and construct protective berms to exclude frequent flows to reduce chances of significant habitat loses

- Establish native cover in areas affected by construction now sparsely vegetated and dominated by invasive exotic species

- Irrigate plants to facilitate growth of roots to groundwater for durations and amounts varying by vegetation types.

Each of the construction alternatives analyzed in detail through the NEPA process are practicable. However, they would accomplish the overall purpose to varying extents, with varying levels of benefits and a range of impacts to the aquatic ecosystem. The impacts would be both adverse (short term) and beneficial (long term). The types of OMRR&R activities would be similar for each alternative, although the level of effort and cost for OMRR&R activities would generally be proportional to the amount of new habitat created.

Additional discussion of the measures combined to formulate the action alternatives is provided in Chapter 2 of the DPR, and a complete discussion of alternatives can be found in Chapter 4 of the DPR Report.

D. Description of the Project Alternatives

Although other alternatives were considered in the study, the following alternatives have been carried though to the final array:

Alternative 1, which is the No Action and future Without-Project Alternative, assumes no restoration is implemented in the channel and that existing environmental conditions in the channel would remain the same or continue to degrade over time due to hydrological and other controls within the watershed, urban development, agriculture, sand and gravel mining and other chronic impacts. Specifically, under this alternative it is assumed that all the effluent from the AWWTP would eventually be diverted from the channel to other uses. The approximate acreage of existing vegetation types within the project area is provided in Table 1 below for the No Action Alternative and the seven action alternatives.

Alternative 2 – Low Water Use extends over the smallest area, approximately 72.1 acres along the reach from McDowell Road to north of Buckeye Road (Figure 26, Appendix A). It requires the smallest input of water at 1.1 million gallons per day (mGPD). The configuration consists of a riparian strip along the western levee from McDowell Road to Coldwater Park (also near the second grade control structure downstream of I-10), and another restored strip along the eastern levee from the I-10 outfall to the second grade control structure. The western riparian strip would consist of filling and regrading the inner slope of the levee, suitable for xeric riparian vegetation and species typical of the more arid conditions of upper flood plains. The eastern riparian strip consists of a narrow and shallow (one to two feet deep) constructed low flow channel paralleling the levee with hydric and mesic riparian vegetation extending from 100 to 600 feet into the channel. Both the western and eastern riparian strips would be limited on the interior of the channel by terrace bank armor to protect the riparian strips from frequent flood events of 10 to 15 years to reduce the chances of significant losses; however, larger flows would still pass through and it is presumed that some losses of vegetation would occur.

Alternative 3 – Moderate Water Use extends over a slightly greater area than Alternative 2, approximately 93.8 acres (Figure 27, Appendix A). It also requires a slightly greater input of water at 1.5 mGPD. The configuration and design are similar to Alternative 2; however there is an additional area of restoration south of Lower Buckeye Road in an unleveed portion of the river.

Alternative 4 – High Water Use with Vegetation Management Areas extends the restoration effort along the greatest length of the 5.5-mile project reach and occupies the greatest total area, estimated at 303.9 acres (Figure 28, Appendix A). It requires the greatest input of 5.2 mGPD of water. The configuration consists of a riparian strip along various segments of the eastern side of the channel. The eastern riparian strip extends down below the Durango Channel at Buckeye road. Within the riparian strip there are one to two slightly meandering low flow channels. The configuration and design with terrace bank armor to protect the riparian strips are similar to that described for Alternative 2.

Alternative 5 – Lower Water Use without Western Levee (counterpart to Alternative 2 without western levee) While the land disturbance is reduced for this alternative, the western side of the levee is drier than the eastern side because it doesn't receive any of the major drainage inputs and depends only on reduced annual flows. Because the proposed planting scheme in this area is for xeric riparian vegetation and vegetation typical of upland areas, the water needs for this alternative are similar to that for Alternative 2. The estimated total acreage for this alternative is 46.2 acres.

Alternative 6 – Moderate Water Use without Western Levee (counterpart to Alternative 3 without western levee) While the land disturbance is reduced for this alternative, the western side of the levee is drier than the eastern side because it doesn't receive any of the major drainage inputs and depends only on reduced annual flows. Because the proposed planting scheme in this area is for xeric riparian vegetation and vegetation typical of upland areas, the water needs for this alternative are similar to that for Alternative 3. The estimated total acreage for this alternative is 67.9 acres.

Alternative 7 – Moderate Water Use with Vegetation Management Areas but without Western Levee (counterpart to Alterative 4 without western levee). While the land disturbance is reduced for this alternative, the western side of the levee is drier than the eastern side because it doesn't receive any of the major drainage inputs and depends only on reduced annual flows. Because the proposed planting scheme in this area is for xeric riparian vegetation and vegetation typical of upland areas, the water needs for this alternative are similar to those for Alternative 4. The estimated total acreage for this alternative is 277.1 acres.

Alternative 8 (Recommended Plan) - Moderate Water Use with Reduced Vegetation Management Areas and Reduced riparian Strips (adaptation of Alternatives 2,4 and 5): This recommended alternative is an adaptation of Alternatives 2, 4 and 5 and would result in the restoration of 114.7 acres. Restoration options are focused on two areas: near I-10 and the I-10 drainage (Papago Diversion Channel); and at the Avondale Wastewater Treatment Plant (AWWTP) discharge (Figures 29 to 31, Appendix A). Restoration at the two locations would involve six primary measures: (1) removal of exotic and invasive species throughout the entire restoration site; (2) construction of a riparian strip along the eastern and western levees; (3) establishment of vegetation management areas between the riparian strips and at the AWWTP site; (4) introduction of water from an external source; (5) non-construction measures to enhance habitat resources (e.g., micro topographic variation, creation of plant regeneration areas, etc.; and (6) measures to eliminate or reduce impacts from adjacent park and trail users. An input of approximately 1.8 mGPD of water would be needed from an external source at the I-10 site, and it is assumed that 1 mGPD of effluent would be retained at the AWWTP site.

I-10 Site. Restoration at this location would be similar to that described for Alternatives 2 and 5. The length of the riparian strip on the eastern side has been modified from Alternative 2; although restoration on the western side has not been eliminated, as in Alternative 5, the area has been reduced. This site would be intersected by a multi-use trail operated by the City of Avondale, which would connect Friendship Park to Coldwater Park. Management measures to minimize or eliminate potential habitat disturbances from the trail and the adjacent park extension are considered in this alternative.

The riparian strip on the eastern side would be constructed with one or two slightly meandering low flow side channels (Figures 29 to 31). The configuration consists of a restoration strip along various segments of the eastern side of the channel from I-10 to Van Buren Street for a total length of 3,130 feet. The eastern riparian strip would be planted with mesic and hydric riparian vegetation and irrigation would come from existing City of Avondale groundwater wells. Terrace bank armor would partially exclude frequent flows (for approximately 10 to 15 year events) from the riparian strip to reduce the chances of significant vegetation losses in the short term; however, the constructed areas and vegetation in the riparian strip are sacrificial to larger flows that would inevitably erode part or all of the fill and vegetation (as might occur under natural conditions).

The western levee would be filled to create a 3:1 slope with a mixture of riverbed and imported fine material. The configuration consists of a restoration strip along various segments of the western side of the channel, totaling in length approximately 2043 feet above the I-10 and 6730 feet below the I-10. The restoration area would be approximately 75 feet wide.

Between the eastern and western riparian strips a vegetation management area of approximately 63 acres would be designated where there would be removal of nonnative species and limited planting of native trees and shrubs.

AWWTP Site. This site is treated similarly to Alternative 4. The area around the AWWTP outflow pipe currently sustains a small marsh and a vegetated strip downstream supported by a perennial source of water from the treatment plant effluent and relatively shallow groundwater. Under Alternative 8, it is assumed that 1 mGPD of the current discharge of 3.5 mGPD of effluent would remain at the site and the remainder would be diverted by the City of Avondale for other uses. In order to ensure that the remaining discharge can sustain as much of the existing vegetation and habitat as possible, a filtration gallery and recirculation system would bring infiltrated effluent and subsurface groundwater at <20 feet back to the upstream end of the site.

Restoration in this area would be focused on vegetation management as described above for the I-10 site. The goal of this management area is to sustain as much as possible of the existing vegetation cover (over 18 acres) with the 1 mGPD of effluent that would be committed to the site. The volume of vegetation would be maintained as much as possible at existing levels, but the establishment of native species would benefit habitat. For this Alternative, no additional water source is proposed for this location to extend the restored area; however, if more water is available in the future, it can be readily incorporated into the operation of the site.

E. Comparison of Alternatives

The No-Action Alternative is not considered practicable because it does not meet the overall project purpose. The No-Action alternative does not provide a permanent gain in the ecosystem benefit within the project area, specifically, to increase the amount (area) of native riparian habitat. Whereas there would be no disturbance of existing vegetation under this

alternative, it provides no impetus to prevent further environmental degradation of existing riparian and wetland habitat.

All seven action alternatives would include restoration of the Agua Fria River channel through some portions of the project implementation area. This work is necessary to ensure hydraulic continuity for conveyance of flood flows, and for improved habitat connectivity with the downstream Gila River and Tres Rios ecosystem restoration project. All alternatives were constrained, as detailed in Section 4 of the DPR, by considerations including maintenance of flood control capacity, water supply availability, potential for adjunct passive recreation, the need to protect structural changes to avoid sacrifice of the improvements during flood events, the sponsors' desire to support more than one native habitat type, and fiscal limitations under the operative Section 1135 CAP authority which strictly limits restoration project costs. Since the sponsors seek ultimately to promote similar restoration along more of the subject corridor, this project has been developed with a view towards serving as a template for future endeavors.

The alternatives were compared with regard to their relative potential habitat value, based on the number of habitat units (HUs) generated as measured by the modified HEP analysis. Table 1 below presents a summary of the HEP analysis detailed in Appendix K. Each alternative was assessed at time intervals 0, 1, 15, and 50 years. The acreage for alternatives was normalized to Alternative 4, which restores the greatest amount of acreage (303.9). The HEP generally showed that the action alternatives would provide a greater number of HUs than existing conditions, with Alternatives 4, 7, and 8 providing the most HUs. Table 2 shows the acreage of habitat types by alternative and construction area, and Table 3 shows cubic yards of fill types by alternative along with Habitat Units.

Table 1 - Summary of Habitat Outputs

ALTERNATIVE	Habitat Units				
	T=0	T=1	T=15	T=50	Average Annual Habitat Unit
Alternative 1 - No Action	77.72	77.72	63.21	63.21	65.63
Alternative 2 - Low Water Use	79.93	87.55	84.97	88.91	86.60
Alternative 3 - Moderate Water Use	77.78	89.76	90.31	95.41	91.78
Alternative 4 -High Water Use and Vegetation Management Areas	77.72	154.90	189.84	209.96	189.60
Alternative 5 - Low Water Use without Western Riparian Strip	76.93	82.16	75.69	78.55	77.69
Alternative 6 - Moderate Water Use without Western Riparian Strip	77.85	84.43	81.09	85.11	82.94
Alternative 7 - High Water Use and Vegetation Management Areas without Western Riparian Strip	77.72	147.35	179.05	197.01	178.74
Alternative 8 – Moderate Water Use, With Reduced Vegetation Management Areas and Western Riparian Strip	77.98	101.68	104.84	113.40	106.87

Habitat outputs for each alternative were also converted and measured as average annual habitat units (AAHU), relative to the 50-year life of the project (Table ES-2).

Table 2 - Summary Estimate of the Acreage of Each Major Alternative for Vegetation/Habitat Types

Alternative/Location	Riparian scrubland/ woodland (xeric)[1]	Riparian scrubland/wood land (mesic)	Riparian scrubland/wood land (hydric) [2]	Riparian wetland/herbac eous (hydric) [2]	TOTAL
Alternative 1 – No Action[3]					
TOTAL	95.8	137.9	59.5	10.7	303.9
Alternative 2 – Low water use					
Eastern riparian strip (6110' X 310')[4]	0	12.3	22.5	4.4[5]	39.2
Western riparian strip (8773' X 75')	15.8	0	0	0	15.8
Vegetation management areas	0	0	0	0	0
Construction Areas[6] (14,883' X 50')	17.1	0	0	0	17.1
Restored Subtotal	32.9	12.3	22.5	4.4	72.1
Unaffected	62.9	125.6	37.0	6.3	231.8
TOTAL	95.8	137.9	59.5	10.7	303.9
Alternative 3 – Moderate water use					
Eastern riparian strip (8820' X 310)	0	23.6	27.6	6.6	57.8
Western riparian strip (8773' X 75)	15.8	0	0	0	15.8
Vegetation management areas	0	0	0	0	0
Construction Areas (17,594' X 50')	20.2	0	0	0	20.2
Restored Subtotal	36.0	23.6	27.6	6.6	93.8
Unaffected	59.8	114.3	31.7	4.1	210.1
TOTAL	95.8	137.9	59.5	10.7	303.9
Alternative 4 – High water use w / Vegetation Management Areas					
Eastern riparian strip (18,690' X 310')	0	89.4	57.5	8.8	155.7
Western riparian strip (8773' X 75')	15.8	0	0	0	15.8

Alternative/Location	Riparian scrubland/ woodland (xeric)[1]	Riparian scrubland/wood land (mesic)	Riparian scrubland/wood land (hydric) [2]	Riparian wetland/herbac eous (hydric) [2]	TOTAL
Vegetation management areas[6]	48.5	48.5	2	1.9	100.9
Construction Areas (27,463' X 50')	31.5	0	0	0	31.5
Restored Subtotal	95.8	137.9	59.5	10.7	303.9
Unaffected	0	0	0	0	0
TOTAL	95.8	137.9	59.5	10.7	303.9
Alternative 5 – Low water use w/o western riparian strip					
Eastern riparian strip (6110' X 310')	0	12.3	22.5	4.4	39.2
Western riparian strip	0	0	0	0	0
Vegetation management areas	0	0	0	0	0
Construction Areas (6110' X 50')	7.0	0	0	0	7.0
Restored Subtotal	7.0	12.3	22.5	4.4	46.2
Unaffected	88.8	125.6	37	6.3	257.7
TOTAL	95.8	137.9	59.5	10.7	303.9
Alternative 6 – Moderate water use w/o western riparian strip					
Eastern riparian strip (8820' X 310')	0	23.6	27.6	6.6	57.8
Western riparian strip	0	0	0	0	0
Vegetation management areas	0	0	0	0	0
Construction Areas (8820' X 50')	10.1	0	0	0	10.1
Restored Subtotal	10.1	23.6	27.6	6.6	67.9
Unaffected	85.7	114.3	31.9	4.1	236.0
TOTAL	95.8	137.9	59.5	10.7	303.9
Alternative 7 – High water use, w / Vegetation Management Areas, w/o western riparian strip					
Eastern riparian strip (18,690' X 310')	0	89.4	57.5	8.8	155.7
Western riparian strip	0	0	0	0	0
Vegetation management areas	48.5	48.5	2	1.9	100.9
Construction Areas (18,690' X 50')	21.4	0	0	0	21.4

Alternative/Location	Riparian scrubland/ woodland (xeric)[1]	Riparian scrubland/wood land (mesic)	Riparian scrubland/wood land (hydric)[2]	Riparian wetland/herbac eous (hydric)[2]	TOTAL
Restored Subtotal	69.9	137.9	59.5	10.7	278
Unaffected	25.9	0	0	0	25.9
TOTAL	95.8	137.9	59.5	10.7	303.9
Alternative 8 – Moderate water use, w / reduced Vegetation Management Areas, w / reduced western riparian strip					
Eastern riparian strip (3130' X 310')	0	6	11	2.2	19.2
Western riparian strip (3885' X 75')	6.5	0	0	0	6.5
Vegetation management areas	38.8	38.8	2	1.4	81
Construction Areas (7015' X 50')	8.0	0	0	0	8.0
Restored Subtotal	53.3	44.8	13	3.6	114.7
Unaffected	42.5	93.1	46.5	7.1	189.2
TOTAL	95.8	137.9	59.5	10.7	303.9

1 Includes species common to upper Sonoran desert scrub and species found under xeric conditions typical of upper flood plains or, as in the present case, alluvial systems deprived of water because of hydrological controls. The total acreage for this habitat type is based on the western levee restoration area.

2 Woodland/scrubland hydric: dominated by woody species with a high hydrologic component (inflexible species); wetland/herbaceous hydric: dominated by herbaceous species with a low hydrologic component (flexible species).

3 The total acreage for this alternative corresponds to the maximum restoration acreage under Alternative 4. For the other alternatives, the restored acreage would be less.

4 Maximum dimensions for each strip. The restored acreage, i.e., revegetated area along the levees may be slightly more or less, depending on the alternative.

5 Approximates the acreage occupied by two low flow channels that would deliver water along the extent of the eastern riparian strip; it would support wetland or facultative wetland species (i.e., there would not be permanent surface water to support an aquatic environment.)

6 Located along the riparian strips towards the interior of the channel. These are sparsely or unvegetated areas within the channel that are dominated by nonnative vegetation. Affected areas that are vegetated at the construction phase would be reseeded with native species. It is assumed the area would have greater habitat value than the existing condition. The construction area is approximately 50 feet wide along the length of the terrace bank armor (i.e., eastern and western riparian strips).

7 Vegetation management areas around I-10, Durango Regional Outfall Channel and the AWWTP support predominantly mesic to xeric riparian conditions, depending on the time of year. The marsh and adjacent areas at the AWWTP discharge are the exception.

Table 3 - Summary Acreage Showing Fill and Habitat Comparisons

Fill in CYs	Restoration Alternatives							
	1 No Action	2 Low Water Use	3 Moderate Water Use	4 High Water Use With Vegetation Management Areas	5 Low Water Use Without Western Riparian Strip	6 Moderate Water Use Without Western Riparian Strip	7 High Water Use With Vegetation Management Areas, Without Western Riparian Strip	8 Moderate Water Use, With Reduced Vegetation Management Areas, With Reduced Western Riparian Strip
Fine Material	0	112,004	125,704	186,504	34,114	44,959	95,174	34,215
Coarse Material	0	168,012	188,556	276,902	45,826	66,221	140,181	49,967
Terrace Bank Armor Materials	0	52,915	62,585	97,645	21,725	31,390	65,455	24,940
Fill Totals in CYs:		**332,933**	**376,848**	**561,055**	**101,670**	**142,576**	**300,817**	**109,130**
mGPD of water	0	1.1	1.5	5.2	0.8	1.2	4.8	1.9
Net Gains in HU's	0	20.97	26.16	123.98	12.07	17.31	113.11	41.24
$/HU Annual	0	$ 38,396	$ 42,559	$ 17,185	$ 32,756	$ 34,832	$ 12,183	$ 12,602

A complete analysis of the impacts and benefits of each alternative is provided in Chapter 5 of the EA.

F. Least Environmentally Damaging Practicable Alternative (LEDPA)

Alternative 8 has been selected as the LEDPA. This alternative maximizes habitat benefit, does not place an excessive burden on water resources, and can also be reasonably managed by the local sponsors to ensure long term success. It best performs, in sum, the following actions:

- Utilizes the existing outflow of treated wastewater near the AWWTP site to substantially enhance the existing habitat by restoring more natives species
- Restores several types of critical riparian habitat to the I-10 site
- Minimizes water needs and associated costs by limiting irrigation to the I-10 site
- Avoids potential land use impacts with the nearby Goodyear Airport associated with bird air-strikes
- Minimizes the amount of land that has to be acquired by private owners, reducing the cost associated with the proposed project
- Enhances the aesthetic and recreational value of the areas around the I-10 site by providing natural riparian habitat that supports native wildlife better than the existing degraded habitat

G. General Description of Dredged or Fill Materials

Materials are needed to: (1) construct terrace bank armor that protects the riparian strips from frequent flood events; (2) create shallow terraces and appropriate topography for planting within the riparian strips; (3) line the low flow channel within the strips with loamy soil overlain by gravelly sand to limit infiltration and ensure water delivery to the downstream areas while reducing surface evaporation losses within each planting segment; and (4) release sediment periodically along the riparian strips to create open spaces suitable for natural regeneration of native species. This last application would be over very small areas, 20 to 50 feet square.

The lower reach of the Agua Fria River contains several soil complexes (FCDMC, 2001b). West of the river is the Laveen-Coolidge soils, and along the Gila River–Agua Fria River confluence is the Carrizo soil. The Laveen-Coolidge soil is composed of nearly level sandy loams, loams, and clay loams on old alluvial fans and valley plains. This soil is deep and when irrigated, makes prime farmland. The Carrizo soil is nearly level and gently sloping, occasionally flooded, and very gravelly or sandy. This soil is evident on flood plains. The Carrizo has a depth of over 60 inches, and has a high permeability. This soil is used mostly for rangeland, but when irrigated, can be prime farmland (FCDMC, 2001b).

The materials in the streambed of the Agua Fria River between New River and the confluence with the Gila River are predominantly loose to medium-dense, non-cohesive sands and gravelly sands with less than 15 percent cobbles to 10 inches in diameter at the upstream end of the reach, gradually becoming finer downstream until silts and sands with less than 5 percent cobbles to 6 inches in diameter predominate below Buckeye Road. Materials are relatively free of cobbles and boulders to about eight feet.

The overbank materials along the Agua Fria River in the study reach are predominantly medium-dense sands, silty sands, and moderately cohesive sandy silts with scattered layers of gravelly sand and generally less than 5 percent cobbles to 10 inches in diameter. In the vicinity of the west levee downstream from Buckeye Road, the foundation materials are relatively loose. These materials were removed or compacted before placement of levee fill materials. The foundation materials at the location of the east levee at Lower Buckeye Road are moderately dense. Surface soils are relatively pervious. The duration of the SPF and lesser floods would indicate that water does not remain long enough after floods to saturate soils.

The majority of material needed for the restoration effort would come from off-site commercial sources and a smaller portion from the alluvium within the channel. This material consists primarily of sands, gravely sands or silty sands, although some areas in the surface or subsurface may be dominated by silts and gravels. Materials from the channel would be obtained from small areas with net deposition that might be cleared under other circumstances to prevent localized ponding or blocking of drainage structures, or would be moved from other parts of the restoration project area. Within the restoration site material would be removed from areas within the riparian strip to create a low flow channel and reutilized to create the adjacent riparian zones. Because the lower reach of the Agua Fria is sediment poor and the materials may be too coarse for project needs, there is the general conclusion that the river would not be a significant source of material for construction of the project.

For this project's Recommended Alternative 8 it is estimated that the amount of fill needed for the riparian strips would be approximately 32,215 cy of finer cohesive materials and 47,649 cy of coarser sand and gravel. Approximately 24,940 cy of material would be needed to construct the terrace bank armor. Approximately 2,318 cy of coarse material would be needed to fill the side channels to prevent the formation of surface water and 1,864 cy of fine material would be needed to line the side channels to reduce infiltration. No more than 5 to 10 percent of the total amount needed for the project would come from within the channel.

H. Description of Proposed Discharge Sites and Disposal Methods

Some material would be incidentally removed from the site during removal of exotic vegetation. This dredged material would consist predominantly of sands with some gravels and silts, and a very small fraction of organic material taken from within the channel in areas dominated by invasive, exotic and disturbed vegetation. Because this material may contain propagules from invasive species, it would be disposed of together with the vegetation waste. However, if it can be buried approximately one foot it can also be recycled as fill for this project or for other projects planned by the City. Aside from this exception, all excess material

would be reutilized in the restoration effort or redistributed in the channel. This is especially important since the channel experiences reduced sediment inputs due to controls in the upper watershed and adjacent urbanization.

Vegetation and soil material would be removed by grubbing and grading and moved with front loaders then transported by truck to an off-site location designated by the Flood Control District of Maricopa County (FCDMC) and/or the City of Avondale within five miles of the project area. The site would be authorized for the disposal of green wastes and soil material, outside any waters of the United States.

I. Timing and Duration of Discharge

Activities that may include the discharge or removal of material in the channel such as site preparation, earth movement, grading and construction of riparian strips and terrace bank armor would be completed within 6 months. Activities like invasive and exotic control and planting may take place outside this timeframe. However, because major construction activities should also avoid periods of precipitation, the construction schedule would also be adapted to avoid the rainy season from November to March and the more intense, short duration rains in July and August.

J. Mitigation Analysis

The goal of this project is to restore riparian habitats along the Agua Fria River. The project would create functioning habitats within portions of the channel; therefore, mitigation for negative environmental impacts is minor. These include measures like best management practices (BMP) for protection of water quality and sediment during construction; public notification for temporary traffic problems along disposal routes; and public education to control accidents and protect the restoration areas. The majority of these simple measures are needed only during project construction. There are no residual significant impacts. In addition, any operation and maintenance activities would ensure the continued health of the restored habitat.

IV. FACTUAL DETERMINATIONS

A. Disposal Site/Physical Substrate Determinations

Impact:____N/A__X__INSIGNIFICANT____SIGNIFICANT

1. Substrate Elevation and Slope: The relevant section of the study area slopes in a generally southerly direction from an elevation of 1,019 to 894 feet above sea level along approximately 5.5 miles.

The usually dry, sandy Agua Fria River bottom is highly disturbed by both natural processes and human activities. Substrate materials include water-rounded gravel, cobble, and principally fine sand. Since these materials are unconsolidated and easily transported by water,

the channel is reconfigured by high flows during flood events. Alteration of the river bottom and terraces by construction equipment would occur during project implementation. This work would be necessary to construct low flow channels, create stable side slopes and terraces, and to transport excess excavated materials to locations where needed. Mostly minor changes in topography would occur along the length of the project area. However, the overall elevations of the channel bottom and the historic flood plain would not be significantly altered.

Some quantities of material would be discharged into the jurisdictional limits of Waters of the U.S. (in this instance, a typically dry condition) during reconstruction of the river channel, regrading of channel banks and terraces, installation of water distribution and irrigation systems, and preparing the ground surface for planting. Construction material would consist of native alluvial soils from the project area, as well as clay, rock, and possibly soil amendments. In terms of volume, the vast majority of dredged and fill material would originate on site. No significant quantities of inadvertently discharged earth materials would remain above existing channel bottom elevations. The approximate pre-construction channel bottom contour would be reestablished to eliminate any potential changes in flooding characteristics. Excess excavated materials would be incorporated into final grades for the project. The disposal of excavated materials outside the project area is thus not anticipated.

2. Sediment Type: The sediment in the channel consists of alluvial materials (sand, sandy loams, silty loams, gravel, and cobbles). Refer to Section 3.4 of the DPR for a detailed soils description. The I-10 site within the restoration area is bounded by levees on both sides; the AWWTP site has no levees. Fill material consists of coarse and fine material, of which a small portion (no more than 5 to 10 percent) would come from within the channel. Aggregate and concrete would be needed to construct terrace bank armor.

Reshaping would include restoration of a low flow channel and adjacent terraces for portions of the project area. On site soils would be redistributed to create new riparian habitats where feasible. Some of the materials needed for this work would be imported to the site. Soil amendments may also be necessary to create conditions suitable for the establishment of native vegetation.

3. Dredged/Fill Material Movement: Construction activities (i.e., creation of riparian strips and terrace bank armor and removal of exotic, invasive species) would result in incidental movement of local soils and sediment into downstream areas during run-off events. In addition, surface runoff and alluvial fan flows after construction would pick up loose soils and transport them downstream. These effects would be short-term; they are initiated during construction and would decrease steadily as vegetation becomes established. In addition, significant impacts during construction would be reduced by: limiting the amount of exposed areas during construction activities; completing earth movement activities during the dry season; revegetation of exposed areas; and implementing an erosion and sedimentation control plan that identifies Best Management Practices (BMPs) suitable for the study area. The erosion and sedimentation control plan is required as part of the Stormwater Pollution Prevention Plan (SWPPP) mandated by the National Pollutant Discharge Elimination System (NPDES) permit for stormwater discharges associated with construction activities.

4. Physical Effects on Benthic Macroinvertebrate Communities (burial, changes in sediment type, composition, etc.): At the northern I-10 site, there is no perennial source of water that supports benthic organisms. In the southern AWWTP site, no major physical disturbance is planned for areas with perennial surface water; however, removal of nonnative, invasive species would result in a temporary disturbance to the benthos. Maintaining the marsh and facilitating the establishment of native species would be beneficial to benthic organisms.

5. Other Effects: Operation and maintenance activities to maintain floodflow activities would entail periodic inspections, annual mowing, periodic sediment removal, and channel side slope activities to maintain structural integrity, yet preserve designated vegetated areas. These effects would be similar to those of project construction, but on a reduced scale.

6. Actions Taken to Minimize Impacts: An Erosion and Sedimentation Control Plan would be prepared for project construction. The plan would also address BMPs for operation and maintenance activities. The BMPs identified in the Erosion and Sedimentation Control Plan would incorporate measures to minimize on-site and off-site erosion.

B. Water Circulation, Fluctuation, and Salinity Determinations

Impact:____N/A__X__INSIGNIFICANT____SIGNIFICANT

1. Effects on Water Quality: The Agua Fria River currently supports ephemeral flows that have been reduced from watershed controls. During flood flows, runoff from the surrounding urban and agricultural lands drains into the channel. At the I-10 site, inputs come from ephemeral surface runoff. At the AWWTP site low flows consist of treated effluent. A Section 401 Water Quality Certification application, to be processed by the Arizona Department of Environmental Quality (ADEQ), has been completed for the proposed restoration project. An NPDES construction permit would be required for the construction operations, which requires an SWPPP to be developed and implemented. The SWPPP along with the other mitigation measures discussed in the DPR would reduce construction-related water quality impacts to a less-than-significant level. No NPDES permit would be required for the discharge of aquatic pesticides to waters of the United States. On December 5, 2002 Arizona was authorized by the EPA to operate the NPDES program (Section 402 of the CWA) on the state level, where the ADEQ would issue the NPDES permit. Although EPA transferred NPDES permitting authority to the ADEQ on December 30, 2002, on August 22, 2005, the 9th U.S. Circuit Court of Appeals vacated EPA's approval of the AZPDES permit program. *Defenders of Wildlife, et al. v. EPA, et al.*, No 03-71439, 2005 WL 2001100. On September 9, 2005, EPA sent a letter to the ADEQ Water Quality Division stating that unless and until the court's mandate is issued, Arizona's authorization to issue NPDES (AZPDES) permits and implement the program remains in effect. The construction permit would be obtained by the construction contractor. The potential also exists for impacts to surface and groundwater quality from minor, chronic or large-scale hazardous spills from construction equipment and from materials stored on site. The SWPPP would also contain a spill prevention

plan that would identify proper storage locations and provide remediation measures for clean up.

A separate AZPDES permit may be required for the removal and/or control of invasive vegetation as part of long-term maintenance of the project. The need for this additional permit would be determined through consultation with the Arizona Department of Environmental Quality before construction.

2. Effects on Current Drainage Patterns and Circulation: The Recommended Plan would not substantially change the surface water hydrology or drainage patterns into the channel. Hydraulic modeling ensures that the conveyance capacity of the channel is not significantly affected, i.e., the standard project flood condition is maintained. Furthermore, operation and maintenance actions would be developed to ensure the standard project flood design capacity is maintained.

3. Effects on Normal Water Level Fluctuations: Water levels vary seasonally in accordance with changing flows generated from rainfall, dam releases and upstream drainage. Periodic flood events cause water levels to rise. For the Recommended Plan, water surface elevations within the channel would not be significantly affected by the incorporation of riparian strips and additional vegetation as demonstrated by hydraulic modeling.

4. Actions Taken to Minimize Impacts: An Erosion and Sedimentation Control Plan would be prepared for project construction. The plan would also address BMPs for operation and maintenance activities.

C. Suspended Particulate/Turbidity Determinations at the Disposal Site

Impact:_____N/A__X__INSIGNIFICANT_____SIGNIFICANT

1. Expected Change in Suspended Particulate and Turbidity Levels in the Vicinity of Disposal Site: Exported disposal material would be taken off site to an authorized landfill within a 5 mile radius of the study area. Because of the length of time that may transpire until project implementation a specific location cannot be defined as it may not be available when the project is finally implemented. However, the City of Avondale is confident that a suitable disposal site would be available within the 5 mile radius. Short-term increases in suspended particulates and turbidity levels may occur locally during construction, if water is flowing. Construction would stop during flow events. As discussed above, an NPDES permit would be required for the construction operations, which requires an SWPPP to be developed and implemented. Suspended particulate/turbidity impacts would be reduced through the implementation of an SWPPP.

2. Effects (degree and duration) on Chemical and Physical Properties of the Water Column: Construction materials such as concrete for terrace bank armor would be separated from flowing water if present. Any spills within the channel would be cleaned according to

measures defined in the SWPP. The SWPPP would also contain a spill prevention plan that would identify proper storage locations and provide remediation measures for clean-up. These measures would reduce impacts to a less-than-significant level.

3. Effects of Turbidity on Biota: Any flowing waters would be separated from construction activities by establishing a barrier and diverting the water toward low flow channels that exist in the interior of the channel; however, ephemeral flows are generally of short duration and do not support the presence of aquatic biota. Temporarily displaced material for constructing the toe of the terrace bank armor or commercial products such as temporary dams may be chosen by the contractor to separate flowing water from the work site. In the marsh area sustained by the AWWTP, temporary disturbance of bed material would occur from the removal of exotic, invasive species and revegetation. Despite the short-term disturbance, this measure would have a long-term benefit to aquatic biota. No significant impacts are anticipated.

4. Actions Taken to Minimize Impacts: Refer to the three previous subsections for mitigation measures.

D. Contamination Determination:

1. A field reconnaissance and research from historical aerial photographs, the ADEQ, the Maricopa County Health Department, Environmental Services Division (MCHD), the City of Avondale Fire Department (AFD), and a First Search environmental database report were completed. No evidence of hazardous waste deposits was identified. The database research did identify a site with ground water contamination (see Section 3.8 of the DPR) within one mile; however, ground water use for the project would not affect nor be affected by this contamination. Currently runoff into the channel from the I-10 site is not monitored and may contain residues of pesticides and other urban and agricultural contaminants. Initial presence or absence sampling of pesticides in sediments was completed to identify the need for avoidance or other measures in this area. Soils samples were tested for pesticides in November 2002 for samples taken near the I-10 channel. The soil tests indicated that pesticide levels were negligible. For the complete soil sample analysis, see Appendix F.

2. Actions Taken to Minimize Impacts. No mitigation measures necessary.

E. Effect on Aquatic Ecosystem and Organism Determination

There is no permanent aquatic environment at the I-10 site. The I-10 drainage (Papago Diversion Channel) supports ephemeral flows into the Agua Fria River; however once the water reaches the river it spreads out and infiltrates or evaporates soon thereafter. It is the Diversion Channel itself that sustains ponded areas that support waterfowl and limited aquatic organisms. At times of the year when the flow is high enough, surface water may collect right at the confluence and waterfowl also forage in the river. These flows or ponded areas would not be interrupted by the project.

At the AWWTP exotic, invasive species control and installation of a clay liner to minimize water infiltration within the marsh area would cause temporary disturbance to bed material and surface water conditions, but result in long term beneficial effects realized through the improved quality of foraging and nesting habitat.

The proposed project would not affect any Federally listed threatened or endangered species or designated critical habitat; however the site is proximate to the Gila River, which does support such species. The restoration site does support migratory waterfowl.

Actions Taken to Minimize Effects. Initial exotic invasive species control at the AWWTP would be timed to avoid the nesting season of waterfowl. Also an SWPPP would be developed to avoid indirect effects. A trained biologist would perform a clearance survey prior to the initiation of site mobilization and periodic site inspections during the construction phase.

On a long-term basis, habitat value in the region would increase substantially for common and potentially sensitive wildlife species. In summary, the project would have a net, long-term beneficial effect on the habitat value of the aquatic ecosystem.

F. Proposed Disposal Site Determinations

The area to be affected during construction of this project would be confined to the minimum area necessary to construct the project features. The project is expected to comply with applicable water quality standards. Implementation of the proposed mitigation measures would ensure that adverse impacts to jurisdictional Waters of the U.S. are minimized.

G. Determination of Cumulative Effects of Disposal of Fill on the Aquatic Ecosystem

The Agua Fria River is a highly modified and degraded ecosystem. That degradation has occurred over decades of development and impacts to the river ecosystem from both private and public projects. The DPR and EA associated with this evaluation describe past activities in detail (see Chapters 2 and 3.) Ongoing projects include adjacent agricultural (row crops, orchards and structured pasture) and commercial and residential developments, which are likely to continue adjacent to and sometimes extending into the Agua Fria River corridor. As described in the Agua Fria Watercourse Master Plan, the Flood Control District of Maricopa County seeks to ameliorate the impacts of such developments by supporting projects such as the restoration proposed herein.

The cumulative effects from the proposed action to WUS are not significant. In the Programmatic Environmental Assessment of the Impacts of the Section 404 Nationwide Permit Program on Cactus Ferruginous Pygmy-owl in Arizona (SWCA 2002, prepared for the Corps' Los Angeles District), the Corps estimated that WUS comprised from 0.03% to 2.85% of the land surface area in desert areas of central Arizona. The Corps also estimated that there were 344,400 acres of jurisdictional waters over a 12,639,000-acre study area in Pinal, Pima and Maricopa counties (excluding the northwest portion of Maricopa County), approximately 2.72% of the land surface area. Extrapolating these percentages to southern Arizona as a whole,

including the proposed project area, these data indicate that there is an enormous amount of jurisdictional acreage remaining in the State.

The Recommended Plan, including appropriate environmental commitments and mitigation, coupled with other projects, would not contribute to negative cumulative impacts within the region for biological resources. Rather the long-term result of this project in conjunction with other regional restoration efforts along the Salt and Gila Rivers and upstream on the Agua Fria River near New Waddell Dam, would directly contribute to the cumulative beneficial effects on the aquatic ecosystem anticipated to result from implementation of this and other ecosystem restoration projects on the Agua Fria River. The Recommended Plan coupled with other restoration efforts on the Agua Fria River may also have the indirect beneficial effect of encouraging the implementation of additional efforts to improve this aquatic ecosystem. The project would not cause significant construction-related impacts to water resources because of the NPDES requirements for construction activities. The SWPPP would address stormwater quality as well as quantity.

A complete analysis of cumulative impacts associated with Alternative 8 is provided in the EA.

H. Determination of Indirect/Secondary Effects of Disposal of Fill on the Aquatic Ecosystem.

Such effects would potentially in include increases in flood potential or changes in wildlife communities in responses to changes in vegetation growing in restored areas. No increase in flood surface water elevations is anticipated as a result of project construction. The indirect effects of this project are generally beneficial. Adequate mitigation is provided for the adverse impacts that may occur.

I. FINDING OF COMPLIANCE

A. Adaptation of the 404(b)(1) guidelines to this evaluation.

No significant adaptations of the 404(b)(1) guidelines were made relative to this evaluation.

B. Evaluation of the Availability of Practicable Alternatives to the Recommended Plan, which would have less adverse impact on the aquatic ecosystem.

Restoration of the project area may require incidental discharge of sediment into waters of the United States. No practicable alternatives exist which would avoid this discharge. The overall, long-term impact of this project is beneficial, rather than adverse.

C. Compliance with Applicable State Water Quality Standards.

The proposed project would comply with water quality standards promulgated by the Arizona Department of Environmental Quality.

D. Compliance with Applicable Toxic Effluent Standard or Prohibition under Section 307 of the CWA.

Since potential toxic contaminants have not been identified in the project area, further investigation would not be required prior to the initiation of construction of the project. Soils samples were tested for pesticides in November 2002 for samples taken near the I-10 channel. The soil tests indicated that pesticide levels were negligible. For the complete soil sample analysis, see Appendix F.

E. Compliance with Clean Air Act as Amended 1990.

As discussed in the DPR, short-term impacts on air quality are expected to result from the temporary emission of dust, fumes, and equipment exhaust throughout the construction period. However, these impacts would be less than significant.

F. Compliance with the Federal Endangered Species Act of 1973.

As discussed in the DPR, the Corps has determined that the proposed project would not have an effect upon the continued existence of any Federally listed threatened or endangered species or designated critical habitat; therefore, the project is in compliance with this Act. In the event federally-listed species are observed in the project are during pre-construction surveys, no construction would be initiated or continued that could affect a federally-listed species until consultation with the USFWS pursuant to section 7 of the ESA is completed.

A review of the proposed project indicates that:

1. As evaluated in the Detailed Project Report the discharge associated with the Recommended Plan represents the least environmentally damaging practicable alternative, and if in a special aquatic site, the activity associated with the discharge must have direct access or proximity to, or be located in the aquatic ecosystem.
   __X__ Yes _____ No

2. The activity does not appear to 1) violate applicable State water quality standards or effluent standards prohibited under the CWA, or 2) jeopardize the existence of Federally listed endangered or threatened species or designated marine sanctuary.
   __X__ Yes _____ No

3. The activity would not cause or contribute to significant degradation of waters of the U.S., including adverse effects on human health; life stages of organisms dependent on the aquatic ecosystem; ecosystem diversity; productivity and stability; and recreational, aesthetic, and economic values.
   __X__ Yes _____ No

4. Appropriate and practicable steps have been taken to minimize potential adverse impacts of the discharge on the aquatic ecosystem.

__X__ Yes _____ No

Note: A negative response indicates that the proposed project does not comply with the guidelines.

On the basis of the guidelines, the proposed disposal site for the discharge of fill material is:

(1) Specified as complying with the requirements of these guidelines; or

X (2) Specified as complying with the requirements of these guidelines, with the inclusion of appropriate and practical conditions to minimize pollution or adverse effects on the aquatic ecosystem; or

(3) Specified as failing to comply with the requirements of these guidelines.

APPENDIX E.

GROUNDWATER INFORMATION

E.1 BUCKEYE WATER CONSERVATION AND DRAINAGE DISTRICT

E.2 ADWR STUDY AREA (WELL, WATER LEVEL, AND WATER QUALITY REPORTS)

E.1 BUCKEYE WATER CONSERVATION AND DRAINAGE DISTRICT

TABLE 1, TABLE 2, AND FIGURE 1

December 11, 2000
REPORT

DOCUMENTATION OF CONTINUING WATERLOGGED CONDITIONS IN BUCKEYE WATER CONSERVATION & DRAINAGE DISTRICT MARICOPA COUNTY, ARIZONA

Prepared for
Buckeye Water Conservation & Drainage District

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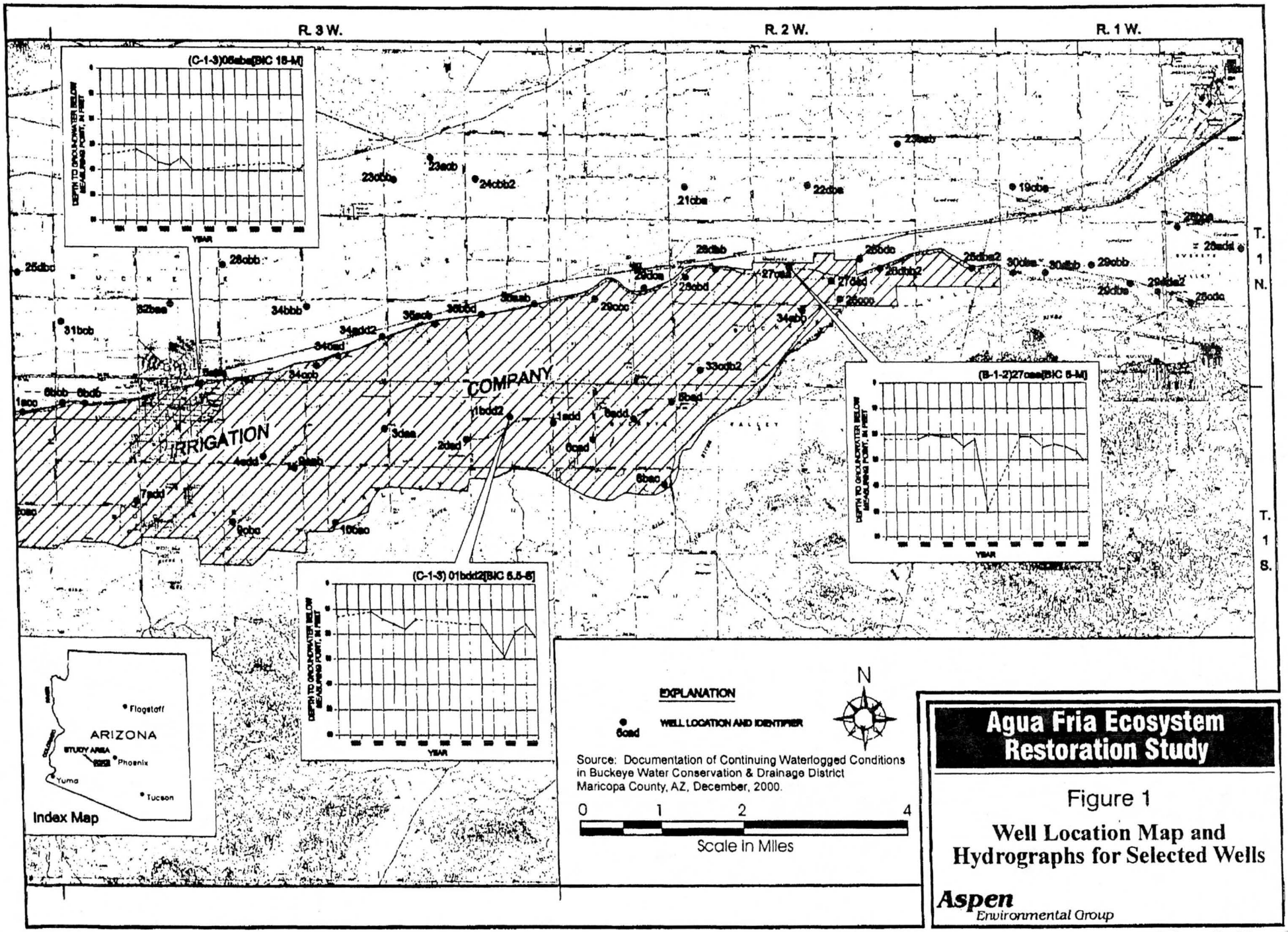
TUCSON • PHOENIX • FLAGSTAFF • SANTIAGO de CHILE

TABLE 1. SUMMARY OF MEASURED GROUNDWATER LEVELS IN WELLS AND PIEZOMETERS, 1986-1987 AND 2000 BUCKEYE WATER CONSERVATION & DRAINAGE DISTRICT

WELL NUMBER	OTHER IDENTIFIER	ALTITUDE OF LAND SURFACE (feet, msl)[a]	NON-PUMPING GROUDWATER LEVELS 1986-1987 DATE MEASURED	1986-1987 DEPTH (feet)	1986-1987 ALTITUDE (feet, msl)	2000 DATE MEASURED	2000 DEPTH (feet)	2000 ALTITUDE (feet, msl)	CHANGE IN GROUNDWATER LEVEL 1986-1987 TO 2000
(B-1-1) 19cba	—[b]	937	23-JAN-87	51.0	886	17-NOV-00	57.0	880	-6
28ada	BIC 0	925	23-JAN-87	20.1	905	15-NOV-00	40(?)[c]	885	-20
28bba	—	925	—	—	—	17-NOV-00	23(?)	902	—
28cdc	BIC 6-A	917	05-JAN-87	18.4	899	15- NOV-00	19	898	-1
29cbb	BIC 2-A	908	JAN-86	27	881	17-NOV-00	21	887	+6
29dbc	BIC 4-A	910	JAN-86	19	891	17-NOV-00	21	889	-2
29dda2	BIC 1-A	915	05-JAN-87	17.8	897	15-NOV-00	22	893	-4
30cba	BIC 3-A	906	JAN-86	25	881	17-NOV-00	25	881	0
30dbb	BIC 5-A	912	05-JAN-87	11.7	900	15-NOV-00	27	885	-15
(B-1-2) 21cba	—	934	22-JAN-87	63.6	870	17-NOV-00	65.4	869	-1
22dba	—	925	27-JAN-87	50.3	875	17-NOV-00	53(?)	872	-3
23aab	—	943	23-JAN-87	59.8	883	17-NOV-00	64.0	879	-4
25dba2	BIC 1-M	897	05-JAN-87	13.4	884	15-NOV-00	22	875	-9
26bdc	BIC 3-M	897	07-JAN-87	20.9	876	15-NOV-00	26	871	-5
26ccc	BIC 1-S	894	JAN-86	21.7	872	17-NOV-00	26(?)	868	-4
26dbb2	BIC 2-M	895	JAN-86	15.2	880	15-NOV-00	34	861	-19
27caa	BIC 5-M	893	07-JAN-87	19.7	873	17-NOV-00	30	863	-10
27dad	BIC 4-M	892	07-JAN-87	17.3	875	17-NOV-00	25	867	-8
28cbd	BIC 8-M	890	07-JAN-87	21.7	868	17-NOV-00	30	860	-8
28dbb	BIC 7-M	888	07-JAN-87	19.5	868	17-NOV-00	28	860	-8
29ccc	BIC 11-M	885	07-JAN-87	22.8	862	17-NOV-00	30	855	-7
29dca	BIC 9-M	895	07 JAN-87	28	867	17-NOV-00	33	862	-5
33cdb2	PIEZ[f]	879	04-MAR-87	15.4	864	14-AUG-00	21.6	857	-7
34abb	BIC 1-L	891	05-JAN-87	17.2	874	17-NOV-00	29	862	-12
(B-1-3) 23acb	—	985	14-JAN-87	150.7	834	17-NOV-00	154.8	830	-4
23cbb	RID[d]	976	14-JAN-87	134.0	842	17-NOV-00	128.4	848	6
24cbb2	—	963	21-JAN-87	107.0	856	17-NOV-00	UTM[e]	—	—
28cbb	RID	946	14-JAN-87	92.6	853	17-NOV-00	92.6	853	0
31bcb	RID	918	14-JAN-87	66.9	851	17-NOV-00	66.4	852	1
32baa	RID	924	14-JAN-87	72.7	851	17-NOV-00	74.0	850	-1
34add2	BIC 15-M	883	05-JAN-87	30.7	852	17-NOV-00	38	845	-7
34bbb	RID	917	14-JAN-87	64.0	853	17-NOV-00	64.4	853	0
34cad	BIC 16-M	880	07-JAN-87	29.1	851	16-NOV-00	UTM	—	—
34ccb	BIC 17-M	882	05-JAN-87	33.4	848	16-NOV-00	41.1	841	-7

TABLE 2. SUMMARY OF RESULTS FOR LABORATORY CHEMICAL ANALYSES FOR
COMMON CONSTITUENTS AND ROUTINE PARAMETERS IN GROUNDWATER SAMPLES, 1984 AND 2000
BUCKEYE WATER CONSERVATION & DRAINAGE DISTRICT

WELL LOCATION	OTHER IDENTIFIER	DATE SAMPLED	SOURCE OF ANALYSIS[b]	COMMON CONSTITUENTS[a] (milligrams per liter) CATIONS Ca	Mg	Na	K	ANIONS CO_3	HCO_3	Cl	SO_4	NO_2/NO_3	F	TDS	pH
(B-1-2)25dba2	BIC 1-M	1984	UA	124	72.6	311	5.46	7.2	107.39	644	182	10.3	0.47	1,419	7.85
		05-JUL-00	ACT	438	180	912	—	—	—	1,780	694	11.8	0.5	4,200	7.0
26bdc	BIC 3-M	1984	UA	213	145	803	7.77	3.6	190.37	1,298	563	17.6	0.95	3,164	7.50
		05-JUL-00	ACT	397	179	1,000	—	—	—	1,660	826	16.6	1.0	4,060	7.0
28dbb	BIC 7-M	1984	UA	616	134	610	6.37	0	331.93	1,597	661	18	1.35	3,830	7.30
		05-JUL-00	ACT	325	133	971	—	—	—	1,320	939	22.4	1.2	3,820	7.2
29dca	BIC 9-M	1984	UA	151	96.8	806	7.64	0	156.2	1,608	66.5	19	1.55	2,849	7.80
		15-MAY-00	IAS	280	110	850	7.0	0	351.4	1,200	290	19.7	—	3,091	7.60
(B-1-3)36aab	BIC 12-M	1984	UA	557	184	896	7.84	9.6	161.09	1,740	1,138	19.6	1.49	4,653	7.7
		19-JUN-00	ACT	244	106	755	—	—	—	990	628	18.6	1.7	2,960	7.4
(C-1-3)02dad	BIC 6-S	1984	UA	78.4	61.1	1,317	18.71	16.8	141.56	1,987	751	13.2	2.8	4,368	8.02
		19-JUN-00	ACT	238	122	1,019	—	—	—	1,450	674	14.5	4.3	3,900	7.3
06bdb	BIC 19-M	1984	UA	220	157	1,153	7.89	14.4	161.09	1,347	1,654	22.7	2.42	4,674	7.71
		05-JUL-00	ACT	194	104	851	—	—	—	842	1,000	23.2	2.1	3,150	7.7
(C-1-4)02cbd	BIC 23-M	1984	UA	877	90.1	1,105	10.42	13.2	161.09	1,503	2,063	23.6	3.32	5,796	7.75
		05-JUL-00	ACT	262	81	1,108	—	—	—	714	1,420	22.5	2.9	3,880	7.5
07bdd	BIC 27-M	1984	UA	406	142	912	7.34	4.8	112.27	1,738	1,185	23.6	2.42	4,488	7.70
		19-JUN-00	ACT	266	78	771	—	—	—	1,000	774	34.4	3.4	3,260	7.40
06bba	BIC 26-M	1984	UA	145	54	628	5.55	9.6	102.51	956	396	22.2	2.72	2,279	7.70
		05-JUL-00	ACT	187	58	592	—	—	—	770	489	18.9	1.5	2,160	7.5
11cbc1	BIC 2-D	1984	UA	183	98.1	1,107	8.4	9.6	107.39	1,549	1,266	20.2	3.8	4,356	7.80
		19-JUN-00	ACT	216	106	910	—	—	—	990	1,160	22.4	4.7	3,690	7.5
12cac	BIC 8-D	1984	UA	173	75.3	1,093	8.46	0	390.51	1,509	687	18.4	2.99	3,999	7.6
		19-JUN-00	ACT	194	107	814	—	—	—	1,010	718	18.7	4.1	3,120	7.4
19aaa1	BIC 4-D	1984	UA	184	74.4	1,211	11.69	13.2	132.77	1,778	816	19.6	2.67	4,212	7.89
		19-JUN-00	ACT	221	85	842	—	—	—	1,090	704	20.2	4.5	3,270	7.3
(C-1-5)01cdd	BIC 28-M	1984	UA	749	167	526	6.55	9.84	42.96	1,816	1,241	29.5	0.79	4,571	7.55
		05-JUL-00	ACT	392	95	601	—	—	—	1,060	1,290	23.9	0.3	3,020	7.2
MAXIMUM CONTAMINANT LEVEL (MCL) OR SECONDARY STANDARD (SS) IN MILLIGRAMS PER LITER										SS 250	SS 250	MCL 10.0	MCL 4.0	SS 500	SS 6.5 – 8.5


R. 3 W.
R. 2 W.
R. 1 W.
T. 1 N.
T. 1 S.
(C-1-3)05abe[BIC 18-M]
(B-1-2)27caa[BIC 8-M]
(C-1-3) 01bdd2[BIC 5.5-8]
DEPTH TO GROUNDWATER BELOW MEASURING POINT, IN FEET
YEAR
COMPANY
IRRIGATION
VALLEY
Index Map
ARIZONA
STUDY AREA
Flagstaff
Phoenix
Yuma
Tucson
EXPLANATION
WELL LOCATION AND IDENTIFIER
6cad
N
Source: Documentation of Continuing Waterlogged Conditions in Buckeye Water Conservation & Drainage District Maricopa County, AZ, December, 2000.
0 1 2 4
Scale In Miles
Agua Fria Ecosystem Restoration Study
Figure 1
Well Location Map and Hydrographs for Selected Wells
Aspen Environmental Group

E.2 ADWR STUDY AREA:

NW CORNER N 33°30'00" W 112° 21'30"
SE CORNER N 33°23'00" W 112°18'30"

WELL, WATER LEVEL, AND WATER QUALITY REPORTS

GroundWater Site Inventory (GWSI)
Water Level Report Codes

Water Level Source Codes

Code	Description
*	UNDETERMINED
A	ADWR
B	USBR
C	CONSULTANT
D	DRILLER
E	NEW MEXICO OFFICE OF STATE ENGINEER
F	APS
G	U OF A
J	MILITARY
L	ASLD
M	BLM
O	OWNER
R	OTHER REPORTED
S	SRP
T	CITY OF TUCSON
U	USGS
W	WMIDD
Z	OTHER

Water Level Method Codes

Code	Description
*	UNDETERMINED
A	AIRLINE
B	ANALOG
C	CALIBRATED AIRLINE
D	PRESSURE TRANSDUCER
E	ESTIMATED
G	PRESSURE GAUGE
H	CALIBRATED PRESSURE GAUGE
L	GEOPHYSICAL LOGS
M	MANOMETER

Water Level Method Codes (cont.)

Code	Description
N	NON-RECORDING GUAGE
R	REPORTED
S	STEEL TAPE
T	ELECTRIC TAPE
V	ELECTRIC SOUNDER
Z	OTHER

Water Level Remarks Codes

Code	Description
*	UNDETERMINED
C	CASCADING WATER
D	DRY
E	RECENTLY FLOWING
F	FLOWING
G	NEARBY FLOWING
H	NEARBY RECENTLY FLOWING
I	INJECTING
N	MEASURMENTS DISCONTINUED
O	OBSTRUCTION
P	PUMPING
R	RECENTLY PUMPED
S	NEARBY PUMPING
T	NEARBY RECENTLY PUMPED
U	NEARBY INJECTING
V	FOREIGN MATERIAL (OIL)
W	WELL DESTROYED
X	SURFACE-WATER EFFECTS
Z	OTHER

Arizona Department of Water Resources

GroundWater Site Inventory (GWSI) Water Level Report

Site Id	Cadastral	Reg No.	Well Altitude	Date	Depth to Water	Water Surface Altitude	Source	Method	Remark
332329112202401	B-01-01 34AAA	804389	930	02/14/1962	43.50	887	U		
				12/21/1962	53.03	877	U		
				01/13/1972	17.00	913	B		
				01/18/1976	21.80	908	U		
				12/20/1982	14.90	915	A	V	
				12/05/1984	10.50	920	A	V	
				01/07/1986	12.60	917	A	V	
				11/27/1991	15.70	914	A	V	
332355112203601	B-01-01 27DAB1	801736	930	12/02/1982	28.90	901	A	V	
				12/05/1984	23.40	907	A	V	
				01/07/1986	21.00	909	A	V	
				11/26/1991	19.60	910	A	V	
332356112203301	B-01-01 27DAB2	801734	930	12/02/1982	28.40	902	A	V	
				11/27/1989	21.00	909	A	V	
				11/26/1991	24.00	906	A	V	
				11/23/1992	21.70	908	A	V	
				11/18/1993	21.00	909	A	V	
				11/22/1994	23.60	906	A	V	
				12/07/1995	21.56	908	A	S	
				10/28/1996	24.90	905	A	V	
				10/28/1997	20.10	910	A	V	
				11/30/1998	25.40	905	A	V	
				11/04/1999	26.80	903	A	V	
				11/06/2000	27.10	903	A	V	
				10/29/2001	30.10	900	A	V	
332422112185101	B-01-01 25BAA	606288	942	12/19/1962	43.14	899	U		
				01/13/1972	23.00	919	B	V	
				12/27/1976	27.90	914	U		
				12/20/1982	18.30	924	A	S	V
				12/03/1984	15.50	927	A	V	V
				01/07/1986	12.00	930	A	V	V
				11/26/1991	17.50	925	A	V	
				11/17/1997	19.50	923	A	V	
332422112272801	B-01-01 28AAA	612584	928	12/27/1976	39.80	888	U	V	
332438112211701	B-01-01 22CBD	633775	940	09/08/1967	211.00	729		R	
332450112204301	B-01-01 22ACD	609093	940	12/05/1991	27.30	913	A	V	
				11/17/1997	30.00	910	A	V	
332511112194401	B-01-01 23ABA	633962	967	11/05/1982	62.80	904	A	V	
				12/20/1982	47.10	920	A	V	

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332512112212801	B-01-01 21AAA	639435	964	02/14/1962	64.89	899	B	V	
				01/15/1963	91.50	873	B	V	
				01/12/1972	79.70	884	B	V	
332513112185101	B-01-01 24ABB	609468	976	01/16/1963	80.40	896	B	V	
				01/13/1972	79.00	897	B	V	
				11/17/1997	54.40	922	A	V	V
332514112212501	B-01-01 22BBB	605785	965	12/21/1962	91.75	873	U	V	
				12/27/1976	73.20	892	U	V	
				12/05/1984	58.60	906	A	V	
332517112192701	B-01-01 14DDD	617881	962	03/01/1971	316.00	646		R	
332525112212301	B-01-01 15CCB	607159	967	11/13/1991	60.90	906	A	V	
				11/13/1997	63.20	904	A	V	
332530112184901	B-01-01 13DBC	607717	983	02/20/1962	91.64	891	S	R	
				12/19/1962	93.66	889	S	R	
				01/01/1973	71.00	912	S	R	
				04/01/1973	65.40	918	S	R	
				02/01/1978	68.00	915	S	R	
				12/18/1978	70.00	913	S	R	
				12/21/1978	66.00	917	S	R	
				12/26/1978	67.00	916	S	R	
				01/02/1979	66.00	917	S	R	
				01/09/1979	67.00	916	S	R	
				01/16/1979	67.00	916	S	R	
				01/23/1979	65.00	918	S	R	
				01/30/1979	70.00	913	S	R	
				02/13/1979	64.00	919	S	R	
				02/20/1979	64.00	919	S	R	
				02/27/1979	66.00	917	S	R	
				03/06/1979	86.00	897	S	R	
				03/13/1979	68.00	915	S	R	
				03/20/1979	72.00	911	S	R	
				03/29/1979	72.00	911	S	R	
				04/03/1979	60.00	923	S	R	
				04/10/1979	58.00	925	S	R	
				04/11/1979	58.00	925	S	R	
				04/17/1979	65.00	918	S	R	
				04/24/1979	62.00	921	S	R	
				05/01/1979	65.00	918	S	R	
				05/08/1979	65.00	918			

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				05/16/1979	60.00	923	S	R	
				05/22/1979	60.00	923	S	R	
				06/05/1979	61.00	922	S	R	
				12/20/1979	60.00	923	S	R	
				02/19/1980	59.00	924	S	R	
				02/26/1980	58.00	925	S	R	
				03/19/1980	58.00	925	S	R	
				04/02/1980	57.00	926	S	R	
				04/16/1980	58.00	925	S	R	
				04/23/1980	60.00	923	S	R	
				04/30/1980	59.00	924	S	R	
				05/12/1980	58.00	925	S	R	
				01/01/1981	54.00	929	S	R	
				12/20/1982	56.80	926	A	V	
				12/05/1984	51.70	931	A	V	
				01/07/1986	49.70	933	A	V	
				11/05/1991	54.50	929	A	V	
				11/14/1997	56.80	926	A	V	
332531112205501	B-01-01 15DCA	608733	964	12/08/1982	60.10	904	A	V	
				12/07/1984	50.60	913	A	V	V
				01/08/1986	50.50	914	A	V	
				12/18/1997	56.30	908	A	V	
332535112203901	B-01-01 15DAB	600085	962	09/14/1982	64.40	898	A	V	
				12/22/1982	52.10	910	A	V	
				12/12/1984	47.90	914	A	S	
				01/08/1986	45.70	916	A	S	
332555112201301	B-01-01 14BBD		955	02/08/1957	55.95	899	U	S	
				01/03/1958	60.07	895	U	S	
				01/08/1959	62.40	893	U	S	
				02/03/1960	62.19	893	U	S	
				02/27/1961	69.30	886	U	S	
				02/01/1962	73.87	881	U	S	
				02/01/1963	78.80	876	U	S	
				02/14/1964	83.13	872	U	S	
				01/22/1965	84.10	871	U	S	
				01/22/1966	80.49	875	U	S	
				01/24/1967	73.03	882	U	S	
332603112200501	B-01-01 14BAB1		968	01/01/1922	12.00	956		R	
332604112205201	B-01-01 15ABB		970	06/01/1929	39.00	931		R	

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332604112205301	B-01-01 15BAD	602773	970	09/13/1982	77.50	893	A	S	
				12/05/1984	62.20	908	A	V	
				01/08/1986	59.70	910	A	V	
				11/27/1991	66.50	904	A	V	
				11/17/1997	70.00	900	A	V	
332604112211901	B-01-01 15BBB2	608729	965	12/08/1982	68.80	896	A	S	V
				12/05/1984	55.40	910	A	V	V
332608112205701	B-01-01 10CDD2		971	09/01/1948	40.00	931		R	
332608112211701	B-01-01 10CCD	609571	966	11/13/1991	65.70	900	A	V	
				10/27/1997	69.70	896	A	V	
332609112205001	B-01-01 10DCC	608732	972	12/08/1982	63.40	909	A	S	V
				12/05/1984	59.60	912	A	V	V
				12/18/1997	108.60	863	A	V	
332616112202301	B-01-01 11CCB2		969	12/04/1991	46.70	922	A	V	
332617112202401	B-01-01 11CCB1		971	12/04/1991	48.40	923	A	V	
				11/17/1997	51.50	920	A	V	
332619112203301	B-01-01 10DDB	608731	976	12/08/1982	55.50	921	A	S	V
				12/05/1984	61.50	915	A	V	V
				01/07/1986	59.50	917	A	V	
				12/18/1997	68.40	908	A	V	
332627112211601	B-01-01 10CBD	800773	969	12/04/1991	75.90	893	A	V	
332632112212201	B-01-01 10CBB	800772	974	09/13/1982	85.10	889	A	V	
				12/05/1984	72.70	901	A	V	
				12/04/1991	70.00	904	A	V	
				11/18/1997	71.40	903	A	V	
332638112204101	B-01-01 10ACD		976	09/15/1982	76.50	900	A	V	
				12/16/1982	73.50	903	A	V	
				12/07/1984	62.60	913	A	V	
				11/25/1991	67.80	908	A	V	
332638112212001	B-01-01 10BCC	609572	974	12/03/1982	77.40	897	A	V	
				12/05/1984	79.20	895	A	V	V
				01/09/1986	69.90	904	A	V	
332646112210001	B-01-01 10BDA	602774	975	12/04/1991	73.00	902	A	V	
				11/17/1997	75.50	900	A	V	
332656112184501	B-01-01 12BAA2	607580	980	02/14/1962	130.48	850			
				12/20/1962	130.48	850	U	V	
				01/15/1963	106.00	874	B	V	
				01/11/1972	99.70	880	B	V	
				12/20/1976	89.30	891	U	V	

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				02/17/1981	64.20	916	U	V	
				01/12/1982	67.90	912	A	V	
				11/29/1982	67.60	912	A	V	
				12/05/1983	52.90	927	A	V	
				12/05/1984	55.40	925	A	V	
				06/26/1985	66.20	914	A	V	
				12/06/1985	51.60	928	A	V	
				01/07/1986	50.60	929	A	V	
				06/03/1986	59.10	921	A	V	
				12/04/1986	52.30	928	A	V	
				06/01/1987	55.10	925	A	V	
				12/14/1987	52.50	928	A	V	
				06/01/1988	66.70	913	A	V	
				12/08/1988	53.20	927	A	V	
				11/27/1989	58.90	921	A	V	
				11/27/1990	62.70	917	A	V	
				11/19/1991	62.30	918	A	V	
				11/23/1992	54.30	926	A	V	
				11/18/1993	45.60	934	A	V	
				11/22/1994	59.90	920	A	V	
				12/07/1995	58.30	922	A	V	
				10/28/1996	65.50	915	A	V	
				10/28/1997	68.90	911	A	V	
				11/30/1998	63.50	917	A	V	
				11/04/1999	65.50	915	A	V	
332657112184501	B-01-01 12BAA1	607579	980	03/06/1946	30.89	949	U	S	
332657112192501	B-01-01 11AAA	632880	972	11/19/1991	50.00	922	A	V	
				11/17/1997	50.90	921	A	V	
332658112193701	B-01-01 11AAB	604520	972	02/14/1962	115.30	857	U		
				11/03/1982	62.40	910	A	V	
				11/29/1982	62.90	909	A	V	
				12/05/1984	42.40	930	A	V	
				01/07/1986	36.00	936	A	V	
				11/19/1991	50.60	921	A	V	
				11/17/1997	51.90	920	A	V	
332658112200401	B-01-01 11BAB	608841	978	11/03/1982	53.00	925	A	V	
				12/05/1984	45.60	932	A	V	
				01/07/1986	37.50	941	A	V	
				11/19/1991	55.20	923	A	V	

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332658112202601	B-01-01 10AAA1		983	11/17/1997	58.70	919	A	V	
				11/04/1947	51.96	931	U	S	
				03/05/1948	51.98	931	U	S	
				02/23/1949	58.20	925	U	S	
				11/04/1949	70.50	913	U	S	
				03/21/1950	67.71	915	U	S	
				12/21/1950	78.02	905	U	S	
				02/14/1951	67.30	916	U	S	
				11/15/1951	65.97	917	U	S	
				01/30/1952	62.35	921	U	S	
				11/10/1952	73.86	909	U	S	
				02/18/1953	72.67	910	U	S	
				10/30/1953	81.64	901	U	S	
				02/18/1954	82.18	901	U	S	
332658112202701	B-01-01 10AAA2	607158	983	01/16/1956	87.80	895	U	S	
				01/28/1957	89.00	894	U	S	
				01/29/1958	93.32	890	U	S	
				01/21/1959	97.59	885	U	S	
				02/16/1960	106.52	876	U	S	
				01/12/1962	107.66	875	U	S	
				02/06/1963	114.86	868	U	S	
				01/21/1964	117.20	866	U	S	
				02/03/1965	117.09	866	U	S	
				01/21/1966	113.17	870	U	S	
				02/08/1967	109.00	874	U		
				01/10/1968	105.50	878	U		
				01/31/1969	99.40	884	U		
				01/23/1970	104.40	879	U		
				01/21/1974	104.10	879	U	S	
				01/23/1975	96.00	887	U		
				01/15/1976	96.90	886	U	T	
				12/16/1982	79.00	904	A	V	
				12/12/1984	66.70	916	A	V	
				01/08/1986	61.20	922	A	V	
				11/27/1989	71.00	912	A	V	
				11/27/1990	73.10	910	A	V	
				11/12/1991	75.30	908	A	V	
				11/23/1992	65.60	917	A	V	
				11/18/1993	59.20	924	A	V	

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				11/22/1994	68.40	915	A	V	
				10/28/1996	72.70	910	A	V	
				10/29/1997	76.90	906	A	V	
				11/30/1998	73.30	910	A	V	
				11/04/1999	76.20	907	A	V	
				11/06/2000	74.50	909	A	V	
				10/30/2001	78.60	904			
332706112202901	B-01-01 03DAC	617174	984	11/13/1991	82.60	901	A	V	
				10/27/1997	79.60	904	A	V	
332723112185301	B-01-01 01CAA		987	09/13/1984	63.30	924	A	V	
				11/19/1991	68.20	919	A	V	
				11/14/1997	70.10	917	A	V	
332724112203001	B-01-01 03DAA1		987	02/14/1962	116.38	871	U		
				01/07/1972	109.40	878	B	V	
332725112192301	B-01-01 02DAA	624725	979	11/03/1982	69.80	909	A	V	
				12/05/1984	56.60	922	A	V	
				01/07/1986	49.10	930	A	V	
				11/29/1988	53.80	925	A	V	
				11/19/1991	64.20	915	A	V	
332733112190001	B-01-01 01CAB	613604	985	11/19/1991	67.20	918	A	V	
332735112185601	B-01-01 01BDA	610425	987	11/19/1991	74.30	913	A	V	
332737112202401	B-01-01 02BCB	618649	991	01/07/1972	117.00	874	B	V	
				12/23/1976	117.60	873	U	V	
				12/02/1982	116.70	874	A	V	
				11/18/1991	89.00	902	A	V	
332739112185901	B-01-01 01BAC	639761	986	11/19/1991	72.60	913	A	V	
				11/14/1997	77.10	909	A	V	
332741112192101	B-01-01 02AAD2	570406	984	10/29/1999	48.20	936	A	V	
332741112192201	B-01-01 01BBC	807954	988	12/01/1947	50.00	938		R	
				01/07/1972	112.10	876	B	V	
332741112192401	B-01-01 02AAD1		984	02/08/1957	96.70	887	U	S	
				01/13/1958	104.30	880	U	S	
				01/08/1959	105.55	878	U	S	
				02/03/1960	118.57	865	U	S	
				02/01/1962	109.55	874	U	V	
				12/21/1962	126.71	857	U	V	
				02/01/1963	120.55	863	U	V	
				02/14/1964	126.30	858	U	V	
				01/22/1965	126.05	858	U	V	

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				01/22/1966	123.60	860	U	V	
332744112185801	B-01-01 01BAD	603350	988	11/19/1991	73.80	914	A	V	
332749112202101	B-01-01 02BBB	607157	994	02/10/1954	97.28	897	U	S	
				02/14/1962	115.41	879	U		
				12/27/1976	122.90	871	U	V	
				11/29/1982	99.70	894	A	V	
				12/12/1984	86.80	907	A	V	S
				01/07/1986	82.10	912	A	V	
				11/12/1991	93.40	901	A	V	
				11/13/1997	92.50	902	A	V	
332750112205601	B-01-01 03BAA	611686	993	02/14/1962	128.70	864	U		
				01/07/1972	124.10	869	B	V	
				11/29/1982	103.80	889	A	V	
				12/05/1984	95.00	898	A	V	
				01/07/1986	88.20	905	A	V	
				11/18/1991	96.50	897	A	V	
				10/28/1997	96.50	897	A	V	
332751112190701	B-02-01 36CCD	570407	987	10/29/1999	41.40	946	A	V	
332752112185501	B-02-01 36CDD	605821	992	11/19/1991	81.50	911	A	V	
				11/19/1997	82.50	910	A	V	
332803112202501	B-02-01 34DDA	611687	996	01/07/1972	136.00	860	B	V	
				12/21/1976	134.70	861	U	V	
				12/16/1982	107.40	889	A	V	
				12/03/1984	95.50	901	A	V	
				11/18/1991	102.30	894	A	V	
				10/28/1997	100.40	896	A	V	
332812112190601	B-02-01 36CBA2	570405	990	10/29/1999	44.60	945	A	V	
332816112192001	B-02-01 36CBB	608794	990	02/26/1962	122.15	868	U		
				11/29/1982	95.10	895	A	V	
				12/03/1984	77.80	912	A	V	
				12/18/1997	87.80	902	A	V	
332816112205601	B-02-01 34CAA1		998	01/01/1945	54.00	944		R	
332816112205701	B-02-01 34CAA2	611688	998	11/18/1991	109.00	889	A	V	
				10/28/1997	107.70	890	A	V	
332821112183801	B-02-01 36ACD	502231	1,003	11/19/1991	98.00	905	A	V	
332831112191501	B-02-01 36BBC	504634	995	12/18/1997	99.90	895	A	V	
332832112193801	B-02-01 35ABD	608795	992	11/18/1991	97.00	895	A	V	
332835112203101	B-02-01 34AAD	611741	1,003	01/01/1945	57.00	946		R	
332840112185401	B-02-01 36BAA	800766	996	11/19/1991	101.50	895	A	V	

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				11/19/1997	104.00	892	A	V	
332841112190801	B-02-01 36BBA2		1,000	12/16/1982	101.90	898	A	S	
				12/03/1984	84.70	915	A	V	
				06/25/1985	86.80	913	A	V	
				12/06/1985	86.40	914	A	S	
				06/03/1986	86.90	913	A	V	
332842112190801	B-02-01 36BBA1		1,000	08/30/1962	166.40	834	U	V	
				01/16/1980	99.00	901			
				01/29/1981	86.40	914			
				01/11/1982	101.60	898	A	V	
				12/05/1983	75.70	924	A	V	
332843112191601	B-02-01 36BBA3	608792	997	11/02/1982	113.40	884	A	V	
				12/03/1984	88.10	909	A	V	
				09/16/1988	98.20	899	A	V	
				12/08/1988	90.20	907	A	V	
				11/27/1989	102.30	895	A	V	
				11/18/1991	106.20	891	A	V	
				11/18/1993	65.00	932	A	V	
				11/22/1994	95.10	902	A	V	
				12/19/1995	92.50	905	A	V	
				10/30/1996	94.30	903	A	V	
				12/18/1998	96.80	900	A	V	
				11/02/1999	106.30	891	A	V	
				11/01/2001	119.30	878	A	V	
332843112193601	B-02-01 35AAB	613664	997	02/22/1962	124.41	873	U	V	
				01/07/1972	148.00	849	B	V	
				12/21/1976	147.30	850	U	V	
				11/29/1982	110.00	887	A	V	
				12/03/1984	106.70	890	A	V	
				11/18/1991	106.00	891	A	V	
332844112205401	B-02-01 27DCC	611689	1,007	01/07/1972	151.00	856	B	V	
				11/18/1991	120.40	887	A	V	
				10/28/1997	119.50	888	A	V	
332845112202701	B-02-01 27DDD		1,010	01/01/1945	65.70	944		R	
332902112212301	B-02-01 27CBC	611690	1,008	12/16/1982	130.80	877	A	V	
				12/03/1984	119.70	888	A	V	
				11/18/1991	120.60	887	A	V	
				10/28/1997	123.10	885	A	V	
332903112202301	B-02-01 26CBC1		1,020	01/25/1945	70.60	949		R	

Well Altitude, Depth to Water, and Water Surface Altitude are in feet.

Arizona Department of Water Resources

GroundWater Site Inventory (GWSI) Water Level Report

Site Id	Cadastral	Reg No.	Well Altitude	Date	Depth to Water	Water Surface Altitude	Source	Method	Remark
332903112202401	B-02-01 26CBC2	611719	1,016	01/06/1961	172.90	843	U	V	
				01/29/1970	170.40	846	U	V	
				01/06/1972	179.00	837	B	V	
				12/03/1982	142.10	874	A	V	
				12/03/1984	136.30	880	A	V	
				11/29/1988	126.80	889	A	V	
				11/11/1991	139.00	877	A	V	
				10/28/1997	137.00	879	A	V	
332909112205701	B-02-01 27CAA	527883	1,015	01/01/1945	68.00	947		R	
332909112212501	B-02-01 27CBB		1,012	01/01/1945	68.00	944		R	
332910112183601	B-02-01 25ADC	607240	1,003	01/07/1972	164.00	839	B	V	
				12/12/1989	108.60	894	A	V	
				11/13/1997	112.40	891	A	V	
332917112192001	B-02-01 25BCB	608796	1,003	11/11/1991	129.30	874	A	V	
332918112193901	B-02-01 26ACA	607156	1,013	12/12/1989	136.60	876	A	V	
				11/11/1991	142.00	871	A	V	
				11/13/1997	142.00	871	A	V	
332921112204001	B-02-01 27ABD	611743	1,019	07/01/1946	77.00	942		R	
332922112183701	B-02-01 25ACA	603815	1,005	11/18/1991	126.20	879	A	V	
332922112200801	B-02-01 26BBD	611679	1,023	11/12/1956	155.00	868		R	
332922112202501	B-02-01 27AAD1	527910	1,022	05/01/1946	72.00	950		R	
332932112191601	B-02-01 25BBB	609048	1,008	11/18/1991	155.70	852	A	V	
				11/18/1997	164.10	844	A	V	
332932112192401	B-02-01 26AAA	501247	1,015	12/08/1982	144.70	870	A	V	
				12/07/1984	160.00	855	A	V	
				12/18/1997	162.20	853	A	V	
332939112195301	B-02-01 23DCC	611720	1,029	01/06/1972	194.00	835	B	V	
				11/02/1982	156.40	873	A	V	
				12/03/1984	152.30	877	A	V	
				10/28/1997	188.90	840	A	V	
332942112192301	B-02-01 23DDD	501288	1,018	11/12/1991	172.40	846	A	V	
332947112192201	B-02-01 24CCB1	617986	1,018	02/26/1962	160.10	858	U		
				12/20/1962	179.27	839	U	V	
332947112195301	B-02-01 23DCB	611678	1,030	11/22/1991	186.10	844	A	V	
				10/28/1997	189.40	841	A	V	
332948112213001	B-02-01 21DDA2		1,036	01/06/1961	175.15	861	U	S	
				12/19/1962	167.40	869	U	S	S

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GroundWater Site Inventory (GWSI) Basic Water Quality Report

Cadastral	Site Id	Reg No.	Date	V	Spec. Cond.	Fluoride	Temp	pH	Alkalinity	Dis. Oxygen
B-01-01 01BBC	332741112192201	807954	07/01/1949	D			25.5			
			09/05/1968		1,300		27.0			
B-01-01 01CBC	332717112192101	625896	07/20/1982		3,100	0.5	22.0			
			07/05/1988		3,700	0.4	23.0	7.1		
B-01-01 02AAD1	332741112192401		05/10/1979		1,300		22.5	7.4		
B-01-01 02BBB	332749112202101	607157	09/05/1986		1,820	0.8	22.5			
			07/06/1993		1,270	0.4	21.0	7.3		
B-01-01 02DAA	332725112192301	624725	09/18/1962				25.5			
			06/29/1988		2,310	0.2	23.5	7.1		
B-01-01 02DBB	332725112194801	618650	07/20/1982		720		25.5			
			06/29/1988		1,320	0.3	26.0	7.7		
B-01-01 03BAA	332750112205601	611686	09/13/1982		1,730	0.4	23.0			
			07/09/1987		1,560	0.7	23.0	7.4		
			08/06/1992		1,500	0.5	23.5	7.1		
			08/01/1995		1,540	3.0	23.5	7.3		
B-01-01 03DAA1	332724112203001		09/05/1968		1,900		23.0			
B-01-01 03DAC	332706112202901	617174	10/26/1989		950	0.5	25.0	7.8		
B-01-01 10AAA1	332658112202601		06/22/1954				22.0			
B-01-01 10AAA2	332658112202701	607158	05/10/1979		1,080		29.0	7.4		
			09/09/1986		1,340	0.2	23.5			
			07/06/1993		1,095	0.4	24.0	7.3		
B-01-01 10ABB	332658112205201		09/13/1956				21.5			
			09/06/1962				23.0			
			07/22/1982		3,850	0.5	22.0			
B-01-01 10BCC	332638112212001	609572	10/25/1989		1,360	0.5	24.0	7.3		
			05/14/1997		1,630	0.6	25.0	7.4		
B-01-01 10BDA	332646112210001	602774	08/22/1991		2,200	0.3	24.5	7.2		
			09/06/1995		1,880		24.0	7.0		
B-01-01 10BDB	332642112210801	617171	10/25/1989		690	0.4	24.0	7.7		
			05/14/1997		780	0.5	25.0	7.7		
B-01-01 10CBB	332632112212201	800772	10/07/1987		5,000	0.9	23.0	7.0		
B-01-01 10CBD	332627112211601	800773	09/13/1982		475	0.4	25.0			
			10/07/1987		765	0.4	25.5	7.8		
B-01-01 10CCD	332608112211701	609571	10/25/1989		1,760	0.5	25.0	7.3		
			05/14/1997		1,550	0.4	25.5	7.4		
B-01-01 10DCC	332609112205001	608732	12/08/1982		1,725	0.4				

Specific Conductance = microsiemens per centimeter @ 25 C.

Fluoride, Alkalinity, and Dissolved Oxygen are measured in milligrams per Liter.

Temperature is measured in degrees Celsius

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GroundWater Site Inventory (GWSI) Basic Water Quality Report

Cadastral	Site Id	Reg No.	Date	V	Spec. Cond.	Fluoride	Temp	pH	Alkalinity	Dis. Oxygen
			10/27/1989		1,760	0.2	26.0	7.7		
B-01-01 10DDB	332619112203301	608731	12/08/1982		1,340	0.4	25.5			
			10/27/1989		1,320	0.4	26.0	7.7		
			05/13/1997		1,560	0.3	26.5	7.4		
B-01-01 11BAB	332658112200401	608841	07/19/1982		1,120	0.2	22.0			
B-01-01 12BAA1	332657112184501	607579	09/12/1994		2,000	0.3	25.0	7.0		
B-01-01 12BAA2	332656112184501	607580	03/01/1946	D			26.6			
			09/05/1968		1,500		26.0			
			07/14/1982		1,840	0.4	24.0			
			09/06/1994		1,850	0.2	25.5	6.8		
B-01-01 14DBD	332524112193701	085686	08/08/1988		1,180	0.7	29.5	8.4		
			07/11/1991		1,080	0.5	31.0	8.4		
B-01-01 15CCB	332525112212301	607159	09/14/1982		2,850	0.4	25.0			
			07/06/1993		2,620	0.8	24.5	6.7		
B-01-01 15DAB	332535112203901	600085	09/14/1982		3,330	0.4				
B-01-01 22BAB	332511112210601	608801	05/10/1979		4,650		25.5	6.7		
			07/19/1982		4,600	0.6	23.0			
B-01-01 22DDD	332427112202501	606293	08/09/1988		2,700	0.5	26.5	7.3		
B-01-01 24ABB	332513112185101	609468	07/05/1988		3,640	0.6	23.0	7.3		
B-01-01 26CBB	332356112202101	606292	08/09/1988		2,350	0.5	26.0	7.4		
B-01-01 27DAB1	332355112203601	801736	07/13/1988		4,800	1.0	22.5	7.3		
B-01-01 27DAB2	332356112203301	801734	09/22/1971		1,400		40.0			
			07/13/1988		2,210	4.0	39.0	8.2		
B-01-01 28AAA	332422112272801	612584	07/27/1976				29.0			
			11/05/1982		5,000	0.7	23.0			
			07/17/1987		4,600	0.8	24.0	7.2		
B-01-01 28ADA2	332409112212401	619781	08/14/1991		3,600	1.0	23.0	7.1		
			04/15/1996		3,580		23.0	7.1		
B-01-01 36BBA	332327112190701	635445	09/22/1995		1,750	0.5	25.0	7.5		
B-02-01 23DCB	332947112195301	611678	03/13/1991		990	0.8	25.0	7.4		
			08/24/1995		1,130		24.0	7.2		
			08/05/1998		1,280		23.5	7.2		
B-02-01 23DCC	332939112195301	611720	01/01/1946	D			24.3			
			05/10/1979		905			7.4		
			07/29/1980				25.5			
			04/15/1985		970	0.5	23.0			

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GroundWater Site Inventory (GWSI) Basic Water Quality Report

Cadastral	Site Id	Reg No.	Date	V	Spec. Cond.	Fluoride	Temp	pH	Alkalinity	Dis. Oxygen
			08/13/1985		924	0.5	25.0			
			07/09/1987		860	1.1	25.0	7.5		
			08/23/1995		713		27.0	8.0		
			08/15/1998		810		26.0	8.0		
B-02-01 23DDD	332942112192301	501288	12/08/1982		590	1.4	25.0			
			02/15/1985		611	1.2	25.0			
			10/27/1989		610	1.0	24.5	8.0		
			05/13/1997		530	1.3	21.0	8.2		
B-02-01 25ADC	332910112183601	607240	08/24/1989		790	0.6	23.0	7.7		
			07/07/1993		870	0.5	22.0	7.7		
B-02-01 25BCB	332917112192001	608796	07/21/1982		740	0.4	23.0			
			07/13/1988		740	0.5	22.0	7.6		
B-02-01 26AAA	332932112192401	501247	12/08/1982		550	1.2	23.5			
			02/15/1985		552	3.5	26.0			
			10/27/1989		610	1.4	26.0	8.4		
			05/13/1997		570	1.1	25.5	8.2		
B-02-01 26ACA	332918112193901	607156	05/19/1987		895	0.9	24.5	8.2		
			08/18/1989		970	0.7	25.0	7.6		
			07/13/1993		1,020	0.5	24.0	7.4		
B-02-01 26CBC1	332903112202301		01/16/1946				22.7			
B-02-01 26CBC2	332903112202401	611719	07/01/1951	D			25.5			
			07/22/1988		1,610	0.7	23.5	7.1		
			08/06/1992		1,660	0.8	24.0	6.4		
			08/03/1995		1,570		23.5	7.1		
B-02-01 27AAD2	332922112202601	611680	02/22/1990		815	1.4	29.0	8.2		
			03/14/1991		865	1.5	28.5	7.8		
			11/22/1991		910	1.5	28.5	7.8		
			08/23/1995		830		29.0	8.1		
			08/05/1998		850		29.0	8.0		
B-02-01 27ABD	332921112204001	611743	11/01/1982		830	1.2	28.5			
B-02-01 27CBC	332902112212301	611690	08/04/1992		2,350	0.7	24.0	6.8		
			08/09/1995		2,690		22.0	7.1		
B-02-01 27DCC	332844112205401	611689	07/09/1987		1,960	0.8	23.5	7.2		
			08/06/1992		1,950	0.8	24.0	6.7		
			08/04/1995		2,100		24.0	7.0		
B-02-01 34AAD	332835112203101	611741	07/09/1987		1,970	0.7	23.0	7.2		

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GroundWater Site Inventory (GWSI) Basic Water Quality Report

Cadastral	Site Id	Reg No.	Date	V	Spec. Cond.	Fluoride	Temp	pH	Alkalinity	Dis. Oxygen
B-02-01 34CAA2	332816112205701	611688	07/08/1987		2,190	0.9	23.5	7.3		
B-02-01 34DDA	332803112202501	611687	08/29/1985		1,470	0.6	23.0			
			08/09/1995		1,365		23.0	7.1		
B-02-01 35AAB	332843112193601	613664	07/13/1982		1,060	0.4	22.5			
B-02-01 35ABD	332832112193801	608795	07/13/1988		1,385	0.4	22.5	7.4		
B-02-01 35DAA	332816112192801	608793	07/05/1988		910	0.3	24.5	7.7		
B-02-01 36BBA3	332843112191601	608792	08/29/1985		970	0.5	23.0			
			05/13/1997		980	0.4	22.5	7.6		
B-02-01 36CAA	332816112190101	605816	09/01/1988		1,520	0.5	26.0	7.2		
B-02-01 36CBA1	332815112191201	608791	07/13/1982		1,500	0.3	20.0			

Specific Conductance = microsiemens per centimeter @ 25 C.

Fluoride, Alkalinity, and Dissolved Oxygen are measured in milligrams per Liter.

Temperature is measured in degrees Celsius

GroundWater Site Inventory (GWSI)
Well Report Codes

Site Use Codes

Code	Description
*	UNDETERMINED
A	ANODE
C	STANDBY, EMERGENCY
D	DRAIN
E	GEOTHERMAL
G	SEISMIC
H	HEAT RES
M	MINE
N	NON-EXEMPT WELL IN AMA/INA
O	OBSERVATION
P	OIL AND/OR GAS
Q	WATER-QUALITY MONITORING
R	RECHARGE
S	REPRESS
T	TEST
U	UNUSED
W	WITHDRAWAL
X	WASTE
Z	WELL DESTROYED

Water Use Codes

Code	Description
*	UNDETERMINED
A	AIR CONDITIONING
B	BOTTLING
C	COMMERCIAL
D	DEWATERING
E	POWER
F	FIRE
H	DOMESTIC
I	IRRIGATION
J	INDUSTRIAL COOLING
K	MINING
M	MEDICINAL

Water Use Codes (cont.)

Code	Description
N	INDUSTRIAL
O	OBSERVATION
P	PUBLIC SUPPLY
Q	AQUACULTURE
R	RECREATION
S	STOCK
T	INSTITUTION
U	UNUSED
Z	OTHER

Well Casing Finish Codes

Code	Description
*	UNDETERMINED
C	POROUS CONCRETE
F	GRAVEL PACK WITH PERFORATIONS
G	GRAVEL PACK WITH SCREEN
H	HORIZONTAL GALLERY
O	OPEN END
P	PERFORATED OR SLOTTED
S	SCREEN
T	SAND POINT
W	WALLED
X	OPEN HOLE
Z	OTHER

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GroundWater Site Inventory (GWSI) Well Report

Cadastral	Site Id	Reg. No.	Longitude	Latitude	Well Alt.	Well Depth	Site Uses	Water Uses	Drill Date	Case Dia.	Well Finish
B-01-01 01BAA	332750112185601	639762	112 18 56	33 27 50	998	200	W	I	01/01/1940	20	S
B-01-01 01BAC	332739112185901	639761	112 18 59	33 27 39	986	350	W	P	10/26/1976	8	S
B-01-01 01BAD	332744112185801	603350	112 18 58	33 27 44	988	312	W	P	04/03/1972	8	S
B-01-01 01BBC	332741112192201	807954	112 19 22	33 27 41	988	406	U	U		16	S
B-01-01 01BDA	332735112185601	610425	112 18 56	33 27 35	987		U	U		8	S
B-01-01 01CAA	332723112185301		112 18 53	33 27 23	987	160	U	U	06/01/1940	24	S
B-01-01 01CAB	332733112190001	613604	112 19 0	33 27 23	985	398	W	H S	01/09/1980	8	S
B-01-01 01CBC	332717112192101	625896	112 19 21	33 27 17	976	300	W	I	04/13/1951	16	S
B-01-01 02AAD1	332741112192401		112 19 24	33 27 41	984	410	U	U	01/01/1943	20	S
									12/08/1946	16	S
									12/12/1955	12	S
B-01-01 02AAD2	332741112192101	570406	112 19 22	33 27 41	984	105	O	U	12/21/1998	2	P
B-01-01 02ABB	332748112195101	570404	112 19 51	33 27 48	982	48	O	U	09/09/1998	4	P
B-01-01 02BBB	332749112202101	607157	112 20 18	33 27 51	994	800	W	I	12/01/1947	20	S
B-01-01 02BCB	332737112202401	618649	112 20 24	33 27 37	991		W	I			
B-01-01 02CBC1	333713112202101	617679	112 20 21	33 27 13	985		U	U			
B-01-01 02CBC2	333713112201901	617678	112 20 19	33 27 13	985		U	U			
B-01-01 02DAA	332725112192301	624725	112 19 23	33 27 25	979		W	I			
B-01-01 02DBB	332725112194801	618650	112 19 48	33 27 25	977	400	W	I	01/01/1978	20	S
B-01-01 03AAA	332748112202701		112 20 27	33 27 48	995	242	Z	U	01/01/1917	26	
B-01-01 03BAA	332750112205601	611686	112 20 56	33 27 50	993	714	W	I	07/23/1948	20	S
B-01-01 03DAA1	332724112203001		112 20 30	33 27 24	987	265	Z	U	05/31/1939	20	S
B-01-01 03DAA2	332724112202901		112 20 29	33 27 24	987	206	Z	U			
B-01-01 03DAC	332706112202901	617174	112 20 33	33 27 12	984	502	W	P	10/20/1974	16	S
B-01-01 10AAA1	332658112202601		112 20 26	33 26 58	983	210	U	U		20	S
B-01-01 10AAA2	332658112202701	607158	112 20 27	33 26 58	983	900	W O	I	01/26/1956	20	S
B-01-01 10AAC	332652112203301		112 20 33	33 26 52	981		U	U		6	S
B-01-01 10ABB	332658112205201		112 20 52	33 26 58	981	318	W	I	07/01/1951	10	S
B-01-01 10ACD	332638112204101		112 20 41	33 26 38	976		W	I			
B-01-01 10BCC	332638112212001	609572	112 21 20	33 26 38	974	1,547	W	P	05/05/1969	16	S
B-01-01 10BDA	332646112210001	602774	112 21 0	33 26 46	975	300	W	I	03/16/1960	16	S
B-01-01 10BDB	332642112210801	617171	112 21 4	33 26 46	974	390	W	P	01/20/1959	16	S
B-01-01 10CBB	332632112212201	800772	112 21 22	33 26 32	974		W	P			
B-01-01 10CBD	332627112211601	800773	112 21 16	33 26 27	969	281	W	P		5	S
B-01-01 10CCD	332608112211701	609571	112 21 17	33 26 8	966	405	W	P	02/15/1955	12	S
B-01-01 10CDD1	332608112205801		112 20 58	33 26 8	971	60	Z	U		10	S
B-01-01 10CDD2	332608112205701		112 20 57	33 26 8	971	170	Z	U	06/01/1948	10	S
B-01-01 10DCC	332609112205001	608732	112 20 50	33 26 9	972		W	P			

Well Depth and Well Altitude are in feet

Casing Diameter is in inches

Arizona Department of Water Resources

GroundWater Site Inventory (GWSI) Well Report

Cadastral	Site Id	Reg. No.	Longitude	Latitude	Well Alt.	Well Depth	Site Uses	Water Uses	Drill Date	Case Dia.	Well Finish
B-01-01 10DDB	332619112203301	608731	112 20 33	33 26 19	976	456	W	P	04/23/1949	16	S
B-01-01 11AAA	332657112192501	632880	112 19 25	33 26 57	972	500	W	H		6	S
B-01-01 11AAB	332658112193701	604520	112 19 37	33 26 58	972	215	W	I		20	
B-01-01 11BAB	332658112200401	608841	112 20 4	33 26 58	978	271	W	I	04/22/1950	15	S
B-01-01 11CCB1	332617112202401		112 20 24	33 26 17	971		U	U			
B-01-01 11CCB2	332616112202301		112 20 23	33 26 16	969		U	U			
B-01-01 12BAA1	332657112184501	607579	112 18 45	33 26 57	980	150	Z	U	01/01/1934	20	S
B-01-01 12BAA2	332656112184501	607580	112 18 52	33 26 56	980	403	Z	I	02/15/1954	20	S
B-01-01 12BAD	332651112185301		112 18 53	33 26 51	980	600	W	I	12/01/1945	20	S
B-01-01 12CDD	332612112185501	632879	112 18 55	33 26 12	982	400	W	H		6	S
B-01-01 13AAB	332607112183001	617281	112 18 30	33 26 7	984	200	W	I	05/01/1940	20	
B-01-01 13AAB2	332602112183101	505797	112 18 31	33 26 1	985	410	W	T	08/03/1983	8	S
B-01-01 13CDA	332527112185301	603632	112 18 53	33 25 27	977	391	W	H		8	S
B-01-01 13DBC	332530112184901	607717	112 18 49	33 25 30	983	200	W	I		20	S
B-01-01 14AAA	332607112192301	640751	112 19 23	33 26 7	967	126	W	H		6	S
B-01-01 14ADD	332541112192401	605041	112 19 24	33 25 41	967	360	W	I	11/20/1980	16	S
B-01-01 14BAB1	332603112200501		112 20 5	33 26 3	968	90			01/01/1922	16	
B-01-01 14BAB2	332603112200601		112 20 6	33 26 3	968	250			11/29/1952	16	S
B-01-01 14BBD	332555112201301		112 20 13	33 25 58	955		U	U	11/29/1952	16	S
B-01-01 14DBD	332524112193701	085686	112 19 37	33 25 32	955	378	W	N	11/02/1981	8	S
B-01-01 14DCB	332520112195301		112 19 53	33 25 20	948		W	I			
B-01-01 14DDD	332517112192701	617881	112 19 27	33 25 17	962	362	U	U	03/06/1971	8	S
B-01-01 15ABB	332604112205201		112 20 52	33 26 4	970	152			06/01/1929	20	S
B-01-01 15ACD1	332542112204601	800820	112 20 46	33 25 42	967	162	W	I			
B-01-01 15ACD2	332542112204501	506456	112 20 45	33 25 42	968	185	W	H	03/19/1984	10	S
B-01-01 15BAD	332604112205301	602773	112 20 57	33 25 58	970	414	W	I	10/01/1951	16	S
B-01-01 15BBB1	332604112212401	611730	112 21 24	33 26 4	964		U	U			
B-01-01 15BBB2	332604112211901	608729	112 21 19	33 26 4	965		W	P			
B-01-01 15CCB	332525112212301	607159	112 21 18	33 25 27	967	203	W	I	04/01/1935	20	S
B-01-01 15DAB	332535112203901	600085	112 20 39	33 25 35	962	276	W	I	01/01/1954	6	
B-01-01 15DCA	332531112205501	608733	112 20 46	33 25 27	964	502	W	P	01/01/1973	20	
B-01-01 21AAA	332512112212801	639435	112 21 28	33 25 12	964	215	W	I	03/01/1951	16	S
B-01-01 21AAD	332507112212601	630811	112 21 26	33 25 7	962	331	W	H			
B-01-01 22ACD	332450112204301	609093	112 20 43	33 24 50	940	180	U	U	09/01/1949	16	S
B-01-01 22BAB	332511112210601	608801	112 21 6	33 25 11	959	90	W	I	01/01/1932	12	
B-01-01 22BBB	332514112212501	605785	112 21 25	33 25 14	965		W	I			
B-01-01 22CBD	332438112211701	633775	112 21 17	33 24 38	940	284			09/08/1967	9	S
B-01-01 22CCA	332434112211501	611332	112 21 15	33 24 34	945	250	W	H			

Well Depth and Well Altitude are in feet

Casing Diameter is in inches

Arizona Department of Water Resources

GroundWater Site Inventory (GWSI) Well Report

Cadastral	Site Id	Reg. No.	Longitude	Latitude	Well Alt.	Well Depth	Site Uses	Water Uses	Drill Date	Case Dia.	Well Finish
B-01-01 22DDD	332427112202501	606293	112 20 25	33 24 27	936	495	W	H N			
B-01-01 23ABA	332511112194401	633962	112 19 44	33 25 11	967	379	U	U	07/13/1978	6	S
B-01-01 23ADA	332456112192901	625221	112 19 29	33 24 56	963	335	W	P	01/01/1966	12	S
B-01-01 23ADD	332448112192401	625220	112 19 24	33 24 48	955	305	W	P	01/01/1966	8	S
B-01-01 23CDA	332434112195801	606289	112 19 58	33 24 34	945	200	W	I	06/17/1940	20	S
B-01-01 24ABB	332513112185101	609468	112 18 51	33 25 13	976	280	U	U	07/04/1951	20	S
B-01-01 24BAA	332512112185301	625281	112 18 53	33 25 12	975		W	I			
B-01-01 24CBA	332446112191101	606290	112 19 11	33 24 46	949	242	W	I H	11/24/1956	20	S
B-01-01 25BAA	332422112185101	606288	112 18 51	33 24 22	942	325	U	U	07/01/1958	20	S
B-01-01 25CDD	332331112185201	645530	112 18 52	33 23 31	940		W	N S			
B-01-01 26CBB	332356112202101	606292	112 20 21	33 23 56	928	267	W	H			
B-01-01 27ACD	332400112204201		112 20 42	33 24 0	0	150	Z	U	01/01/1928	20	
B-01-01 27ADD	332356112202301	613224	112 20 23	33 23 56	928	20	O	U	04/21/1980	6	S
B-01-01 27DAB1	332355112203601	801736	112 20 36	33 23 55	930	176	W	I	04/27/1956	20	S
B-01-01 27DAB2	332356112203301	801734	112 20 33	33 23 56	930	602	W O	I	10/04/1967	20	S
B-01-01 28AAA	332422112272801	612584	112 21 25	33 24 22	928	790	W	I	01/27/1969	24	S
B-01-01 28ADA1	332409112212901		112 21 29	33 24 9	925	98	U	U	04/01/1947	20	S
B-01-01 28ADA2	332409112212401	619781	112 21 24	33 24 9	925	337	W	I	03/01/1964	20	S
B-01-01 34AAA	332329112202401	804389	112 20 24	33 23 29	930	330	W	I			
B-01-01 36ACB	332312112185001	800507	112 18 50	33 23 12	939	225	W	H			
B-01-01 36BBA	332327112190701	635445	112 19 7	33 23 27	937		W	P			
B-02-01 21DDA1	332947112213001		112 21 30	33 29 47	1,036	160	U	U	01/01/1917	26	
B-02-01 21DDA2	332948112213001		112 21 30	33 29 48	1,036	463	U	U	08/01/1941		
B-02-01 23CCC	332940112202201		112 20 22	33 29 40	1,024		U	U			
B-02-01 23DCB	332947112195301	611678	112 19 53	33 29 47	1,030	587	W	P	07/01/1966	20	S
B-02-01 23DCC	332939112195301	611720	112 19 53	33 29 39	1,029	502	W	P	03/01/1941	20	S
B-02-01 23DDD	332942112192301	501288	112 19 23	33 29 42	1,018	530	W	P	11/20/1981	18	S
B-02-01 24CCB1	332947112192201	617986	112 19 22	33 29 47	1,018	460	W	I	09/14/1946	20	S
B-02-01 24CCB2	332948112192201	639903	112 19 22	33 29 48	1,018	480	W	H			
B-02-01 25ACA	332922112183701	603815	112 18 37	33 29 22	1,005	607	W	C	10/10/1948	20	S
									12/14/1970	16	S
B-02-01 25ADC	332910112183601	607240	112 18 36	33 29 10	1,003	750	W	I			
B-02-01 25BAC	332928112190401	604593	112 19 4	33 29 28	1,007	705	W	C	12/22/1972	20	S
B-02-01 25BBB	332932112191601	609048	112 19 16	33 29 32	1,008	488	W	I	11/06/1979	16	S
B-02-01 25BCB	332917112192001	608796	112 19 20	33 29 17	1,003	550	W	I	11/01/1946	20	S
B-02-01 26AAA	332932112192401	501247	112 19 24	33 29 32	1,015	608	W	P	01/01/1981	18	S
B-02-01 26ACA	332918112193901	607156	112 19 39	33 29 18	1,013	800	W	I	12/26/1947	20	S
B-02-01 26BBD	332922112200801	611679	112 20 8	33 29 22	1,023	500	U	U	04/01/1946	12	

Well Depth and Well Altitude are in feet

Casing Diameter is in inches

Arizona Department of Water Resources
GroundWater Site Inventory (GWSI) Well Report

Cadastral	Site Id	Reg. No.	Longitude	Latitude	Well Alt.	Well Depth	Site Uses	Water Uses	Drill Date	Case Dia.	Well Finish
									11/01/1966	10	
B-02-01 26CBC1	332903112202301		112 20 23	33 29 3	1,020	180	Z	U	11/01/1917	26	
B-02-01 26CBC2	332903112202401	611719	112 20 24	33 29 3	1,016	702	W	I	09/01/1948	20	S
B-02-01 27AAD1	332922112202501	527910	112 20 25	33 29 22	1,022	265	U	U	05/01/1946	12	
B-02-01 27AAD2	332922112202601	611680	112 20 26	33 29 22	1,018	700	W	P	12/31/1960	12	S
B-02-01 27ABD	332921112204001	611743	112 20 40	33 29 21	1,019	402	Z	U	07/01/1946	12	S
B-02-01 27BCB	332919112212501	611676	112 21 25	33 29 19	1,017	555	W	R	01/01/1967	16	
B-02-01 27CAA	332909112205701	527883	112 20 57	33 29 9	1,015	214	W	H	11/01/1917	26	S
B-02-01 27CBB	332909112212501		112 21 25	33 29 9	1,012	274	Z	U	01/01/1917	16	
B-02-01 27CBC	332902112212301	611690	112 21 23	33 28 57	1,008	902	W	I	01/01/1952	20	
B-02-01 27DCC	332844112205401	611689	112 20 54	33 28 44	1,007	930	W	I	06/01/1952	20	S
B-02-01 27DDD	332845112202701		112 20 27	33 28 45	1,010	303	Z	U	02/01/1930	20	S
B-02-01 34AAD	332835112203101	611741	112 20 26	33 28 31	1,003	386	W	I	05/01/1940	20	S
B-02-01 34CAA1	332816112205601		112 20 56	33 28 16	998	200	Z	U		26	S
B-02-01 34CAA2	332816112205701	611688	112 20 57	33 28 16	998	1,014	W	I	01/01/1951	20	
B-02-01 34DDA	332803112202501	611687	112 20 25	33 28 3	996	926	W	I	01/01/1954	20	S
B-02-01 35AAB	332843112193601	613664	112 19 36	33 28 43	997	130	W	I	01/01/1942	16	S
B-02-01 35ABD	332832112193801	608795	112 19 38	33 28 32	992	600	W	I	01/01/1948	20	S
B-02-01 35DAA	332816112192801	608793	112 19 28	33 28 16	988	867	W	I	03/01/1978	18	S
B-02-01 36ACD	332821112183801	502231	112 18 38	33 28 21	1,003	383	W	H	08/05/1982	8	S
B-02-01 36ADC	332822112183601	500548	112 18 36	33 28 22	1,003	326	W	N	11/30/1981	8	S
B-02-01 36BAA	332840112185401	800766	112 18 54	33 28 40	996	420	W	H S	05/28/1970	8	S
B-02-01 36BBA1	332842112190801		112 19 8	33 28 42	1,000	188	Z	U	01/01/1941	20	S
B-02-01 36BBA2	332841112190801		112 19 8	33 28 41	1,000		Z	U			
B-02-01 36BBA3	332843112191601	608792	112 19 12	33 28 43	997	866	W O	P	02/19/1977	20	S
B-02-01 36BBC	332831112191501	504634	112 19 15	33 28 31	995	925	W	P	03/20/1983	30	S
B-02-01 36CAA	332816112190101	605816	112 18 56	33 28 16	995	400	W	H N			
B-02-01 36CBA1	332815112191201	608791	112 19 12	33 28 15	991	250	W	I	01/01/1933		
B-02-01 36CBA2	332812112190601	570405	112 19 6	33 28 12	990	101	O	U	12/22/1998	2	P
B-02-01 36CBB	332816112192001	608794	112 19 20	33 28 16	990	650	W	P	05/01/1953	20	S
B-02-01 36CCD	332751112190701	570407	112 19 7	33 27 51	987		O	U			
B-02-01 36CDD	332752112185501	605821	112 18 55	33 27 52	992	400	W	H N			
B-02-01 36DBB	332816112184601	605817	112 18 46	33 28 16	1,004	350	W	I		20	S

Well Depth and Well Altitude are in feet

Casing Diameter is in inches

APPENDIX F.

GEOTECHNICAL AND SOILS ANALYSIS

Geotechnical and Soils Appendix F

Geotechnical Recommendations Provided by Ninyo & Moore Geotechnical and Environmental Consultants, Phoenix AZ

Construction Considerations for Protective Berms

Plans call for new soil berms and vegetated riparian strips to be created along segments of the existing side slopes of levees along the lower Agua Fria River. These berms will be terraced to accommodate vegetation and will extend as much as 4 feet above the river bottom. To create these berms, we recommend that soil types classified as SP, SM, SC or CL by the Unified Classification System be used. These soil type designations represent poorly graded fine to coarse sands, silty sands, clayey sands and clays, respectively. Gravelly soils, typically classified as GP, GM, and GC, could also be used; however, the gravel content should be limited to about 50 percent. In addition, the gravel should be angular or sub-angular. It should be noted that some of these gravels might not support the vegetation that is planned. In addition, silts (typically classified as ML) are not recommended because they tend to easily erode.

The above-mentioned soil types should be placed in horizontal lifts and compacted by appropriate mechanical methods, to 95 percent or more relative compaction, in accordance with ASTM D 698-00 at moisture contents within two percent of optimum. Such embankments could be constructed to slope angles of 2:1 (horizontal: vertical) or shallower, provided that the slope height is 10 feet or less. Constructed slopes made of these soil types and compacted as described above should be structurally stable for the anticipated usage.

Some erosion of the faces of newly constructed slopes will likely be experienced during the 10, 25 of 100 years event. The extent of erosion cannot reliably be predicted with the available information. However, in order to reduce the fill slope erosion potential, we recommend that the surface of the fill slopes be armored with riprap or a coarse soil/cement layer.

According to the *Soil Survey of Maricopa County, Arizona Central Part,* there are several units mapped within the river channel between McDowell Road and the confluence of the Gila River which may be suitable for borrow. These units include Agualt loam, the Vint loamy fine sand and the Vint fine sandy loam, which are typically classified as SP and SM according to the Unified Classification System. In addition, Brios loamy sand, sandy loam and loam were also indicated with the river channel, which are typically classified as SP and SM but are also described as gravelly. Many of these soils may be suitable; however, the gravel content and angularity should be carefully evaluated prior to use as borrow. Because the project plans do not call for significant cutting, and due to the lack of large deposits of fines in the channel, the volume of suitable material in the channel is expected to be insufficient for this project. Therefore, the need for import of off-site materials should be anticipated.

Several units were mapped within a 2-mile radius of the Agua Fria channel that may also be suitable as borrow for this project. These include Avonda clay loam, Cashion clay, saline-alkali, Estrella loam, Gadsden clay, Glenbar loam and clay loam, Vint fine sandy loam, loamy fine sand and loam, Coolidge sandy loam, Mohall sandy loam, loam and clay loam, and Valencia sandy

loam. These soil units are typically classified as SP, SM, SC-SM, SW-SM, CL, and CH. As with the soils within the river channel, some of these units are described as gravelly. Therefore the gravel content and angularity should be carefully evaluated prior to use as borrow.

The soil survey maps do not shown a clear pattern with regards to the location and/or size of these various soil units. Therefore, the quantity of each soil unit available is not known. However, most of the soil units mentioned within the river channel or within about 2 miles outside of the river channel appeared to be suitable for reuse as borrow. The exceptions would be those classified as silts (ML) and gravels (GP or GW), which were indicated at some locations outside of the river channel.

As part of our scope of work for this project we interviewed several governmental agencies with regards to potential off-site borrow sites that may be used to create the proposed riparian strips. These agencies included Arizona Department of Transportation (ADOT), Maricopa Department of Transportation (MCDOT), the Flood Control District of Maricopa County (FCDMC), and the City of Avondale (COA). In addition, we consulted with Sunrise Construction, a local soil broker who is familiar with current or upcoming projects that yield borrow soil for general use.

Based on our conversations with FCDMC and COA, we understand that both of these agencies are in the planning stages of cooperatively developing retention/detention basins near 115th Avenue and Buckeye Road. This site is located about 1.5 miles from the project site. There will be about 35 acres of land used for this project, however, no estimates of the amount of borrow generated are currently available. If this project is approved, the construction could possibly begin as soon as 2003.

The FCDMC indicated that there may be other borrow sites within about 2 miles of the project site; however, these projects are in the planning stages and the exact location and quantity of borrow available is not know at this time. In addition, the construction schedule associated with these FCDMC projects is not known and may not coincide with the construction schedule for the project.

Based on our conversations with ADOT, MCDOT and Sunrise Construction we understand that no other projects are currently planed that could yield a large enough volume of borrow for the project within about 2 miles of the project site. According to Sunrise Construction, the borrow materials needed may be easier to obtain from commercial sources outside of a 2 mile radius of the project site.

Soil Analysis and Laboratory Report Provided by Wallace Labs, El Segundo, CA

WALLACE LABORATORIES
365 Coral Circle
El Segundo, CA 90245
phone (310) 615-0116 fax (310) 640-6863

May 16, 2002

Fax 818/597-8001
Aspen Environmental Group
30423 Canwood Street, Suite 215
Agoura Hills, CA 91301

RE: project - Agua Fria River Channel

Dear Marc,

The soils have moderately high alkalinity. The pH values range from 8.08 to 8.70. Limestone is present in 4 of the 7 samples. Salinity is low to moderate. Phosphorus is low in over half the samples. No. 6 has sufficient nitrogen but the others samples are low. Nitrogen is readily leachable and is ephemeral. Nitrogen becomes available as soil organic matter mineralizes and as nitrogen is fixed biologically. Nitrogen can be supplied in a slow-release form. Boron is low except in No. 10. Zinc is low in No. 12 and No. 14.

The metal scans do not show abnormal conditions.

The addition of gypsum is expected to lower the alkalinity. The pH expected to decrease to less than 8.0 with leaching.

Recommendations

General soil preparation: Broadcast the following materials uniformly. The rates are per 1,000 square feet. Incorporate them homogeneously to a 6-inch deep:

Ureaformaldehyde (38-0-0) - 8 pounds
triple superphosphate (0-45-0) - 3 pounds
agricultural gypsum - 20 pounds, 40 pounds for No. 10
good quality soil amendment - 3 cubic yards

For backfill of container plants, incorporate homogeneously the following materials into the excavated soil. Rates are expressed on a cubic yard basis:

Ureaformaldehyde (38-0-0) - 1/3 pound
triple superphosphate (0-45-0) - 1/4 pound
agricultural gypsum - 1 pound, 2 pounds for No. 10
good quality soil amendment - 15% by volume

Soil amendment:

1. Humus material shall have an ash content of no less than 8% and no more than 50%.
2. The pH of the material shall be between 6 and 7.5.
3. The salt content shall be less than 10 millimho/cm @ 25° C. (ECe less than 10) on a saturated paste extract.
4. Boron content of the saturated extract shall be less than 1.0 parts per million.
5. Silicon content (acid-insoluble ash) shall be less than 30%.
6. Calcium carbonate shall not be present if to be applied on alkaline soils.
7. Types of acceptable products are composts, manures, mushroom composts, straw, alfalfa, sludges, peat mosses etc. low in salts, low in heavy metals, free from weed seeds, free of pathogens and other deleterious materials.
8. Composted wood products are conditionally acceptable [stable humus must be present]. Wood based products are not acceptable which are based on red wood or cedar.
9. Sludge-based materials are not acceptable if the soil already has a high level (toxic level) of zinc, copper or other heavy metals based on soil analysis.
10. Carbon:nitrogen ratio is less than 25:1.
11. The compost shall be aerobic without malodorous presence of decomposition products.
12. The maximum particle size shall be 0.5 inch, 80% or more shall pass a No. 4 screen.

Maximum total permissible pollutant concentrations in amendment in parts per million on a dry weight basis:

arsenic	20	copper	150	selenium	50
cadmium	15	lead	200	silver	10
chromium	300	mercury	10	vanadium	50
cobalt	50	molybdenum	60	zinc	300
		nickel	100		

Higher amounts of salinity or boron may be present if the soils are to be preleached to reduce the excess or if the plant species will tolerate the salinity and/or boron.

Sincerely,

Garn A. Wallace, Ph. D.
Executive Director
GAW:n

WALLACE LABS
365 Coral Circle
El Segundo, CA 90245
(310) 615-0116

SOILS REPORT

April 25, 2002

Location: Agua Pria river channel
Requester: Aspen Environmental

graphic interpretation: * very low, ** low, *** moderate, **** high, ***** very high

ammonium bicarbonate/DTPA
extractable - mg/kg soil
Interpretation of data
low medium high

Sample ID Number	02-114-15 #2		02-114-16 #4		02-114-17 #8		02-114-18 #10	
elements		graphic		graphic		graphic		graphic
phosphorus (0 - 7 8-15 over 15)	3.23	**	7.85	**	4.35	**	6.85	**
potassium (0-60 60 -120 121-180)	81.91	***	159.29	****	64.83	***	142.21	****
iron (0 - 3 3 - 5 over 5)	2.79	**	8.49	****	4.37	***	4.71	***
manganese (0- 0.5 0.6- 1 over 1)	1.07	****	10.82	*****	1.20	****	3.59	****
zinc (0 - 1 1 - 1.5 over 1.5)	0.92	**	1.13	***	2.01	****	1.33	***
copper (0- 0.2 0.3- 0.5 over 0.5)	1.11	****	2.80	****	1.41	****	3.27	*****
boron (0- 0.2 0.2- 0.5 over 1)	0.08	*	0.07	*	0.02	*	0.26	***
calcium	370.27	***	314.74	***	386.08	***	333.52	***
magnesium (ratio of calcium to magnesium needs to be more than 2 or 3)	167.62	*****	226.14	*****	76.82	***	195.81	*****
sodium (should be less than potassium)	100.07	***	75.83	**	48.60	*	321.05	****
sulfur	9.01	*	8.92	*	4.35	*	22.67	*
molybdenum	nd	*	nd	*	nd	*	0.02	***
aluminum (The following trace elements may be toxic. The degree of toxicity depends upon the pH of the soil, soil texture, organic matter, and the concentrations of the individual elements as well as to their interactions.)	nd	*	nd	*	0.79	**	nd	*
arsenic	nd	*	0.07	*	nd	*	nd	*
barium	1.88	*	0.83	*	1.67	*	1.37	*
cadmium	nd	*	nd	*	nd	*	nd	*
chromium	nd	*	nd	*	nd	*	nd	*
cobalt	nd	*	0.04	*	nd	*	nd	*
lead	0.82	*	1.24	**	0.84	*	1.11	**
lithium	nd	*	0.02	*	nd	*	0.09	*
mercury	nd	*	nd	*	nd	*	nd	*
nickel	0.05	*	0.40	*	0.03	*	0.17	*
selenium	nd	*	nd	*	nd	*	nd	*
silver	nd	*	nd	*	nd	*	nd	*
strontium	6.03	**	4.51	*	3.77	*	5.67	**
tin	nd	*	nd	*	nd	*	nd	*
vanadium	0.16	*	0.41	*	0.11	*	0.30	*

The pH optimum depends upon soil organic matter and clay content- for clay and loam soils: under 5.2 is too acidic; 6.5 to 7 is ideal; over 8.5 is too alkaline

Saturation Extract

pH value	8.10	****	8.08	****	8.39	****	8.21	****
ECe (millimho/cm) (The ECe is a measure of the soil salinity: 1-2 affects a few plants; 2-4 affects some plants; > 4 affects many plants.)	0.69	**	0.46	**	0.31	*	1.32	***
	millieq/l		millieq/l		millieq/l		millieq/l	
calcium	31.9	1.6	30.9	1.5	17.3	0.9	29.5	1.5
magnesium	12.8	1.1	15.2	1.3	5.9	0.5	13.6	1.1
sodium	86.5	3.8	49.8	2.2	33.3	1.4	225.3	9.8
potassium	5.6	0.1	8.9	0.2	4.5	0.1	9.5	0.2
cation sum		6.6		5.2		2.9		12.6
chloride (problems over 150 ppm)	82	2.3	30	0.8	28	0.8	196	5.5
nitrate as N (good 20 - 30 ppm)	5	0.4	9	0.6	6	0.4	11	0.8
phosphorus as P	0.3	0.0	0.5	0.0	0.3	0.0	0.5	0.0
sulfate as S (toxic over 800)	20.2	1.3	12.8	0.8	7.8	0.5	43.4	2.7
anion sum		3.9		2.3		1.7		9.0
boron as B (toxic over 1 for many plants)	0.08	*	0.08	*	0.03	*	0.37	**
SAR (increasing problems start at 3)	3.3	***	1.8	**	1.8	**	8.6	****
est. gypsum requirement-lbs./1000 sq. ft.	17		13		8		55	
relative infiltration rate	slow/fair		slow/fair		fair		fair	
estimated soil texture	loamy sand		loam		loamy sand		loam	
lime (calcium carbonate)	no		yes		yes		yes	
organic matter	low		low		low		low	
moisture content of soil	3.3%		2.4%		1.7%		2.1%	
half saturation percentage	14.2%		17.0%		14.8%		17.2%	

Elements are expressed as mg/kg dry soil or mg/l for saturation extract.
pH and ECe are measured in a saturation paste/extract. nd means not detected.

WALLACE LABS
365 Coral Circle
El Segundo, CA 90245
(310) 615-0116

SOILS REPORT

April 25, 2002

Location: Agua Fria river channel
Requester: Aspen Environmental

graphic interpretation: * very low, ** low, *** moderate, **** high, ***** very high

ammonium bicarbonate/DTPA
extractable - mg/kg soil
Interpretation of data
low medium high

Sample ID Number	02-114-19 # 14	graphic	02-114-20 # 6	graphic	02-114-21 # 12	graphic
elements						
phosphorus (0-7 8-15 over 15)	3.67	**	4.44	**	4.78	**
potassium (0-60 60-120 121-180)	76.47	***	91.11	***	116.05	***
iron (0-3 3-5 over 5)	2.10	**	4.40	***	2.01	**
manganese (0-0.5 0.6-1 over 1)	1.92	****	2.22	****	1.47	****
zinc (0-1 1-1.5 over 1.5)	0.32	*	3.28	****	0.50	*
copper (0-0.2 0.3-0.5 over 0.5)	0.82	****	3.27	*****	0.91	****
boron (0-0.2 0.2-0.5 over 1)	0.12	**	0.03	*	0.08	*
calcium	366.79	***	342.83	***	383.76	***
magnesium (ratio of calcium to magnesium needs to be more than 2 or 3)	61.13	***	143.79	****	83.74	***
sodium (should be less than potassium)	44.59	*	61.10	**	45.41	*
sulfur	5.86	*	6.61	*	5.94	*
molybdenum	nd	*	0.02	**	nd	*
aluminum (The following trace elements may be toxic. The degree of toxicity depends upon the pH of the soil, soil texture, organic matter, and the concentrations of the individual elements as well as to their interactions.)	nd	*	nd	*	0.05	*
arsenic	nd	*	nd	*	nd	*
barium	1.89	*	1.27	*	1.94	*
cadmium	nd	*	nd	*	nd	*
chromium	nd	*	nd	*	nd	*
cobalt	nd	*	nd	*	nd	*
lead	0.39	*	2.08	**	0.38	*
lithium	nd	*	nd	*	nd	*
mercury	nd	*	nd	*	nd	*
nickel	0.02	*	0.06	*	0.02	*
selenium	nd	*	nd	*	nd	*
silver	nd	*	nd	*	nd	*
strontium	4.31	*	4.19	*	4.63	*
tin	nd	*	nd	*	nd	*
vanadium	0.08	*	0.35	*	0.11	*
Saturation Extract						
pH value (The pH optimum depends upon soil organic matter and clay content- for clay and loam soils: under 5.2 is too acidic, 6.5 to 7 is ideal, over 8.5 is too alkaline)	8.70	****	8.48	****	8.68	****
ECe (milli-mho/cm) (The ECe is a measure of the soil salinity: 1-2 affects a few plants, 2-4 affects some plants, > 4 affects many plants.)	0.31	*	0.40	**	0.33	*
	millieq/l		millieq/l		millieq/l	
calcium	15.7	0.8	33.1	1.7	21.3	1.1
magnesium	5.8	0.5	9.0	0.7	5.9	0.5
sodium	37.2	1.6	32.4	1.4	27.5	1.2
potassium	8.0	0.2	5.8	0.1	13.9	0.4
cation sum		3.1		4.0		3.1
chloride (problems over 150 ppm)	23	0.7	13	0.4	28	0.8
nitrate as N (good 20 - 30 ppm)	2	0.1	19	1.4	3	0.2
phosphorus as P	0.3	0.0	0.3	0.0	0.4	0.0
sulfate as S (toxic over 800)	10.1	0.6	10.8	0.7	11.2	0.7
anion sum		1.4		2.4		1.7
boron as B (toxic over 1 for many plants)	0.18	*	0.07	*	0.11	*
SAR (increasing problems start at 3)	2.0	**	1.3	*	1.4	*
est. gypsum requirement-lbs./1000 sq. ft.	8		10		8	
relative infiltration rate	fair		slow/fair		fair/good	
estimated soil texture	loamy sand		loam		loamy sand	
lime (calcium carbonate)	no		yes		no	
organic matter	low		low		low	
moisture content of soil	0.6%		2.9%		1.5%	
half saturation percentage	18.0%		19.1%		18.0%	

Elements are expressed as mg/kg dry soil or mg/l for saturation extract.
pH and ECe are measured in a saturation paste/extract. nd means not detected.

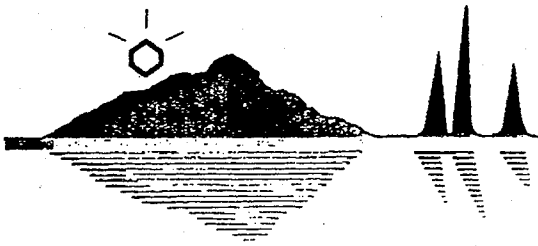
WALLACE LABS ANALYSES DATE: April 25, 2002

365 Coral Circle
El Segundo, CA 90245
(310) 615-0116

Location Aspen Environmental
Requester Agua Fria Tiver channel
Method EPA 3051
Material soil

	02-114To-20 # 6	02-114To-21 # 12
elements		
aluminum	4,775.39	3,893.57
arsenic	4.39	4.22
barium	107.32	86.02
boron	1.17	0.94
cadmium	0.60	0.51
calcium	########	8,892.01
chromium	8.76	6.86
cobalt	6.09	5.53
copper	17.31	13.42
iron	7,680.11	7,622.66
lead	10.68	4.40
lithium	9.93	8.29
magnesium	4,716.82	4,443.59
manganese	339.78	245.93
mercury	0.23	0.43
molybdenu	0.07	< 0.05
nickel	13.69	11.89
phosphorus	666.28	620.26
potassium	1,390.75	1,141.55
selenium	< 0.25	< 0.25
silicon	18.89	23.64
silver	< 0.05	< 0.05
sodium	655.35	628.38
strontium	91.21	66.05
sulfur	126.20	73.07
tin	< 2.50	< 2.50
titanium	46.17	60.90
vanadium	17.44	16.12
zinc	57.48	35.62
chloride	< 5000	< 5000
	1	1

Elements expressed as mg/kilogram (parts per million) on a dry weight basis.



TRANSWEST GEOCHEM

November 21, 2002

Tom Scofield
Aspen Environmental
1760 Creekside Oak Drive
Sacramento, CA 95833

RE: Agua Fria & I-10 - Pesticides
Work Order No.: 0210316

Dear Tom,

Transwest Geochem, Inc. received 2 samples on 10/24/2002 1:35:00 PM for the analyses presented in the following report.

The Case Narrative of this report addresses any Quality Control and/or Quality Assurance issues associated with this Work Order.

If you have any questions regarding these test results, please feel free to call us at (602) 437-0330.

Sincerely,

Beth Proffitt
Project Manager

ADHS License No. AZM133/AZ0133

Date Printed: 21-Nov-02

Client:	Aspen Environmental
Work Order:	0210316
Project Name:	Agua Fria & I-10 - Pesticides
Project Number:	

CASE NARRATIVE

Transwest Geochem, Inc. uses the methods outlined in the following references:

Code of Federal Regulations, 40CFR, Part 136, Revised July 1995.

Standard Methods for the Examination of Water and Wastewater, 18th Edition, 1992 and 19th Edition, 1995.

Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, Revised March 1983.

Methods for the Determination of Inorganic Substances in Environmental Samples, EPA/600/R-93/100, Revised August 1993.

Methods for the Determination of Metals in Environmental Samples, EPA/600/R-94/111, Revised May 1994.

Hach, Water Analysis Handbook, 2nd Edition, 1992.

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW846, 3rd Edition.

Secondary Source QC Sample (LCSV) results may not be reported for all methods and/or analysis dates.

All method blanks, laboratory spikes, and/or matrix spikes met quality control objectives for the parameters associated with this Work Order except as detailed below or on the Data Qualifier page of this report. Data Qualifiers used in this report are in accordance with ADEQ Arizona Data Qualifiers, Revision 1.0 05/13/2002.

Data qualifiers ("flags") contained within this analytical report have been issued to explain a quality control deficiency, and do not affect the quality (validity) of the data unless noted otherwise in the case narrative.

3725 E. Atlanta Ave • Suite 2 • Phoenix, Arizona 85040 • (602) 437-0330 • 1-800-927-5183 • Fax (602) 437-0660

TRANSWEST GEOCHEM

Date Printed 21-Nov-02
License No. AZM133/AZ0133

CLIENT: Aspen Environmental
Project Name: Agua Fria & I-10 - Pesticides
Project Number:
Work Order: 0210316
Date Received: 24-Oct-02

Case Narrative
Data Qualifiers

One or more of the following data qualifiers may be associated with your analytical and/or quality control data.

M1	Matrix spike recovery was high, the method control sample recovery was acceptable.
R9	Sample RPD exceeded the laboratory control limit.
M2	Matrix spike recovery was low, the method control sample recovery was acceptable.

TRANSWEST GEOCHEM

Date Printed 21-Nov-02
License No. AZM133/AZ0133

CLIENT: Aspen Environmental
Project Name: Agua Fria & I-10 - Pesticides
Project Number:
Work Order: 0210316
Date Received: 24-Oct-02

Work Order Sample Summary

Client Sample ID	Lab Sample ID	Test Code	Collection Date
1ASPEN	0210316-01A	SW8081A	10/24/2002 12:10:00 PM
2ASPEN	0210316-02A	SW8081A	10/24/2002 12:38:00 PM

TRANSWEST GEOCHEM

Date Printed 21-Nov-02

License No. AZM133/AZ0133

CLIENT: Aspen Environmental
Project Name: Agua Fria & I-10 - Pesticides
Project Number:
Work Order: 0210316
Date Received: 24-Oct-02

Definitions

Analytical Spike (AS)	The AS is a known amount of a target analyte added to a sample after it has been distilled, digested, or extracted and is ready for analysis. The AS is generally performed if the MS has failed. It is used to indicate interference that arises from sample distillation, digestion, or extraction as opposed to interference that is innate to the matrix.
Continuing Curve Verification (CCV)	The CCV is also referred to as a curve check. This is a standard analyzed at specified intervals during an analysis. The CCV verifies the stability and accuracy of the calibration curve. There are specific CCV recovery acceptance criteria for each method.
Dilution Factor (DF)	The DF is an indication of how much a sample had to be diluted in order to quantitate it on a standard curve. The DF is indicated in the reported sample result. The sample PQL increases as the dilution increases.
Internal Standard (IS)	The IS is a compound that is similar to the organic compound of interest in terms of chemical composition but is unique in that it is rare in the environment. The same concentration of IS is added to every sample for some organic methods.
Laboratory Control Sample (LCS)	The LCS is also referred to as a blank spike. The LCS is an addition of a known amount of a target analyte (from the same source as calibration standards or spikes) to an aliquot of deionized water or other appropriate clean matrix. The LCS is processed through the entire method procedure in the same manner as samples.
Matrix Spike (MS)	The MS is a known amount of a target analyte added to a sample. The MS is processed through the entire method procedure in the same manner as samples.
Method Blank (MB)	The MB is an aliquot of deionized water or other appropriate clean matrix that is thought to be free of the analyte in question. The MB is processed through the entire extraction or analysis procedure and is used to indicate contamination in the lab.
Method Detection Limit (MDL)	The MDL is the lowest level of detection of which a method is capable.
Practical Quantitation Limit (PQL)	The PQL is the lowest value at which Transwest Geochem can detect an analyte in matrix with a high degree of confidence. The PQL will increase as the DF increases. The PQL is greater than or equal to the MDL.
Relative Percent Difference (RPD)	The RPD is a measure of precision (the ability to obtain the same result on re-analysis of the same sample). It is calculated using the result of a sample, MS, LCS, or LCSV and its associated duplicate result.
Secondary Source QC Sample (LCSV)	The LCSV is also referred to as a second source laboratory control sample. It is the same type of standard as a calibration or spiking standard but is obtained from a different source. The LCSV is an indication of the primary standard quality, method performance, and instrument performance.
Surrogate	A surrogate compound is similar to the organic compound of interest in terms of chemical composition but is unique in that it is rare in the environment. When surrogates are used, they are added to every sample, blank and standard. Surrogate recovery is used as an indication of extraction and/or analytical success.
Trip Blank (TB)	The TB is a portion of deionized water preserved in the same manner as the samples. The TB travels from the lab, to the field, and then back to the lab with the samples from the field. The TB serves as an indication of contamination introduced during sample transportation.

TRANSWEST GEOCHEM

Date Printed 21-Nov-02

License No. AZM133/AZ0133

CLIENT: Aspen Environmental
Work Order: 0210316
Lab ID: 0210316-01
Project Name: Agua Fria & I-10 - Pesticides
Project Number:

Client Sample ID: 1ASPEN
Collection Date: 10/24/2002 12:10:00 PM
Matrix: SOIL

Analyte	Result	PQL	Qual	Units	DF	Test Code	Date Prepared	Date Analyzed	Analyst	Batch ID
Aldrin	<0.010	0.010		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 18:42	BM	5587
alpha-BHC	<0.010	0.010		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 18:42	BM	5587
beta-BHC	<0.010	0.010		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 18:42	BM	5587
delta-BHC	<0.010	0.010		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 18:42	BM	5587
gamma-BHC	<0.010	0.010		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 18:42	BM	5587
Chlordane	<0.033	0.033		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 18:42	BM	5587
4,4'-DDD	<0.010	0.010		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 18:42	BM	5587
4,4'-DDE	<0.010	0.010		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 18:42	BM	5587
4,4'-DDT	<0.010	0.010		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 18:42	BM	5587
Dieldrin	<0.010	0.010		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 18:42	BM	5587
Endosulfan I	<0.010	0.010		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 18:42	BM	5587
Endosulfan II	<0.010	0.010		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 18:42	BM	5587
Endosulfan sulfate	<0.010	0.010		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 18:42	BM	5587
Endrin	<0.010	0.010		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 18:42	BM	5587
Endrin aldehyde	<0.010	0.010		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 18:42	BM	5587
Heptachlor	<0.010	0.010		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 18:42	BM	5587
Heptachlor epoxide	<0.010	0.010		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 18:42	BM	5587
Methoxychlor	<0.010	0.010		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 18:42	BM	5587
Toxaphene	<0.033	0.033		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 18:42	BM	5587
Decachlorobiphenyl (Surrogate)	84	51-124		%REC	1.0	SW8081A	11/5/02	11/10/02 18:42	BM	5587

Confidential and Privileged

CLIENT: Aspen Environmental
Work Order: 0210316
Lab ID: 0210316-02
Project Name: Agua Fria & I-10 - Pesticides
Project Number:

Client Sample ID: 2ASPEN
Collection Date: 10/24/2002 12:38:00 PM
Matrix: SOIL

Analyte	Result	PQL	Qual	Units	DF	Test Code	Date Prepared	Date Analyzed	Analyst	Batch ID
Aldrin	<0.010	0.010		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 19:29	BM	5587
alpha-BHC	<0.010	0.010		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 19:29	BM	5587
beta-BHC	<0.010	0.010		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 19:29	BM	5587
delta-BHC	<0.010	0.010		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 19:29	BM	5587
gamma-BHC	<0.010	0.010		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 19:29	BM	5587
Chlordane	<0.033	0.033		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 19:29	BM	5587
4,4'-DDD	<0.010	0.010		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 19:29	BM	5587
4,4'-DDE	<0.010	0.010		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 19:29	BM	5587
4,4'-DDT	<0.010	0.010		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 19:29	BM	5587
Dieldrin	<0.010	0.010		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 19:29	BM	5587
Endosulfan I	<0.010	0.010		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 19:29	BM	5587
Endosulfan II	<0.010	0.010		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 19:29	BM	5587
Endosulfan sulfate	<0.010	0.010		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 19:29	BM	5587
Endrin	<0.010	0.010		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 19:29	BM	5587
Endrin aldehyde	<0.010	0.010		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 19:29	BM	5587
Heptachlor	<0.010	0.010		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 19:29	BM	5587
Heptachlor epoxide	<0.010	0.010		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 19:29	BM	5587
Methoxychlor	<0.010	0.010		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 19:29	BM	5587
Toxaphene	<0.033	0.033		mg/Kg	1.0	SW8081A	11/5/02	11/10/02 19:29	BM	5587
Decachlorobiphenyl (Surrogate)	85	51-124		%REC	1.0	SW8081A	11/5/02	11/10/02 19:29	BM	5587

Confidential and Privileged

TRANSWEST GEOCHEM

Date: 21-Nov-02

License No. AZM133/AZ01

CLIENT: Aspen Environmental
Work Order: 0210316
Project: Agua Fria & I-10 - Pesticides

QC SUMMARY REPORT
Method Blank

Analyte	Result	PQL	Qual	Units	DF	Test Code	Date Prepared	Date Analyzed	Analyst	Batch ID
Aldrin	<0.010	0.010		mg/Kg	1	SW8081A	11/5/02	11/8/02 8:14:00 AM	BM	5587
alpha-BHC	<0.010	0.010		mg/Kg	1	SW8081A	11/5/02	11/8/02 8:14:00 AM	BM	5587
beta-BHC	<0.010	0.010		mg/Kg	1	SW8081A	11/5/02	11/8/02 8:14:00 AM	BM	5587
delta-BHC	<0.010	0.010		mg/Kg	1	SW8081A	11/5/02	11/8/02 8:14:00 AM	BM	5587
gamma-BHC	<0.010	0.010		mg/Kg	1	SW8081A	11/5/02	11/8/02 8:14:00 AM	BM	5587
Chlordane	<0.033	0.033		mg/Kg	1	SW8081A	11/5/02	11/8/02 8:14:00 AM	BM	5587
4,4'-DDD	<0.010	0.010		mg/Kg	1	SW8081A	11/5/02	11/8/02 8:14:00 AM	BM	5587
4,4'-DDE	<0.010	0.010		mg/Kg	1	SW8081A	11/5/02	11/8/02 8:14:00 AM	BM	5587
4,4'-DDT	<0.010	0.010		mg/Kg	1	SW8081A	11/5/02	11/8/02 8:14:00 AM	BM	5587
Dieldrin	<0.010	0.010		mg/Kg	1	SW8081A	11/5/02	11/8/02 8:14:00 AM	BM	5587
Endosulfan I	<0.010	0.010		mg/Kg	1	SW8081A	11/5/02	11/8/02 8:14:00 AM	BM	5587
Endosulfan II	<0.010	0.010		mg/Kg	1	SW8081A	11/5/02	11/8/02 8:14:00 AM	BM	5587
Endosulfan sulfate	<0.010	0.010		mg/Kg	1	SW8081A	11/5/02	11/8/02 8:14:00 AM	BM	5587
Endrin	<0.010	0.010		mg/Kg	1	SW8081A	11/5/02	11/8/02 8:14:00 AM	BM	5587
Endrin aldehyde	<0.010	0.010		mg/Kg	1	SW8081A	11/5/02	11/8/02 8:14:00 AM	BM	5587
Heptachlor	<0.010	0.010		mg/Kg	1	SW8081A	11/5/02	11/8/02 8:14:00 AM	BM	5587
Heptachlor epoxide	<0.010	0.010		mg/Kg	1	SW8081A	11/5/02	11/8/02 8:14:00 AM	BM	5587
Methoxychlor	<0.010	0.010		mg/Kg	1	SW8081A	11/5/02	11/8/02 8:14:00 AM	BM	5587
Toxaphene	<0.033	0.033		mg/Kg	1	SW8081A	11/5/02	11/8/02 8:14:00 AM	BM	5587
Decachlorobiphenyl	86	51-124		%REC	1	SW8081A	11/5/02	11/8/02 8:14:00 AM	BM	5587

TRANSWEST GEOCHEM

Date: 21-Nov-02

License No. AZM133/AZ0133

CLIENT: Aspen Environmental

Work Order: 0210316

Project: Agua Fria & I-10 - Pesticides

QC SUMMARY REPORT

Sample Matrix Spike

Analyte	Result	PQL	SPK value	SPK Ref Val	% Rec	Low Limit	High Limit	RPD Ref Val	% RPD	RPD Limit	Qual
Sample ID: **0211007-26A-MS**	Batch ID: 5587			Test Code: SW8081A				Date Analyzed: 11/08/02 13:38			
Client ID:				Units: mg/Kg				Date Prepared: 11/5/02			
gamma-BHC	0.1083	0.050	0.1333	<0.050	81%	47	109				
4,4'-DDT	<0.050	0.050	0.1333	<0.050	0%	32	172				M2
Dieldrin	0.2150	0.050	0.1333	<0.050	161%	49	141				M1
Methoxychlor	0.4467	0.050	0.1333	<0.050	335%	26	167				M1
Decachlorobiphenyl	0.1300	N/A	0.1333	N/A	98%	51	124				
Sample ID: **0211007-26A-MSD**	Batch ID: 5587			Test Code: SW8081A				Date Analyzed: 11/08/02 14:16			
Client ID:				Units: mg/Kg				Date Prepared: 11/5/02			
gamma-BHC	0.1267	0.050	0.1333	<0.050	95%	47	109	0.1083	16%	28	
4,4'-DDT	<0.050	0.050	0.1333	<0.050	0%	32	172	<0.050	0%	44	M2
Dieldrin	0.5133	0.050	0.1333	<0.050	385%	49	141	0.2150	82%	30	M1,R9
Methoxychlor	0.6250	0.050	0.1333	<0.050	469%	26	167	0.4467	33%	45	M1,R9
Decachlorobiphenyl	0.1383	N/A	0.1333	N/A	104%	51	124				

TRANSWEST GEOCHEM

Date: 21-Nov-02

License No. AZM133/AZ0133

CLIENT: Aspen Environmental
Work Order: 0210316
Project: Agua Fria & I-10 - Pesticides

QC SUMMARY REPORT

Blank Spike

Analyte	Result	PQL	SPK value	SPK Ref Val	% Rec	Low Limit	High Limit	RPD Ref Val	% RPD	RPD Limit	Qual
Sample ID: LCS-5587	Batch ID: 5587			Test Code: SW8081A				Date Analyzed: 11/08/02 08:52			
				Units: mg/Kg				Date Prepared: 11/5/02			
gamma-BHC	0.1047	0.010	0.1333	<0.010	79%	46	118				
4,4'-DDT	0.1223	0.010	0.1333	<0.010	92%	59	136				
Dieldrin	0.1173	0.010	0.1333	<0.010	88%	62	121				
Methoxychlor	0.1150	0.010	0.1333	<0.010	86%	62	131				
Decachlorobiphenyl	0.1190	N/A	0.1333	N/A	89%	51	124				
Sample ID: LCSD-5587	Batch ID: 5587			Test Code: SW8081A				Date Analyzed: 11/08/02 09:30			
				Units: mg/Kg				Date Prepared: 11/5/02			
gamma-BHC	0.1070	0.010	0.1333	<0.010	80%	46	118	0.1047	2%	18	
4,4'-DDT	0.1293	0.010	0.1333	<0.010	97%	59	136	0.1223	6%	14	
Dieldrin	0.1257	0.010	0.1333	<0.010	94%	62	121	0.1173	7%	15	
Methoxychlor	0.1280	0.010	0.1333	<0.010	96%	62	131	0.1150	11%	20	
Decachlorobiphenyl	0.1203	N/A	0.1333	N/A	90%	51	124				

APPENDIX G.

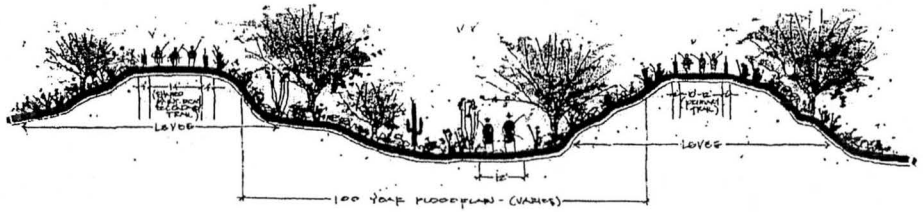
EXCERPTS FROM THE TRANSPORTATION CORRIDOR MASTER PLAN (SOUTHERN TRAIL SEGMENTS)

G.1 MAPS OF SOUTHERN TRAIL SEGMENTS

G.2 LAND OWNERSHIP OF SOUTHERN TRAIL SEGMENTS IN RESTORATION AREA

G.1 Maps of Southern Trail Segments

Trail Type	Width (Feet)	Distance (Linear Feet)	Distance (in Miles)	Material
Primary Trail	10-12	69,351	13.1	asphalt/concrete
Secondary Trail	8-10	34,671	6.6	decomposed granite
Neighborhood/Transit/Connector	8-10	22,894	4.3	asphalt/concrete
Conservation/Interpretive Trail	4-6	0	0.0	decomposed granite
Equestrian Corridor	4-6	23,029	4.4	sand/gravel



RIVER CHANNEL CROSS SECTION

Trail Amenities	Symbol	Quantity
Gateway		4
Primary Staging Area/Gateway		0
Secondary Staging Area		1
Trail Connection		4
Riverbed Access Ramp		1
Future Roadway Bridge		0
Prefabricated Pedestrian Bridge		1
Transit Connection Node		0
Trail Underpass Improvements		2
At-Grade Primary Trail Crossing		0

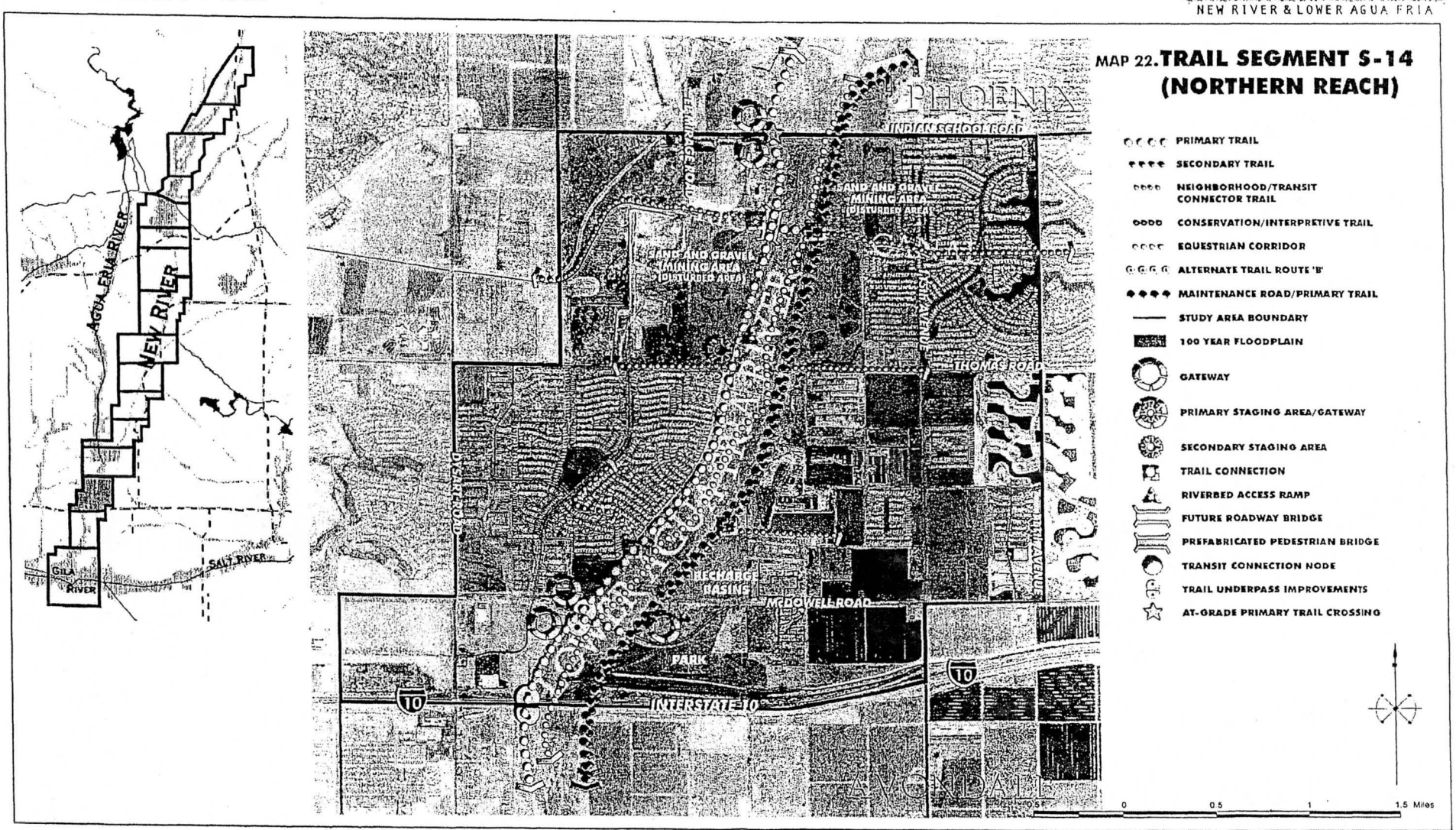
TRAIL SEGMENT S-14

Indian School Road to I-10

Affected Jurisdictions: Avondale

Design Considerations:

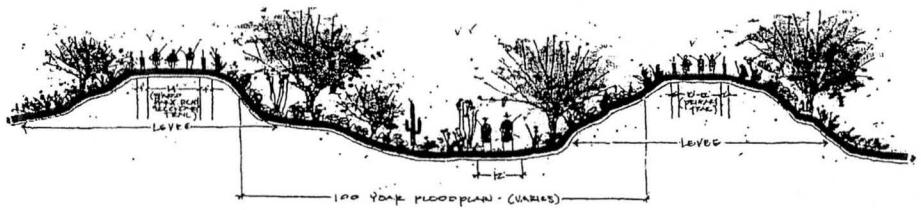
- Long-term plans of current sand and gravel operations is to restore the disturbed landscape and provide for parallel primary trail shared use/maintenance road improvements along the west bank. A series of neighborhood connector trails are also proposed for the west bank, once current sand and gravel operations are discontinued.
- An equestrian route located in the channel will provide continuous facilities for equestrian needs along the Lower Agua Fria River.
- Secondary trail facilities located on the east bank, will be developed throughout trail segment S-14 to accommodate pedestrians and bicyclists in the area. This trail type will be shared with the Flood Control District of Maricopa County (FCDMC) maintenance road.
- Re-vegetation and riverbank reconstruction efforts designed to conserve the natural attributes of the Corridor should be a primary consideration along both banks of the Lower Agua Fria River.
- Provide future neighborhood access to the primary trail system for residential areas west of the Lower Agua Fria River. Existing and planned neighborhood on-street bike routes and side paths within the neighborhoods should be connected to the primary trail to encourage interconnections and avoidance of higher traffic volume streets.
- Retrofitting existing bridge structures to include underpass crossings at McDowell Road and Interstate 10 will increase safety for trail users and provide uninterrupted flows on the trail system. Any future plans for a bridge at Thomas Road should also include an underpass.
- A primary trail bridge structure is required on the west bank south of Indian School Road to link the primary trail from north to south.
- Existing soil cement bank protected areas will require modification at Indian School Road, McDowell Road and I-10 bridge structures for proposed new underpass facilities.
- Key sites along the Lower Agua Fria River include the "Chicken Ranch" and Coldwater Springs.



MAP 22. TRAIL SEGMENT S-14 (NORTHERN REACH)

- PRIMARY TRAIL
- SECONDARY TRAIL
- NEIGHBORHOOD/TRANSIT CONNECTOR TRAIL
- CONSERVATION/INTERPRETIVE TRAIL
- EQUESTRIAN CORRIDOR
- ALTERNATE TRAIL ROUTE 'B'
- MAINTENANCE ROAD/PRIMARY TRAIL
- STUDY AREA BOUNDARY
- 100 YEAR FLOODPLAIN
- GATEWAY
- PRIMARY STAGING AREA/GATEWAY
- SECONDARY STAGING AREA
- TRAIL CONNECTION
- RIVERBED ACCESS RAMP
- FUTURE ROADWAY BRIDGE
- PREFABRICATED PEDESTRIAN BRIDGE
- TRANSIT CONNECTION NODE
- TRAIL UNDERPASS IMPROVEMENTS
- AT-GRADE PRIMARY TRAIL CROSSING

Trail Type	Width (Feet)	Distance (Linear Feet)	Distance (in Miles)	Material
Primary Trail	10-12	46,835	8.9	asphalt/concrete
Secondary Trail	8-10	15,717	3.0	decomposed granite
Neighborhood/Transit/Connector	8-10	19,709	3.7	asphalt/concrete
Conservation/Interpretive Trail	4-6	0	0.0	decomposed granite
Equestrian Corridor	4-6	33,233	6.3	sand/gravel



RIVER CHANNEL CROSS SECTION

Trail Amenities	Symbol	Quantity
Gateway		5
Primary Staging Area/Gateway		0
Secondary Staging Area		1
Trail Connection		5
Riverbed Access Ramp		2
Future Roadway Bridge		0
Prefabricated Pedestrian Bridge		0
Transit Connection Node		3
Trail Underpass Improvements		3
At-Grade Primary Trail Crossing		0

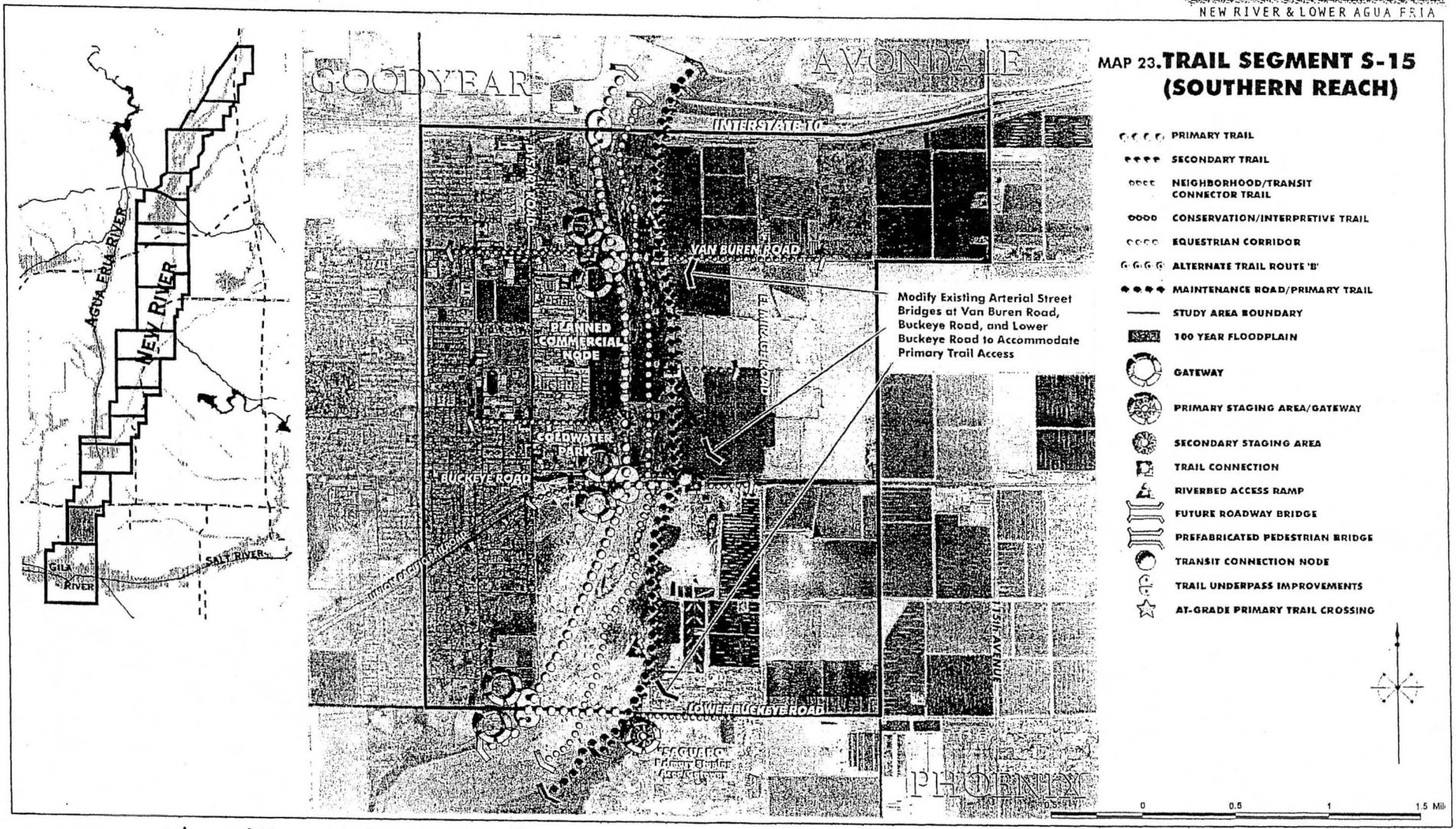
TRAIL SEGMENT S-15

I-10 to Lower Buckeye Road

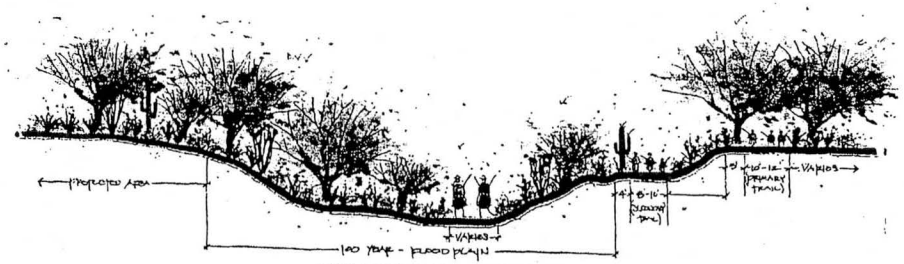
Affected Jurisdictions: Avondale, Arizona Department of Transportation (ADOT), Flood Control District of Maricopa County (FCDMC), Union Pacific Railroad

Design Considerations:

- Primary trail shared-use with the FCDMC maintenance road to be located on the west bank. An equestrian route located in the channel will provide continuous facilities for equestrian needs.
- Integrate urban plaza linkages to primary and public activity areas at future commercial core area planned between Van Buren and Buckeye Roads, on the west bank of the Lower Agua Fria River.
- Secondary trail facilities located adjacent to the primary trail, will be developed from I-10 to Van Buren Road to accommodate pedestrians and bicyclists in the area.
- Re-vegetation and riverbank reconstruction efforts designed to conserve the natural attributes of the Corridor should be a primary consideration along both banks of the Lower Agua Fria River. A dedicated trail easement of 50-150 feet should be established to protect and preserve the Lower Agua Fria River Corridor.
- Provide future neighborhood access to the primary trail system for those residential areas located south of New River Dam. Existing neighborhood on-street bike routes and side paths within the neighborhoods should be connected to the primary trail to encourage interconnections and avoidance of higher traffic volume street area.
- Retrofitting existing bridge structures into below-grade crossings at I-10, Van Buren Road, Buckeye Road and the Union Pacific Railroad will increase safety for trail users and provide uninterrupted flows on the trail system.
- Modify existing arterial bridge structures at Van Buren Road, Buckeye and Lower Buckeye Roads, and the Union Pacific Railroad to accommodate bicycle/pedestrian primary trails and link existing and future neighborhoods to the primary trails on both sides of the Lower Agua Fria River.
- Existing soil cement bank protected areas will require modification at I-10, Van Buren Road, Buckeye Road, and the Union Pacific Railroad bridge structures for proposed new underpasses.


GOODYEAR
AVONDALE
PHOENIX
INTERSTATE 10
VAN BUREN ROAD
BUCKEYE ROAD
LOWER BUCKEYE ROAD
PLANNED COMMERCIAL NODE
COLDWATER PARK
EL MIRAGE ROAD
175TH AVENUE
AGUA FRIA RIVER
NEW RIVER
GILA RIVER
SALT RIVER
Modify Existing Arterial Street Bridges at Van Buren Road, Buckeye Road, and Lower Buckeye Road to Accommodate Primary Trail Access
MAP 23. TRAIL SEGMENT S-15 (SOUTHERN REACH)
PRIMARY TRAIL
SECONDARY TRAIL
NEIGHBORHOOD/TRANSIT CONNECTOR TRAIL
CONSERVATION/INTERPRETIVE TRAIL
EQUESTRIAN CORRIDOR
ALTERNATE TRAIL ROUTE 'B'
MAINTENANCE ROAD/PRIMARY TRAIL
STUDY AREA BOUNDARY
100 YEAR FLOODPLAIN
GATEWAY
PRIMARY STAGING AREA/GATEWAY
SECONDARY STAGING AREA
TRAIL CONNECTION
RIVERBED ACCESS RAMP
FUTURE ROADWAY BRIDGE
PREFABRICATED PEDESTRIAN BRIDGE
TRANSIT CONNECTION NODE
TRAIL UNDERPASS IMPROVEMENTS
AT-GRADE PRIMARY TRAIL CROSSING
0
0.5
1
1.5 Mile

Trail Type	Width (Feet)	Distance (Linear Feet)	Distance (in Miles)	Material
Primary Trail	10-12	76,257	14.4	asphalt/concrete
Secondary Trail	8-10	50,979	9.7	decomposed granite
Neighborhood/Transit/Connector	8-10	0	0.0	asphalt/concrete
Conservation/Interpretive Trail	4-6	0	0.0	decomposed granite
Equestrian Corridor	4-6	27,894	5.3	sand/gravel



RIVER CHANNEL CROSS SECTION

Trail Amenities	Symbol	Quantity
Gateway		7
Primary Staging Area/Gateway		2
Secondary Staging Area		0
Trail Connection		2
Riverbed Access Ramp		0
Future Roadway Bridge		0
Prefabricated Pedestrian Bridge		1
Transit Connection Node		0
Trail Underpass Improvements		0
At-Grade Primary Trail Crossing		0

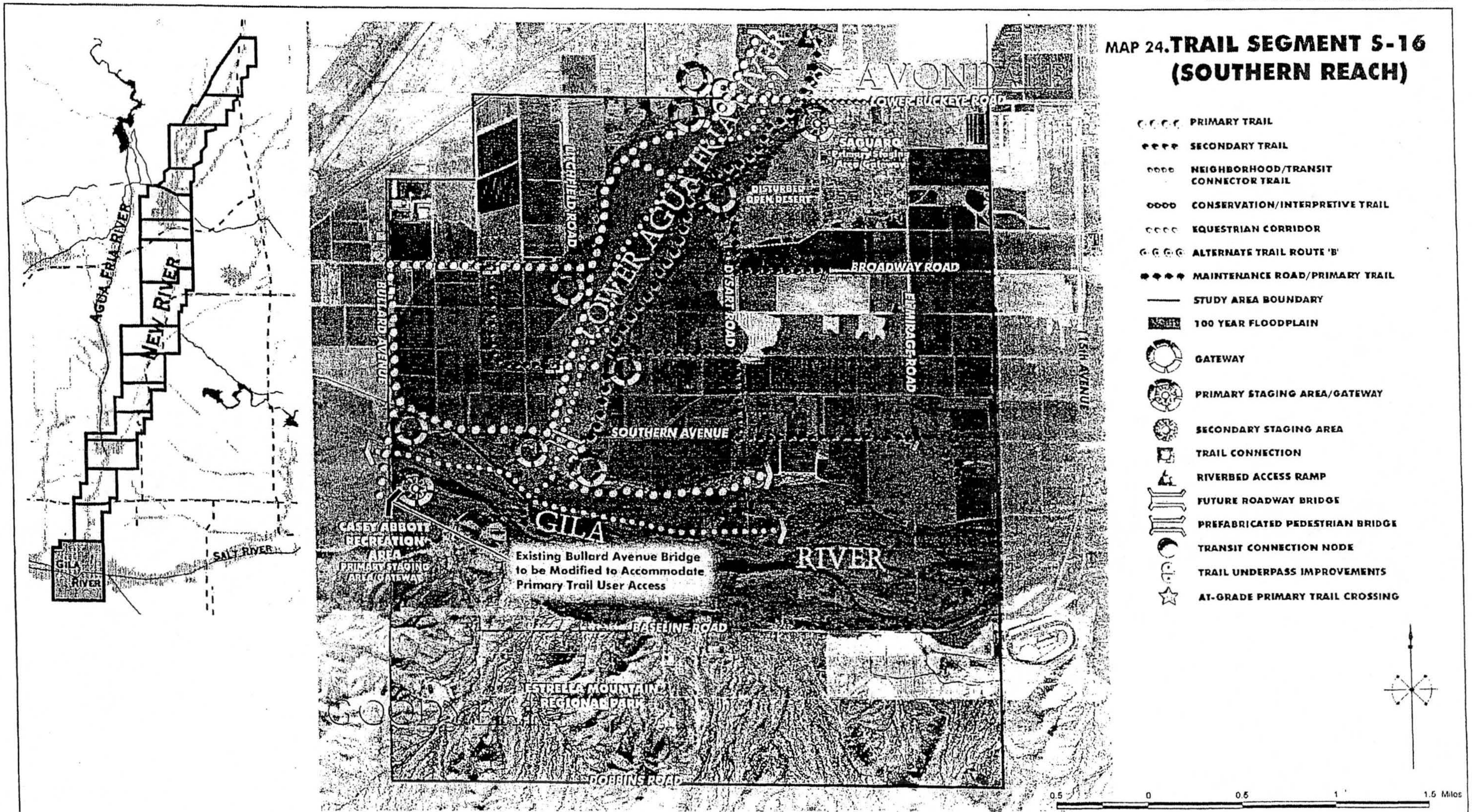
TRAIL SEGMENT S-16

Lower Buckeye Road to Dobbins Road/Gila River Confluence

Affected Jurisdictions: Avondale, Maricopa County

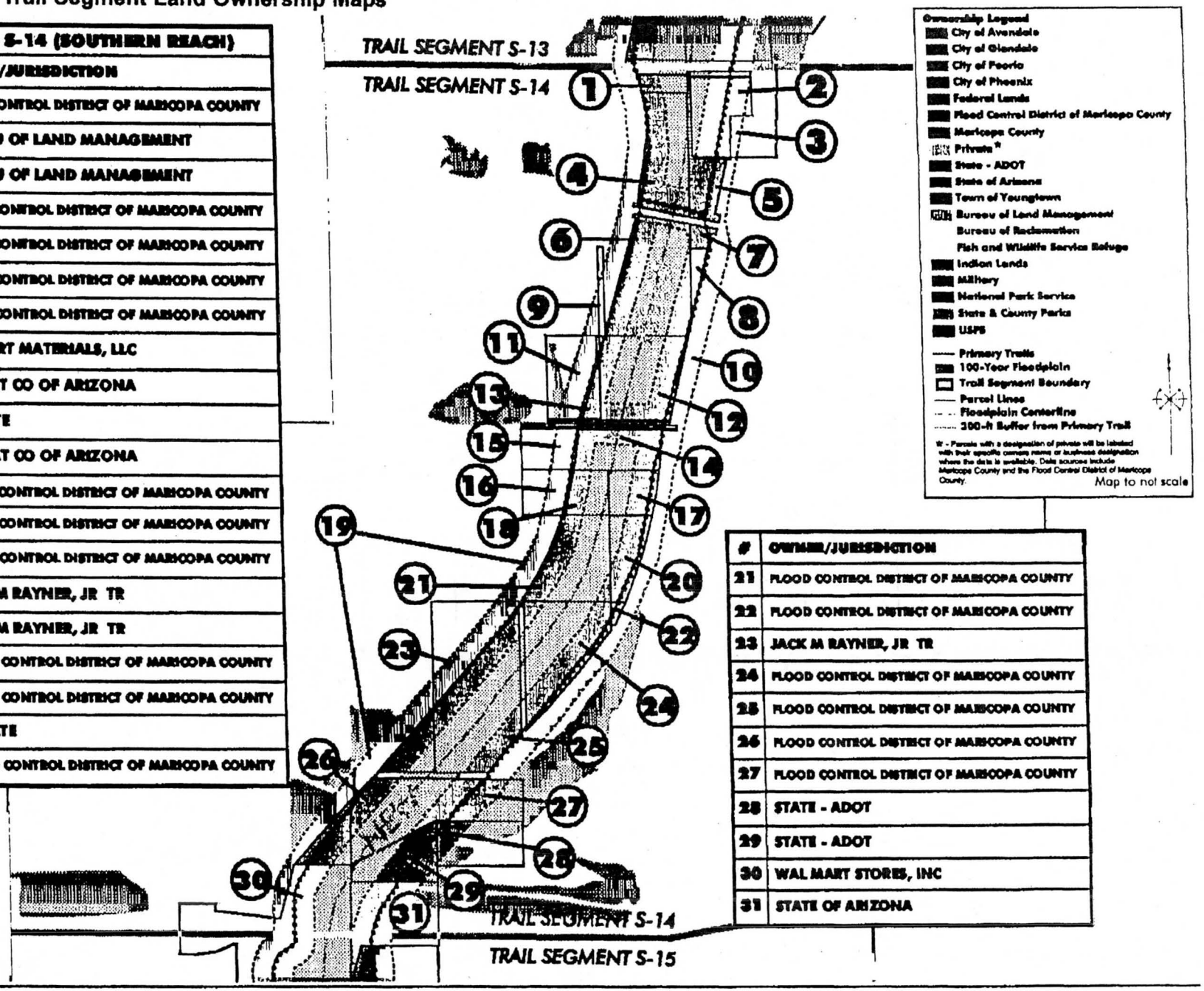
Design Considerations:

- An equestrian route located in the channel will provide continuous facilities for equestrian needs.
- Re-vegetation and riverbank reconstruction efforts designed to conserve the natural attributes of the Corridor should be a primary consideration along both banks of the New River. Before further development continues in this area a dedicated set aside or easement should be established to protect and preserve the West Valley Multi-Modal Transportation Corridor. Primary, secondary and conservation/interpretive trails throughout this area should serve to protect the existing natural desert as much as possible.
- Retrofitting existing bridge structure into below-grade crossings at Lower Buckeye Road will increase safety for trail users and provide uninterrupted flows on the trail system.
- The Casey-Abbott Recreation Area and Estrella Mountain Regional Park offer significant recreational opportunities. Primary trail access to these recreational destinations will be critical.
- Existing soil cement bank protected areas will require modification at Lower Buckeye Road bridge structure for proposed new underpass facilities.
- New landscape plantings along the bank areas will provide a restored desert habitat. New reclaimed water lines will then be required to support landscape improvements along the trail facilities.
- A primary trail is located along both banks of the New River to allow linkages to the trail systems in both the West Valley Multi-Modal Transportation Corridor Master Plan and the Agua Fria River Watercourse Master Plan. Right-of-way access along this trail segment is primarily ownership of the Flood Control District of Maricopa County (FCDMC).
- Secondary trail access into planned and existing neighborhoods to link the Lower Agua Fria River Corridor will require coordination between local city jurisdictions, developers, and neighborhood associations along the West Valley Recreation Corridor.
- Bullard Avenue bridge to be modified to accommodate primary trail access to the planned Casey-Abbott Recreation Area –primary staging area/gateway.

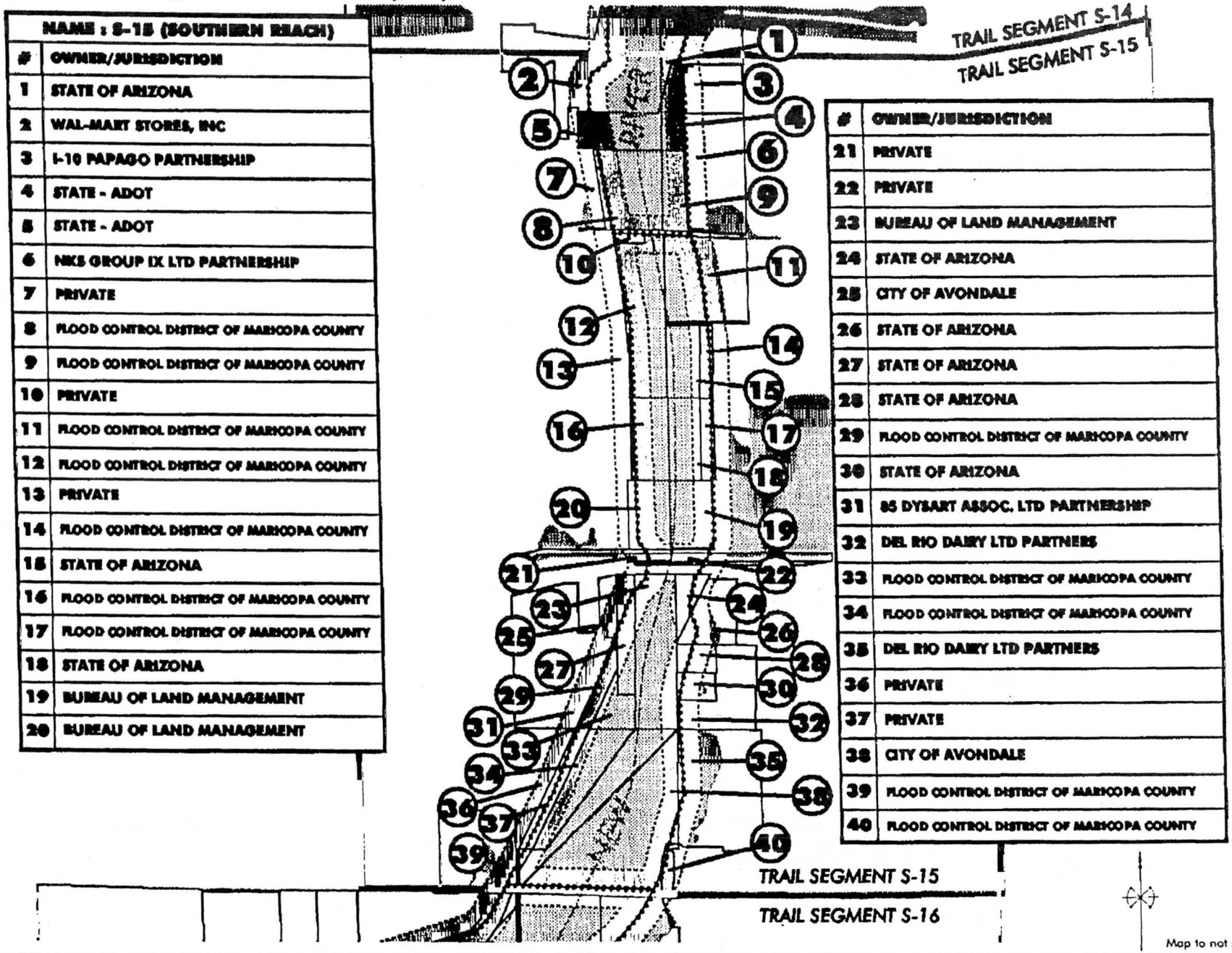

AGUA FRIA RIVER
NEW RIVER
GILA RIVER
SALT RIVER
AVONDALE
LOWER BUCKEYE ROAD
SAGUARO
Primary Staging Area/Gateway
DISTURBED OPEN DESERT
LITCHFIELD ROAD
LOWER AGUA FRIA
BROADWAY ROAD
BULLARD AVENUE
DYSART ROAD
EL MIRAGE ROAD
115TH AVENUE
SOUTHERN AVENUE
CASEY ABBOTT RECREATION AREA
PRIMARY STAGING AREA/GATEWAY
GILA
RIVER
Existing Bullard Avenue Bridge to be Modified to Accommodate Primary Trail User Access
BASELINE ROAD
ESTRELLA MOUNTAIN REGIONAL PARK
GOODYEAR
DOBBINS ROAD
MAP 24. TRAIL SEGMENT S-16 (SOUTHERN REACH)
PRIMARY TRAIL
SECONDARY TRAIL
NEIGHBORHOOD/TRANSIT CONNECTOR TRAIL
CONSERVATION/INTERPRETIVE TRAIL
EQUESTRIAN CORRIDOR
ALTERNATE TRAIL ROUTE 'B'
MAINTENANCE ROAD/PRIMARY TRAIL
STUDY AREA BOUNDARY
100 YEAR FLOODPLAIN
GATEWAY
PRIMARY STAGING AREA/GATEWAY
SECONDARY STAGING AREA
TRAIL CONNECTION
RIVERBED ACCESS RAMP
FUTURE ROADWAY BRIDGE
PREFABRICATED PEDESTRIAN BRIDGE
TRANSIT CONNECTION NODE
TRAIL UNDERPASS IMPROVEMENTS
AT-GRADE PRIMARY TRAIL CROSSING
0.5
0
0.5
1
1.5 Miles

G.2 Land Ownership of Southern Trail Segments in Restoration Area

NAME : S-14 (SOUTHERN REACH)	
#	OWNER/JURISDICTION
1	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
2	BUREAU OF LAND MANAGEMENT
3	BUREAU OF LAND MANAGEMENT
4	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
5	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
6	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
7	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
8	STEWART MATERIALS, LLC
9	CALMAT CO OF ARIZONA
10	PRIVATE
11	CALMAT CO OF ARIZONA
12	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
13	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
14	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
15	JACK M RAYNER, JR TR
16	JACK M RAYNER, JR TR
17	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
18	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
19	PRIVATE
20	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY



#	OWNER/JURISDICTION
21	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
22	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
23	JACK M RAYNER, JR TR
24	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
25	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
26	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
27	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
28	STATE - ADOT
29	STATE - ADOT
30	WAL MART STORES, INC
31	STATE OF ARIZONA

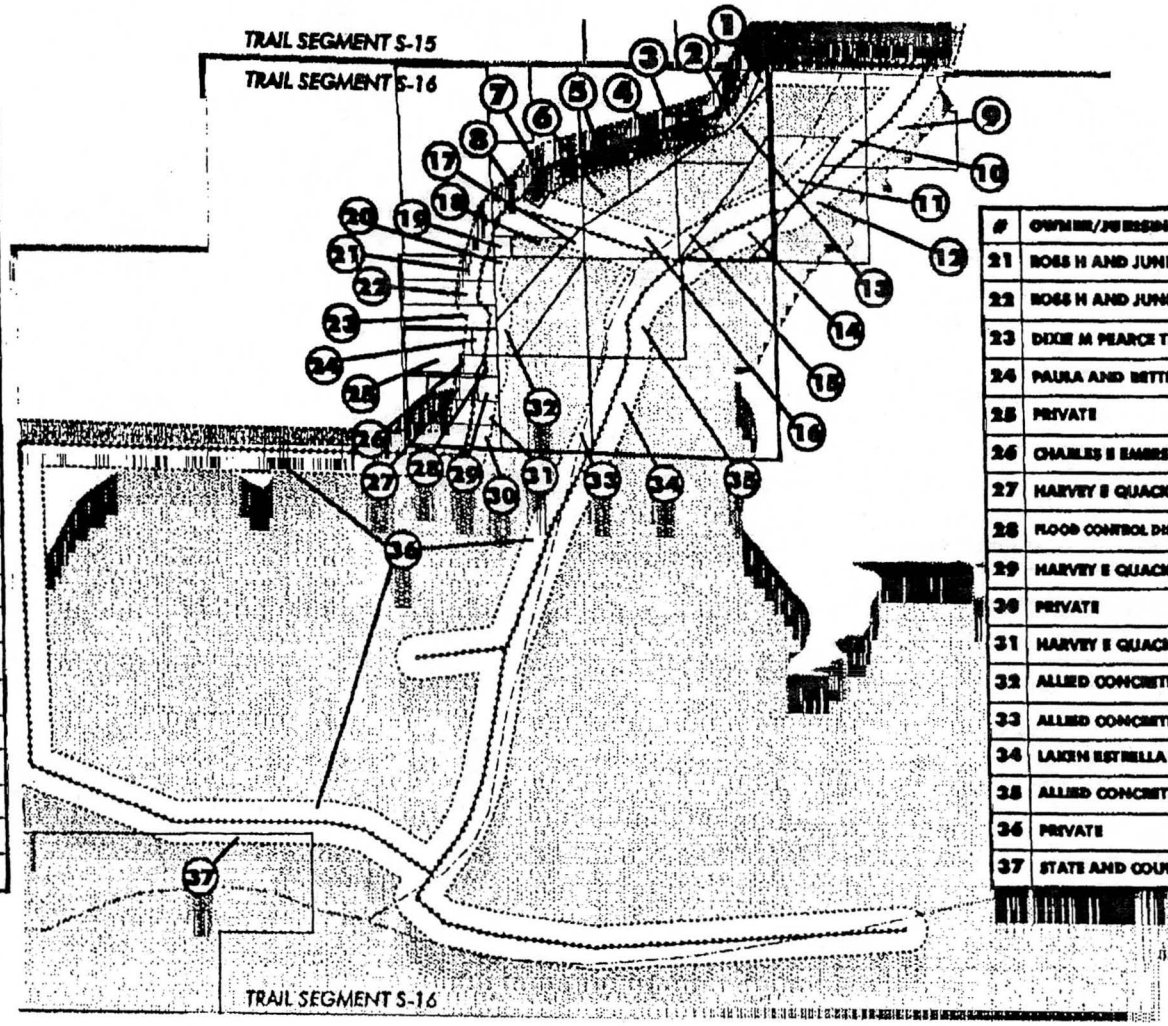


NAME : S-15 (SOUTHERN REACH)	
#	OWNER/JURISDICTION
1	STATE OF ARIZONA
2	WAL-MART STORES, INC
3	I-10 PAPAGO PARTNERSHIP
4	STATE - ADOT
5	STATE - ADOT
6	NKS GROUP IX LTD PARTNERSHIP
7	PRIVATE
8	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
9	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
10	PRIVATE
11	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
12	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
13	PRIVATE
14	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
15	STATE OF ARIZONA
16	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
17	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
18	STATE OF ARIZONA
19	BUREAU OF LAND MANAGEMENT
20	BUREAU OF LAND MANAGEMENT

#	OWNER/JURISDICTION
21	PRIVATE
22	PRIVATE
23	BUREAU OF LAND MANAGEMENT
24	STATE OF ARIZONA
25	CITY OF AVONDALE
26	STATE OF ARIZONA
27	STATE OF ARIZONA
28	STATE OF ARIZONA
29	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
30	STATE OF ARIZONA
31	85 DYSART ASSOC. LTD PARTNERSHIP
32	DEL RIO DAIRY LTD PARTNERS
33	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
34	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
35	DEL RIO DAIRY LTD PARTNERS
36	PRIVATE
37	PRIVATE
38	CITY OF AVONDALE
39	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
40	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

Appendix B: Trail Segment Land Ownership Maps

NAME : S-16 (SOUTHERN REACH)	
#	OWNER/JURISDICTION
1	VALLEY NATIONAL BANK
2	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
3	PRIVATE
4	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
5	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
6	EAGLE TAIL LAND DEVELOPMENT LTD
7	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
8	EAGLE TAIL LAND DEVELOPMENT LTD
9	ALLIED CONCRETE, INC (STEWART TITLE)
10	ALLIED CONCRETE, INC (STEWART TITLE)
11	ALLIED CONCRETE, INC (STEWART TITLE)
12	ALLIED CONCRETE, INC (STEWART TITLE)
13	ALLIED CONCRETE, INC (STEWART TITLE)
14	ALLIED CONCRETE, INC (STEWART TITLE)
15	ALLIED CONCRETE, INC (STEWART TITLE)
16	ALLIED CONCRETE, INC (STEWART TITLE)
17	STEWART TITLE
18	CITY OF AVONDALE
19	PRIVATE
20	CITY OF AVONDALE



#	OWNER/JURISDICTION
21	ROSS H AND JUNE LAGERSCHULTE
22	ROSS H AND JUNE LAGERSCHULTE
23	DIXIE M PEARCE TR
24	PAULA AND BETTIE M BELL
25	PRIVATE
26	CHARLES E EMERSON
27	HARVEY E QUACKENBUSH III
28	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
29	HARVEY E QUACKENBUSH III
30	PRIVATE
31	HARVEY E QUACKENBUSH III
32	ALLIED CONCRETE, INC (STEWART TITLE)
33	ALLIED CONCRETE, INC (STEWART TITLE)
34	LAKEN ESTRELLA RANCH LTD PARTNERSHIP
35	ALLIED CONCRETE, INC (STEWART TITLE)
36	PRIVATE
37	STATE AND COUNTY PARKS

Map to not scale

APPENDIX H.

REAL ESTATE ANALYSIS

July 2003

Real Estate Appendix
Agua Fria Riparian Restoration Project

1. Abstract of Project Data:

Project Name: Agua Fria Environmental Restoration Project

Location: Maricopa County, Arizona

Project Purposes: Environmental Restoration

Acreage: 114.7

Project Sponsor: Maricopa County Flood Control District

2. Introduction and Purpose:

This is a project modification to the Aqua Fria Flood Control Project. The Maricopa County Flood Control District sponsored that project. The Corps' objectives in the proposed Section 1135 project are aimed at environmental restoration through modification and replacement of riparian habitat and vegetation communities. The recommended plan for implementation is known as "alternative 8" which derives from analysis and comparisons of a number of alternatives. This plan involves habitat modifications to relatively small areas within the historic river channel and floodplain areas. The upstream area is near the Interstate 10 Bridge overpass and another segment lies downstream near the Avondale Wastewater treatment Plant. The riparian areas selected to receive modifications are within the channel and project areas of the existing flood control project operated by the Maricopa Flood Control District. There are no separable recreation lands. Since this is a small and uncomplicated Continuing Authorities Project, the treatment and level of detail presented here is commensurate with the scale and scope of the project.

3. Authority:

The Corps of Engineers has ample authority to conduct the study. Legal authority for this project is contained in Section 1135 of the Water Resources Development Act 0f 1986. The intent of such projects is the restoration of the environment, addressing impacts attributed to previous Corps of Engineers civil works projects, which may have disturbed or negatively impacted the natural environment or ecosystems.

4. Purpose of this Report:

This report is submitted as the Real Estate Plan to support the decision to authorize the

project under Section 1135 of the Continuing Authorities Program.

5. Crediting for LERRDs and LERRD Estimate:

This is a Continuing Authorities project with some of the lands within the project footprint of a previous civil works project. The Maricopa County Flood Control District obtained flood control easements to construct and operate the levees and conduct floodwaters through the channel. In some of the restoration areas, the Flood Control District may need to consolidate and acquire the underlying fee simple title for the purposes of the environmental restoration project. The upstream restoration area near Interstate 10 is within the bridge crossing and right-of-way owned by the Arizona Department of Transportation. To establish riparian vegetation and irrigation systems etc., in the corridor of the right-of-way beneath the bridge, the sponsor can acquire a right-of-way use permit from ADOT. Since the right-of-way is owned by a public agency and supports a permanent feature - an Interstate Highway - there is no risk of the underlying fee being alienated for any other purpose or use. A use permit can be obtained by public agencies to cross and utilize the existing public right-of-way and this action should entail only an administrative cost to issue the use permit.

Current policy for environmental restoration projects allows for the use of an informal value estimate in lieu of a full appraisal for the purposes of planning real estate costs, otherwise known as Lands, Easements Rights-of-Way, Relocations and Disposal Areas or "LERRDS". A detailed appraisal is no longer needed for Continuing Authorities Projects. Based on other environmental restoration projects in Maricopa County, other similar land appraisals and acquisition experience by local sponsors, land within designated floodplains and floodways and within river channels typically ranges between $10,000 and $20,000 per acre. For purposes of estimating, plan formulation and economics only, the informal value estimate for the Agua Fria River lands is $20,000 per acre, typical.

Thus the estimate for Alternative 8, 114.7 acres @ $20,000 = $2,294,000.

Actual "LERRD" crediting will be based on acquisition and crediting appraisals submitted by the sponsor and approved by the Corps during crediting for a constructed project, should the project proceed. Actual approved credits can vary from the planning estimate. For example the ADOT right-of-way could be acquired by the recommended use permit for only a nominal administrative cost. This estimate is only provided to support the economics and plan formulation estimates prior to project authorization and is not intended to estimate or predict actual LERRD credit that is computed after the project is implemented.

It is further noted that ER-405-1-12, Paragraph 4-35 c., dictates that credit may not be afforded for lands or interests previously provided as an item of local cooperation for another civil works project. In this case, this policy would apply to the lands or easements that were utilized for the completed Agua Fria Flood Control Project. On some lands, the value of the existing flood control easement, that is the extent to which

these lands are restricted and encumbered, may have to be considered in appraising the actual acquisition costs of these Lands and eventual LERRD credit. Since this is an appraisal exercise this would be computed and judged at the time of the actual acquisition appraisals.

6. Land Use and Acreage Allocations:

The selected alternative includes approximately 114.7 acres of riparian and channel lands all within the levee and previous project footprint. The area includes riverbed and channel areas occupied by the Aqua Fria River. This acreage is allocated and is to be used for the purpose of environmental restoration.

7. Federal Lands, Interests or Reservations:

There are no federally owned lands within the study area. Federal regulatory power is exercised over these lands to the extent of the jurisdiction, authorities and governing regulations of the Corps and EPA in administering the Clean Water Act and other environmental and floodplain laws and regulations.

8. Navigational Servitude:

The Aqua Fria River is non-navigable. It is an ephemeral wash and receives hydrologic inputs only during episodic events, storms, monsoons or similar events or weather systems visited upon the Sonoran Desert of Central Arizona. The river is considered non-navigable and not subject to the navigation servitude doctrine.

9. Description of Lands:

These lands all lie inside the existing riverbed and levee footprint. These are all unimproved riverbed lands, vacant and undeveloped. Due to the floodplain, wetland and floodway influences on this riverbed land, there is no potential use for improvement or development that could make use of this property.

10. Project Areas of Selected Plan:

The selected or recommended plan includes 177.5 acres. This land will be acquired in fee simple title for environmental restoration. The project area includes the area needed for construction and construction access and such areas will support a dual role in being part of the overall restoration areas along the river corridor.

11. Project Maps:

Project maps are included in the main body of the Feasibility Report.

12. Crediting for LERRD's and Special Issues:

Thus crediting is expected to follow normal procedures and will be governed by a standard model PCA. There are no extraordinary or special issues affecting these project lands or the project formulation.

13. Facility Relocations:

Public facilities or utilities and crossings in the project area will be allowed to remain in place and the project will work around such installations. Since the project objective is for environmental restoration, design and formulation is aimed at maximizing environmental outputs and therefore costs associated with relocations of existing utilities have been avoided as a deliberate planning decision in plan formulation.

No facility relocations will be required and such public utilities and crossings, if any, will be allowed to remain in place rather than be removed altered or relocated.

Note: This is a required explanatory note and disclaimer concerning the description of relocations in project feasibility reports. The following policy statement and disclaimer concerning any potential facility relocations prevails over any other statement, description or presentation in this report. Any conclusion or categorization contained in this report that an item is a utility or facility relocation to be performed by the Non Federal Sponsor as part of its LERRD responsibilities is preliminary only. The Government will make a final determination of the relocations necessary for the construction, operation and maintenance of the project after further analysis.

An Attorney's Opinion of Compensability will be generated for each facility/utility relocation and that is required for the project and which will be performed by, and credited to, the Local Sponsor under the definitions and terms of the PCA.

14. Mineral Activity:

There is no known mineral activity currently occurring inside the selected project areas. There are signs of previous common materials extraction, i.e. sand and gravel, inside and along the riverbed and on adjacent areas along the Agua Fria corridor. These activities are regulated both by the Clean Water Act and local floodplain use regulations.

15. Estates:

The recommended estates for environmental restoration are fee simple title. Fee will be acquired as the standard project estate in all areas where permanent environmental restoration features are to be located. This is the prescribed standard estate for environmental restoration projects.

16. Construction Induced Flooding:

There will be no construction induced flooding.

17. Relocation Assistance (URA Relocations):

The property is unimproved. Thus no URA business or residential relocations are involved in this project.

18. Other Matters:

No timber activity affects these lands. The sponsor is not using any zoning ordinances in lieu of acquisitions of lands within the project take areas.

19. Hazardous Waste Assessments:

The sponsor fully understands its responsibilities for assessing the properties for any potential or presence of hazardous waste materials as defined and regulated under CERCLA. There are no known "Superfund" sites or sites presently under CERCLA remediation or response orders identified in the project area. There is no known presence of any substances in the project area that are regulated under CERCLA or other environmental statutes or regulations. Assessments and site investigations for the presence of such substances have not been conducted to date. The LERRD estimate (i.e. Gross appraisal) is predicated on the assumption that all lands and properties are clean and require no remediation. The model PCA conditions shall be followed in assigning responsibility and cost allocation for such matters.

20. Recreation Land:

There is no identified separable land. That is, land acquired exclusively for recreation purposes for this project. All lands are allocated for the project purpose of environmental restoration. Separable recreation land means land purchased above and beyond the footprint required for the main project purpose and used exclusively for a recreational purpose.

21. Attitude of Landowners:

There is no focused or organized landowner opposition to the project. There is no indication of any unusual or extraordinary landowner issues on this particular project.

22. Report Content:

This report follows the prescribed content for Real Estate Planning Reports in ER405-1-12, Chapter 12, and incorporates the results of the various reviews and responses to

comments where appropriate. The report is based on the information that is available on

the project formulation and recommended plan at that time it was prepared and dated.

APPENDIX I.

HYDROLOGY, HYDRAULICS, AND ENGINEERING ANALYSIS

I.1 HYDRAULIC RESULTS FOR ALTERNATIVES 2 THROUGH 4

I.2 HYDRAULIC RESULTS FOR ALTERNATIVE 8 (RECOMMENDED PLAN)

I.3 GRAPHICS FOR HYDRAULIC ANALYSIS OF ALTERNATIVE 8 (RECOMMENDED PLAN)

I.4 SINGLE EVENT SCOUR ANALYSIS FOR ALTERNATIVE 8 (RECOMMENDED PLAN)

I.5 DETERMINATION OF DOMINANT DISCHARGE

1. INTRODUCTION

This appendix summarizes the baseline hydrologic conditions and the hydraulic design and analysis of the alternatives proposed for the Agua Fria Section 1135 Ecosystem Restoration Project. Depending on the alternative, the project involves the environmental restoration of up to 350 acres of riparian habitat to the degraded ecosystem along portions of a 5.5-mile reach at the south-end of the Agua Fria River. The scope of this Detailed Project Report consists of evaluating potential restoration alternatives in order to restore habitat conditions that would support an increased diversity of wildlife and provide linkages with existing riparian habitat downstream of the project site.

The proposed modifications consist of creating low bank terraces along portions of the river. These terraces would be planted with hydroriparian and mesoriparian vegetation supported by streamcourses fed by wells. Management measures would also be implemented to remove and control exotic vegetation in existing and proposed vegetated areas.

The purpose of the Agua Fria River Restoration hydraulic analysis was to understand and quantify the hydraulic impacts of the proposed ecosystem restoration. Any proposed river restoration changes will require the maintenance of the minimum freeboard of three feet at the levees. The increased scour potential at any of the bridge structures due to changing hydraulic parameters must also be minimized. Another purpose of the hydraulic analysis was to determine the necessary toe down depth for the bank protection that will be placed to anchor the toe of the fill material used for addition of the riparian vegetation.

The hydraulic analysis was completed in two parts coincident with the development of alternatives: Section 4 provides the analysis for Alternatives 2 to 7; and Section 5 provides the analysis for Alternative 8, which was defined later. Some information in Section 4 is repeated in Section 5; however, the reports are maintained separately because more detail is provided in the second report.

2. FUTURE WITHOUT-PROJECT CONDITIONS

Future uses of treated effluent from the Avondale Wastewater Treatment Plant will remove a significant water source that currently supports habitat in the southernmost portion of the study area. Without this water, most of this habitat will probably be lost. Channel disturbances due to maintenance and construction will favor the establishment of non-native species. Barring further levee construction, there is anticipated to be no major changes to the channel configuration.

3. ANALYSIS OF ALTERNATIVES

3.1 ALTERNATIVE 1 – NO ACTION

Under this alternative, no restoration project would be undertaken. Existing and future without-project conditions will prevail.

3.2 ALTERNATIVE 2 – LOW WATER USE

Alternative 2 (Figures I-1, I-4, I-6) has the same features as Alternative 4, except for the following:

- No water will be released into vegetation management areas
- Approximately two wells feed habitat areas
- There are no habitat areas downstream of Buckeye Road
- Approximately 112,008 cubic yards of fine materials defined as silty loam will be needed
- Approximately 168,012 cubic yards of coarser material defined as gravels with fines or sands with fines will be needed
- Approximately 3,639 and 4,525 cubic yards of fine and coarse material, respectively will be needed for the side channels along the eastern riparian strip
- Approximately 52,915 cubic yards of material will be needed to construct the terrace bank armor along the riparian strips
- Water use for this alternative is estimated at 1.1 million gallons per day (mGPD) average (Table I-1).

Table I-1 Alternative 2 Water Use

		Water Usage (ET & Infilt.)			
Habitat Type	Area (ac.)	Ac. Ft./year/ac	Total ac. Ft./yr	mGPD	GPM *
Riparian Strip - Xeric riparian	15.8	16.3	257.5	0.2	159.7
Riparian Strip - Mesic riparian	12.3	18.4	226.3	0.2	140.3
Riparian Strip – Hydric riparian	22.5	20.6	463.5	0.4	287.4
Riparian Strip – Channel	4.4	20.1	88.4	0.1	54.8
Vegetation Management Areas (all habitat types) [2]	0.0	18.4	0.0	0.0	0.0
Construction Areas (reseeded to native xeric riparian vegetation) [1] [2]	17.1	16.3	278.7	0.2	172.8
* GPM = gallons per minute.		108	1314.4	1.1	815

Note:
Area disturbed by construction of terrace bank armor is sparsely vegetated or unvegetated and is included in the total restored acreage.
Water use for vegetation management areas is similar to mesic vegetation; for construction areas it is based on average rainfall in area of 8 inches/year (http://www.worldclimate.com)
Water usage is based on an infiltration rate of 0.02 inches per hour.
Water usage in Vegetation Management Areas is similar to mesic riparian.

3.3 ALTERNATIVE 3 – MEDIUM WATER USE

Alternative 3 (Figures I-2, I-4, I-6, I-7) has the same features as Alternative 4, except for the following:

- No water will be released into vegetation management areas
- Approximately three wells feed habitat areas
- There are no habitat areas between Buckeye Road and Lower Buckeye Road
- The habitat area downstream of Lower Buckeye Road is reduced to approximately 18 acres
- Approximately 125,704 cubic yards of fine materials defined as silty loam will be needed

- Approximately 188,556 cubic yards of coarser material defined as gravels with fines or sands with fines will be needed
- Approximately 5,252 and 6,532 cubic yards, respectively of fine and coarse material will be needed for the side channels along the eastern riparian strip
- Approximately 62,585 cubic yards of material will be needed to construct the terrace bank armor along the riparian strips
- Water use for this alternative is estimated at 1.5 mGPD average (Table I-2).

Table I-2 Alternative 3 Water Use

		Water Usage (ET & Infilt.)			
Habitat Type	Area (ac.)	Ac. Ft./ year/ac	Total ac. Ft./yr	mGPD	GPM
Riparian Strip - Xeric riparian	15.8	16.3	257.5	0.2	159.7
Riparian Strip - Mesic riparian	23.6	18.4	434.2	0.4	269.2
Riparian Strip - Hydric riparian	27.6	20.6	568.6	0.5	352.5
Riparian Strip – Channel	6.6	20.1	132.7	0.1	82.3
Vegetation Management Areas (all habitat types) [2]	0.0	18.4	0.0	0.0	0.0
Construction Areas (reseeded to native xeric riparian vegetation) [1] [2]	20.2	16.3	329.3	0.3	204.2
		108	1722.3	1.5	1067.9

3.4 ALTERNATIVE 4 – HIGH WATER USE

Basic Concept

This alternative extends the restoration effort along the greatest length of the 5.5-mile project reach and occupies the greatest total area without affecting the SPF condition (Figure I-3). Habitat would be supported by approximately five wells located throughout the project reach as well as both temporary and permanent irrigation. The configuration consists of a riparian strip along various segments of the eastern side of the channel totaling 18,690 feet. The strip varies in width from 100 to 600 feet, with an average width of 310 feet. Within the riparian strip there are one to two slightly meandering channels. These habitat areas are protected from frequent flow events by a soil-cement bank extending approximately two feet above grade, covered with a gabion-protected berm extending approximately two more feet (Figures I-4, I-5, I-6, I-8). The soil cement will extend below grade to a depth of approximately 10 feet to protect it from scour from up to a 10-year event. Frequent flows of up to 10- to 15-year events will be partially excluded from the riparian strip to reduce the chances of significant losses; however, larger flows will still pass over and through the habitat areas.

Along the west side of the channel from approximately McDowell Road to the second grade control structure between Van Buren Street and Buckeye Road for 8,773 feet, the interior slopes of the levee will be filled with varying slope averaging approximately 4:1. This strip of vegetation on the west side would also be protected by soil cement bank protection as described above.

Pumped groundwater may be directed, on a seasonal basis, to areas in undisturbed portions of the channel. Under this high water-use alternative, there would be no change to the input of 3.5 mGPD of

effluent from the AWWTP. It is assumed that this will cover the portion of water needs for the AWWTP site.

Water needs for this alternative are estimated to average approximately 5.2 mGPD (Table I-3). This will vary throughout the year to accommodate different vegetation types and mimic the seasonality of natural flows in the area.

Table I-3 Alternative 4 Water Use

		Water Usage (ET & Infilt.)			
Habitat Type	Area (ac.)	Ac. Ft./year/ac	Total ac. Ft./yr	mGPD	GPM
Riparian Strip - Xeric riparian	15.8	16.3	257.5	0.2	159.7
Riparian Strip - Mesic riparian	89.4	18.4	1645.0	1.5	1019.9
Riparian Strip - Hydric riparian	57.5	20.6	1184.5	1.1	734.4
Riparian Strip – Channel	8.8	20.1	176.9	0.2	109.7
Vegetation Management Areas (all habitat types) [2]	100.9	18.4	1644.7	1.7	1151.1
Construction Areas (reseeded to native xeric riparian vegetation) [1] [2]	31.5	16.3	513.5	0.5	318.4
		108	5422.1	5.2	3493.1

Major Structural and Other Physical Elements

Bank Protection. The major structural component of this alternative is the bank protection between the riparian strips and the remainder of the channel. The purpose of this structure is to protect the riparian strips from frequent and moderately frequent flood events up to 10 to 15 years. The 10 to 15 year return period was chosen as a result of flow and risk analysis described in Appendix I.5.

The base of the riparian area would be armored approximately two feet above grade with coarse, earth-toned soil cement at a 3:1 slope. An additional berm above the soil cement extending two more feet at a reduced slope would be armored by gabions. The slope of the berm towards the habitat areas will not be protected by gunnite or soil cement. Plants with fibrous root systems will add further protection against erosion, should the flow overtop the berm.

Streamcourses. Several factors must be considered in the final design of water delivery through the length of the habitat strips: (1) evaporative losses; (2) high infiltration and plant uptake rates; and (3) low gradient. The streamcourses would be graded to the same slope as the adjacent portion of the undisturbed channel, averaging 0.2 percent. These channels will not be very large, approximately 10 feet wide by 1 foot deep, and will be somewhat shaded by canopy to minimize evaporative losses. Water may also be piped further downstream to ensure that infiltration losses do not prevent water from reaching the downstream. The channels may be constructed with a subsurface layer of approximately 8 inches of less permeable material such as agricultural soil (Wass, pers. com., 2002). The channels will

be filled with rock and cobble to prevent the formation of surface water, but allow the flow of irrigation water.

Western Levee Fill. A portion of the western levee from McDowell Road to Coldwater Park will be filled with a mixture of riverbed and imported fine material on the channel side to create a varying slope averaging approximately 4:1. The slope will be contoured to create terraces of lesser gradient and to provide some microsite variation for wildlife and plants.

Imported Soil. Borrow for the project will be needed for several purposes:

- Cohesive material for fill along the eastern and western levees suitable for revegetation of the riparian strip.
- Semi-permeable fill for lining the low flow channel and areas where water may be accumulated to reduce (but not eliminate) infiltration losses.
- Material to construct soil cement bank protection.

For these needs it is estimated that approximately 175,374 cubic yards of fine materials defined as silty loam will be needed; approximately 263,061 cubic yards of coarser material defined as gravels with fines or sands with fines will be needed. Approximately 11,130 and 13,841 cubic yards, respectively of fine and coarse material will be needed for the side channels. Approximately 97,645 cubic yards of material will be needed to construct the terrace bank armor along the riparian strips.

Wells and Water Distribution. Well locations shown on Figures I-1 through I-3 are approximate. Actual well locations and water distribution network designs would be determined during the Plans & Specs phase of the project. Each well would have a reservoir tank to prevent the pumps from operating constantly. Water would be piped from the reservoir into the habitat area streamcourses. Pipes would daylight in a concrete headwall at the top of the streamcourse. If necessary due to infiltration losses or evapotranspiration losses, multiple inverts per streamcourse may be necessary.

Irrigation Systems. A standard drip irrigation system will be required to support the vegetation on the western levee terraces. This system will connect to the existing City of Avondale water system, and will be controlled by a programmable controller. Coordination will be needed to select a system that is compatible with existing City of Avondale requirements.

Additionally, a temporary irrigation system consisting of both drip and spray components would be needed in the other habitat areas during the establishment phase to support the new vegetation. This system would be abandoned at the end of this period. Drip irrigation would be used to water shrub and tree vegetation, while spray irrigation would be used to water the remainder of the plantings. Spray heads mounted three to six feet above the surface would be used to simulate rain and avoid any irrigation shadows caused by large plants or other materials. The actual design of the irrigation systems would be undertaken in the Plans & Specs phase.

3.5 ALTERNATIVES 5 THROUGH 7

Alternatives 5 through 7 are similar to Alternatives 2 through 4, respectively. Alternatives 5 through 7 lack the western levee terraces. Tables I-4 through I-6 show the water use for these alternatives.

Table I-4 – Alternative 5 Water Use

		Water Usage (ET & Infilt.)			
Habitat Type	Area (ac.)	Ac. Ft./ year/ac	Total ac. Ft./yr	mGPD	GPM
Riparian Strip - Xeric riparian	0.0	16.3	0.0	0.0	0.0
Riparian Strip - Mesic riparian	12.3	18.4	226.3	0.2	140.3
Riparian Strip - Hydric riparian	22.5	20.6	463.5	0.4	287.4
Riparian Strip - Channel	4.4	20.1	88.4	0.1	54.8
Vegetation Management Areas (all habitat types) [2]	0.0	18.4	0.0	0.0	0.0
Construction Areas (reseeded to native xeric riparian vegetation) [1] [2]	7.0	16.3	114.1	0.1	70.7
		108	892.3	0.8	553.2

Table I-5 – Alternative 6 Water Use

		Water Usage (ET & Infilt.)			
Habitat Type	Area (ac.)	Ac. Ft./ year/ac	Total ac. Ft./yr	mGPD	GPM
Riparian Strip - Xeric riparian	0.0	16.3	0.0	0.0	0.0
Riparian Strip - Mesic riparian	23.6	18.4	434.2	0.4	269.2
Riparian Strip - Hydric riparian	27.6	20.6	568.6	0.5	352.5
Riparian Strip - Channel	6.6	20.1	132.7	0.1	82.3
Vegetation Management Areas (all habitat types) [2]	0.0	16.3	0.0	0.0	0.0
Construction Areas (reseeded to native xeric riparian vegetation) [1] [2]	10.1	16.3	164.6	0.1	102.1
		108	1300.1	1.1	806.1

Table I-6 – Alternative 7 Water Use

		Water Usage (ET & Infilt.)			
Habitat Type	Area (ac.)	Ac. Ft./ year/ac	Total ac. Ft./yr	mGPD	GPM
Riparian Strip - Xeric riparian	0.0	16.3	0.0	0.0	0.0
Riparian Strip - Mesic riparian	89.4	18.4	1645.0	1.5	1019.9
Riparian Strip - Hydric riparian	57.5	20.6	1184.5	1.1	734.4
Riparian Strip - Channel	8.8	20.1	176.9	0.2	109.7
Vegetation Management Areas (all habitat types)	100.9	18.4	1644.7	1.7	1151.1
Construction Areas (reseeded to native xeric riparian vegetation)	21.4	16.3	348.8	0.3	216.3
		108	4999.9	4.8	3231.4

Imported Soil

Alternative 5:

- Approximately 31,114 cubic yards of fine materials defined as silty loam will be needed for the riparian strips and side channels
- Approximately 45,826 cubic yards of coarser material defined as gravels with fines or sands with fines will be needed for the riparian strips and side channels

- Approximately 21,725 cubic yards of material will be needed to construct terrace bank armor.

Alternative 6:

- Approximately 44,959 cubic yards of fine materials defined as silty loam will be needed for the riparian strips and side channels
- Approximately 66,221 cubic yards of coarser material defined as gravels with fines or sands with fines will be needed for the riparian strips and side channels
- Approximately 31,390 cubic yards of material will be needed to construct terrace bank armor.

Alternative 7:

- Approximately 95,174 cubic yards of fine materials defined as silty loam will be needed for the riparian strips and side channels
- Approximately 140,181 cubic yards of coarser material defined as gravels with fines or sands with fines will be needed for the riparian strips and side channels
- Approximately 66,455 cubic yards of material will be needed to construct terrace bank armor.

3.6 ALTERNATIVE 8 – RECOMMENDED PLAN

Basic Concept

This alternative extends the restoration effort along a ¾-mile project reach. The plan view and cross-sections of the engineered elements of this alternative are presented in Figures I-9 to I-15. Figure I-9 is a topographic plan view of the entire project area. Figure I-10 provides a plan view of the project design at the Interstate-10 restoration site. Figure I-11 provides a detailed cross-section, followed by more conceptual cross-sections in Figures I-12 to I-14. Figure I-15 provides a plan view and cross section of engineered elements of this alternative at the AWWTP site. The hydraulic analysis (Section 5) indicates that this alternative does not affect the SPF condition. Habitat would be supported by one City of Avondale well located approximately ¼-mile north of Van Buren Street on 10th Street/Eliseo C. Felix Way (well ID# 55-583017). The habitat configuration consists of a riparian strip along the eastern side of the channel totaling 3,130 feet long, approximately 310 feet in width. Within the riparian strip there are two slightly meandering side channel. These habitat areas are protected from flow events by a soil cement bank extending approximately two feet above grade, with a gabion-protected berm extending approximately two more feet (Figures I-10 through I-14). The soil cement will extend below grade to a depth of approximately 10 feet to protect it from scour from up to a 10-year event. Frequent flows of up to 10- to 15-year events will be partially excluded from the riparian strip to reduce the chances of significant losses; however, larger flows will still pass over and through the habitat areas.

Along the west side of the channel from approximately the Interstate 10 bridge to about 800 feet downstream of Van Buren Street, soil cement and gabion protection will be installed approximately 75 feet from the toe of the existing bank protection in the same manner as described above for the east side. The area between this new bank protection and the existing levee will be filled to a depth of at least one foot to provide soil as a base for plantings of habitat similar to that of the east side.

Pumped groundwater may be directed, on a seasonal basis, to areas in portions of the channel identified for vegetation management. Under this alternative it is assumed that 1 mGPD of effluent from the AWWTP would be retained at the AWWTP site.

Water needs for this alternative are estimated to be a maximum of approximately 1.7 mGPD (Table I-7). This will vary throughout the year to accommodate different vegetation types and mimic the seasonality of natural flows in the area.

Table I-7 Alternative 8 Water Use

		Water Usage (ET & Infilt.)			
Habitat Type	Area (ac.)	Ac. Ft./year/ac	Total ac. Ft./yr	mGPD	GPM
Riparian Strip - Xeric riparian	6.5	16.3	106.0	0.1	65.7
Riparian Strip - Mesic riparian	6.0	18.4	110.4	0.1	68.4
Riparian Strip - Hydric riparian	11	20.6	226.6	0.2	140.5
Riparian Strip - Channel	2.2	20.1	44.2	0.0	27.4
Vegetation Management Areas (all habitat types) [2]	81.0	18.4	1320.3	1.3	924.0
Construction Areas (reseeded to native xeric riparian vegetation) [1] [2]	8.0	16.3	130.4	0.1	80.8
		108.0	1937.9	1.9	1306.8

Major Structural and Other Physical Elements

Bank Protection. The major structural component of this alternative is the bank protection between the riparian strips and the remainder of the channel. The purpose of this structure is to protect the riparian strips from frequent and moderately frequent flood events up to 10-15 years. The 10 to 15 year return period was chosen as a result of flow and risk analysis described in Appendix I.5.

The base of the riparian area would be armored approximately two feet above grade with coarse, earth-toned soil cement at a 3:1 slope. An additional berm above the soil cement extending two more feet at a reduced slope would be armored by gabions. The tops of the berms towards the habitat areas will not be protected by gunnite or soil cement. Plants with fibrous root systems will add further protection against erosion, should the flow overtop the berms.

Streamcourses. Several factors must be considered in the final design of water delivery through the length of the habitat strips: (1) evaporative losses; (2) high infiltration and plant uptake rates; and (3) low gradient. The streamcourses would be graded to the same slope as the adjacent portion of the undisturbed channel, averaging 0.2 percent. These channels will not be very large, approximately 10 feet wide by 1 foot deep. They will be filled with coarse gravel/crushed rock to above the water level so as to inhibit mosquito breeding and reduce evaporation losses. The channel will also be somewhat shaded by a tree canopy to minimize evaporative losses. Water may also be piped further downstream to ensure that infiltration losses do not prevent water from reaching the downstream habitat areas. The channels may be constructed with a subsurface layer of approximately 8 inches of less permeable material such as agricultural soil (Wass, pers. com., 2002).

Imported Soil. Borrow for the project will be needed for the same purposes as described for the other alternatives.

- Approximately 32,251 cubic yards of fine materials defined as silty loam will be needed
- Approximately 47,649 cubic yards of coarser material defined as gravels with fines or sands with fines will be needed
- Approximately 1,864 and 2,318 cubic yards, respectively of fine and coarse material will be needed for the side channels along the eastern riparian strip
- Approximately 24,940 cubic yards of material will be needed to construct the terrace bank armor along the riparian strips

Wells and Water Distribution. The well may require a reservoir tank to prevent the constant operation. Water would be piped from the well into the habitat area streamcourses. Pipes would daylight in a concrete headwall at the top of the streamcourse. If necessary due to infiltration losses or evapotranspiration losses, multiple inverts per streamcourse may be necessary.

Irrigation Systems. A standard drip irrigation system will be required to support the vegetation on the western levee terraces. This system will connect to the well, and will be controlled by a programmable controller. A system that is compatible with existing City of Avondale requirements should be selected.

Additionally, a temporary irrigation system consisting of both drip and spray components would be needed in the other habitat areas during the establishment phase to support the new vegetation. This system would be abandoned at the end of this period. Drip irrigation would be used to water shrub and tree vegetation, while spray irrigation would be used to water the remainder of the plantings. Spray heads mounted three to six feet above the surface would be used to simulate rain and avoid any irrigation shadows caused by large plants or other materials. The actual design of the irrigation systems would be undertaken in Plans & Specs phase.

Filtration Galleries. Because the effluent discharge to the AWWTP site will be reduced from 3.5 to 1 mGPD, this alternative includes a system to capture and recirculate infiltrated effluent and shallow ground water. Filtration galleries will be built toward the interior of the channel just outside the vegetation management area. The galleries consist of coarse fill designed to collect shallow groundwater to a depth of approximately 20 feet. Collected water will be pumped to the upgradient end of the vegetation management area and will then be distributed along a system of pipes to supplement the treated effluent. Electricity to operate the system will come from a transmission line connect to the existing grid at Southern Avenue.

4. HYDRAULIC ANALYSIS OF ALTERNATIVES 2 THROUGH 7

4.1 ALTERNATIVE DESCRIPTIONS

Six alternatives were initially analyzed as part of this study. Alternative 2 calls for changes on both banks of the river. Xeric riparian vegetation will be installed on the west bank of the river, where a 75-

foot wide strip will be placed between McDowell Road and a grade control structure that is nearly 2000 feet north of Buckeye Road. New fill material will be imported to support the xeric vegetation. This will soften the hardened trapezoidal cross-section of the river and will also reduce conveyance capacity. Hydric and mesic riparian vegetation with a protected side channel will be installed on the east bank of the river. Width of this segment varies, but has a maximum width of about 300 feet. A minimum 1-foot shallow layer of fill will be imported to support the hydric and mesic riparian vegetation.

In addition to the same features from Alternative 2, Alternative 3 calls for the installation of a 20,000-foot long hydric and mesic riparian vegetation section on the west bank of the floodplain south of Lower Buckeye Road.

Alternative 4 also has the same features described in Alternative 2 as well as additional hydric and mesic riparian vegetation with a protected side channel on the west bank of the floodplain that extends from one-half mile upstream of Lower Buckeye Road to about the Broadway Road alignment. Because there is no hardened levee on the west bank, the width of proposed vegetation varies from 200 to 600 feet.

Alternatives 5, 6, and 7 are the same as Alternatives 2, 3, and 4 with the exception of the xeric vegetation and fill that will be installed along the western bank. In Alternatives 5, 6, and 7 proposed changes will be limited to the area adjacent to the eastern riverbank.

4.2 HYDRAULIC ANALYSIS

The water-surface profile model used in this study was based upon the model developed by Kimley-Horn and Associates (KHA) for the Agua Fria River Watercourse Master Plan. KHA and their associates converted the effective FIS HEC-2 model to HEC-RAS.

In the water surface profile models created for this analysis, the areas beyond the scope of the proposed vegetative changes were not altered. All hydraulic characteristics, roughness characteristics and channel geometry were unchanged. The existing characteristics were established by the planning model created during the approved Agua Fria Watercourse Master Plan.

4.3 TOPOGRAPHY AND CHANNEL GEOMETRY

In Alternatives 2 through 7, the river restoration proposes that two feet of fill be added to the areas designated hydric and mesic riparian vegetation areas. The design of xeric riparian vegetation areas call for new fill material that will be placed in a 75-foot wide strip at varying depths on the west bank. Elevation and channel geometry information in the water-surface profile models were adjusted to reflect the placement of the fill for the three vegetation types. In all areas of proposed hydric and mesic vegetation, the channel geometry was increased to reflect the fill that will be placed to support the vegetation.

Fill placed for the xeric vegetation area on the west bank will not have a uniform shape such as the east bank. The channel geometry on the west bank was adjusted using the graphic cross-section editor

feature in HEC-RAS. The trapezoidal shape of the channel bed and levee was softened and altered to reflect the intent of the xeric vegetation areas as found in the exhibit of cross-section type D.

It was assumed that the protected side channels have insignificant hydraulic capacity in any flow event, so their shape was not hard coded into the hydric and mesic vegetation areas. All other channel geometry and elevation data were not altered from the existing conditions model.

Alternatives 5 through 7 have the same geometric changes as Alternatives 2 through 4 with the exception of the changes on the west bank. Alternatives 5 through 7 have no plans for xeric riparian vegetation.

4.4 *N*-VALUE ASSESSMENT

n-values for the proposed vegetation were found following the guidelines set forth in the USGS report, *Estimated Manning's Roughness Coefficients for Stream Channels and Flood Plains in Maricopa County, Arizona* (USGS, 1991). This is a variation on the procedure developed by Cowan as found in Chow (Chow, 1959). The procedure for determining the composite *n*-values is founded on the selection of a base *n*-value for the channel bed material assuming a straight uniform channel. Adjustments for channel irregularities, obstructions, vegetation, and channel cross-section variation are then added to the base *n*-valve. This value is then multiplied by a factor based upon the degree of meandering. Roughness values outside the areas of proposed changes were not altered. *n*-values in the protected side channels were assumed to be the same as in the hydric vegetation areas.

Composite *n*-values developed for the Agua Fria River restoration are in Table I-8.

Table I-8 Composite *n*-values

Vegetation Type	*n*-value
Hydric Riparian Vegetation	0.11
Mesic Riparian Vegetation	0.07
Xeric Vegetation	0.05

Depending on the frequency of the discharge in the river, *n*-values vary greatly. The proposed vegetation amounts will create a greater friction resistance to flow during lower discharge events than during larger events. Channel irregularities, obstructions, channel cross-section variation and the degree of meandering all have a greater effect on flow resistance at lower discharge rates, thus increasing the *n*-value.

Hydraulic analyses at several discharge rates were important for this study. The USACE requires the SPF for all hydraulic analysis for the minimum freeboard requirement. The floodplain and floodway hydraulics are based upon the 100-year discharge event; the toe down depth necessary for the proposed vegetation bank protection is based on the 10-year discharge event. Different *n*-values can be determined for each of these return frequencies. As this analysis would be prohibitive, the *n*-values determined for this study are based upon the 100-year return frequency discharge, but the values that would be used in a 10-year discharge event were also considered. A balance between the two return frequencies was found by choosing the *n*-value components from the upper range of possible values for

the 100-year event. This will ensure a more realistic analysis at the lower discharge rates and a more conservative analysis at the higher discharge rates.

4.5 FLOW RATES

The same flow rates were used in all of the alternatives. These flow rates were extracted from the Agua Fria River Watercourse Master Plan study. The SPF hydrology is based upon analysis developed for the USACE prior to the construction of the New Waddell Dam on the Agua Fria River. All other hydrology (i.e., for 2-year to 100-year discharge frequencies) is based on analysis developed after the construction of the dam. In many of the results, the term 'Old SPF' refers to the SPF discharge rates before the construction of the dam.

4.6 CONCLUSIONS OF HYDRAULIC ANALYSIS

Since the hydraulic conditions for Alternatives 5 through 7 are less restrictive than Alternatives 2 through 4 (i.e., the former do not have the western levee restoration), the WSELs for these alternatives are lower and Appendix I.1 presents the results for Alternatives 2 through 4. For Alternative 2, the maximum increase in water-surface elevation (WSEL) due to the proposed changes is about 1.7 feet for the SPF discharge event. This maximum increase occurs between Van Buren Street and the grade control structure north of the Buckeye Road crossing. This section of the river has levees on both banks. The available river conveyance in this area is decreased by the fill material that will be placed to support the different vegetation types. Downstream of the grade control structure, there are no changes in WSEL. There are no proposed vegetative changes downstream of the grade control structure, so this was expected. In the area of maximum WSEL increase, the amount of freeboard provided by the levees is still above three feet.

The same maximum WSEL increase of 1.7 feet was experienced in Alternative 3 between Van Buren Street and the grade control structure. The proposed changes south of Lower Buckeye Road cause a maximum increase of 0.5 foot during the SPF discharge event and 0.4 foot during the 100-years discharge event. The west bank of the river has a levee, and the amount of freeboard during the SPF event is still above three feet.

In Alternative 4, the maximum WSEL increase was also 1.7 feet, which occurred between Van Buren Street and the grade control structure. The proposed changes south of Lower Buckeye Road cause a maximum increase of 1.3 feet during the SPF discharge event and 1.1 feet during the 100-year discharge event. The west bank of the river has a levee, and the amount of freeboard during the SPF event is still above three feet with the exception of one minor violation of 0.1 foot at River Station 2.02.

In Alternative 5, the maximum WSEL increase during the probable maximum flood (PMF) event was 1.6 feet and occurred between the Van Buren Street crossing and the grade control structure. As in Alternative 2, the amount of freeboard in this area is still above three feet. The maximum WSEL increase is lower than that in Alternative 2. As no fill will be placed on the West Bank, a lower WSEL maximum increase was expected.

In Alternative 6, the maximum increase in WSEL is 1.6 feet, as in Alternative 5. In the area of proposed changes south of Buckeye Road, the maximum WSEL increase during the 100-year event is 0.5 foot.

Alternative 7 has the same maximum WSEL increase of 1.6 feet between Van Buren Street and the grade control structure and has an increase in the 100-year SWEL of 1.1 feet in the area south of Lower Buckeye Road. In this area, the west bank of the river has a levee, and the amount of freeboard during the SPF event is still above three feet with the exception of one minor violation of 0.1 foot at River Station 2.02.

At the Buckeye Road crossing, the same freeboard violation that occurs under the existing conditions occurs under the proposed conditions. The magnitude of the freeboard violation at Buckeye Road does not change in any alternative. The graphs shown in Appendix I.1 also show apparent violations at the McDowell Road crossing, but in reality no violation occurs because this is the confluence of the I-10 storm drain channel and the Agua Fria River.

4.7 SCOUR

The proposed vegetative changes will only cause minor differences in the contraction and pier scour potential at the bridge crossing structures.

The necessary toe down depth for the bank protection is approximately 10 feet. This is based upon a 10-year return frequency discharge event. The 10 year return period was chosen as a result of flow and risk analysis described in Appendix I.5. This includes both the single event scour and long-term scour components. As the descriptions indicate, the single event scour occurs during a single event or close series of events. Long-term scour occurs over time and is the depth the river will seek to achieve equilibrium and create an armor layer.

The long-term scour component accounts for over 75 percent of the total scour depth. In further analysis, the significance of the long-term scour event should be analyzed. Grade control structures located in the project area and an active maintenance program may limit the ability of the watercourse to reach the significant armor depths.

4.8 RECOMMENDATIONS

Under the existing conditions, the minimum levee requirement of three feet is violated at the Buckeye Road Bridge. The proposed riparian vegetation restoration designs clearly avoid the vicinity of the Buckeye Road Bridge and do not affect any of the hydraulic parameters at the Buckeye Road Bridge. The violation may be rectified by increasing the conveyance area just downstream of the bridge, but this may be outside the scope of this project.

We also estimate that the maximum scour depth of the main channel will be approximately 10 feet. This is conservative as it assumes the main channel of the river could laterally migrate to the toe of the bank protection that fortifies the fill material used in the vegetation restoration. We recommend that an aggressive maintenance program be included with any proposed riparian vegetation design. This could

negate the destructive long-term scour effects and consequently decrease the toe down depth of the bank protection.

The use of wells will require coordination with the City of Avondale and the Flood Control District of Maricopa County. Possible recharge credits could offset the cost of pumping groundwater. All alternatives require some imported fill material; however, the improvements along the western levee in Alternatives 2, 3, and 4 will require large quantities of imported fill material. The cost of importing this amount of material may be excessive. The lack of geotechnical information regarding percolation rates makes it difficult to determine water use to a reasonable degree of accuracy. Water infiltration can be minimized effectively by using semi-permeable agricultural soils to line the stream channels. If further study shows semi-permeable soils are insufficient to slow percolation, some sort of geotextile or clay liner may be considered under the channels. The lack of sufficient contour information reduces the degree of accuracy of the earthwork calculations and the hydraulic analysis.

Pumping groundwater to support types of habitat that were destroyed in part by over-pumping of the aquifer may be seen as counter-intuitive. There may be negative public reaction to these concepts.

Prior to final design, a complete geotechnical report will be needed to determine accurate percolation rates. Prior to final design, updated topographic mapping (at one foot contour intervals) will be needed to complete accurate earthwork quantities and hydraulic models.

None of the proposed alternatives has a negative impact on the hydrology of the river; therefore, from a hydrology standpoint, all are feasible. All of the proposed alternatives are feasible from an engineering standpoint. In fact, from an engineering standpoint, there is little difference in complexity between the alternatives. They differ only in quantities of material needed and constructed items. The large quantities of import material needed for the western levee terracing in Alternatives 2 through 4 may not be feasible, from a material availability or cost standpoint. Removal of these improvements, as in Alternatives 5, 6, and 7 increases the construction feasibility. Since grading operations will be taking place in the channel anyway, some borrow material could be taken from the channel to increase the conveyance area just downstream of the Buckeye Road Bridge, thus eliminating the levee freeboard violations there. Use of an aggressive maintenance program to negate any destructive long-term scour effects on the proposed bank armoring would decrease the necessary toe-down depth of the bank protection.

5. HYDRAULIC ANALYSIS OF ALTERNATIVE 8

5.1 ALTERNATIVE DESCRIPTION

The final alternative calls for changes on both banks of the river. Xeric Riparian vegetation will be installed on the west bank of the river, where a 75-foot wide strip will be placed from Interstate-10 to the south side of Van Buren Street. New fill material with a minimum depth of one foot deep will be imported to support the xeric vegetation.

Hydric and Mesic Riparian vegetation with a protected side channel will be installed on the east bank of the river. Width of this segment varies, but has a maximum width of about 325 feet. A 1-foot shallow layer of fill will be imported to support the Hydric and Mesic Riparian vegetation.

5.2 HYDRAULIC ANALYSIS

The water-surface profile model used in this study was based upon the model developed by Kimley-Horn and Associates (KHA) for the Agua Fria River Watercourse Master Plan. KHA and their associates converted the effective FIS HEC-2 model to HEC-RAS.

In the water-surface profile models created for this analysis, the areas outside of the proposed design restoration were not altered. All hydraulic characteristics, roughness characteristics, and channel geometry were unchanged. The existing characteristics were established by the planning model created during the approved Agua Fria Watercourse Master Plan. The results of the hydraulic analysis for Alternative 8 (Recommended Plan) are provided in Appendix I.2 (model results) and I.3 (graphics).

5.3 TOPOGRAPHY AND CHANNEL GEOMETRY

The river ecosystem restoration proposes that a minimum one foot of fill be added to the areas designated Hydric and Mesic Riparian vegetation areas. Elevation and channel geometry information in the water-surface profile models were adjusted to reflect the placement of the fill for the three vegetation types.

In all areas of proposed hydric and mesic vegetation, the channel geometry was increased to reflect the fill that will be placed to support the vegetation.

5.4 *N*-VALUE ASSESSMENT

n-values for the proposed vegetation were found following the guidelines set forth in the USGS report, *Estimated Manning's Roughness Coefficients for Stream Channels and Flood Plains in Maricopa County, Arizona* (USGS, 1991). This is a variation on the procedure developed by Cowan as found in Chow (1959). The procedure for determining the composite *n*-values is founded on the selection of a base *n*-value for the channel bed material assuming a straight uniform channel. Adjustments for channel irregularities, obstructions, vegetation, and channel cross-section variation are then added to the base *n*-value. This value is then multiplied by a factor based upon the degree of meandering. Roughness values outside the areas of proposed changes were not altered. *n*-values in the protected side channels were assumed to be the same as in the hydric vegetation areas. Composite *n*-values developed for the Agua Fria River Restoration are in Table I-8.

Depending on the frequency of the discharge in the river, *n*-values vary greatly. The proposed vegetation amounts will create a greater friction resistance to flow during lower discharge events than during larger events. Channel irregularities, obstructions, channel cross-section variation, and the degree of meandering all have a greater effect on flow resistance at lower discharge rates, thus increasing the *n*-value.

Hydraulic analyses at several discharge rates were important for this study. The USACE requires the SPF for all hydraulic analysis for the minimum freeboard requirement. The flood insurance study floodplain and floodway hydraulics are based upon the 100-year discharge event; the toe down depth necessary for the proposed vegetation bank protection is based on the 10-year discharge event. Different *n*-values can be determined for each of these return frequencies. As this analysis would be prohibitive during the conceptual stage, the *n*-values determined for this study are based upon the 100-year return frequency discharge, but the values that would be used in a 10-year discharge event were also considered. A balance between the two return frequencies was found by choosing the *n*-value components from the upper range of possible values for the 100-year event. This will ensure a more realistic analysis at the lower discharge rates and a more conservative analysis at the higher discharge rates.

5.5 FLOW RATES

These flow rates were extracted from the Agua Fria River Watercourse Master Plan study. The SPF hydrology is based upon analysis developed for the USACE prior to the construction of the New Waddell Dam on the Agua Fria River. All other hydrology is based on analysis developed after the construction of the dam. In many of the results, the term "Old SPF" refers to the SPF discharge rates before the construction of the dam.

5.6 SCOUR

The single event scour was based upon a level one method developed by Tetra Tech, Inc. The method uses the unit discharge to estimate the potential single event scour depth (Table I-9). The method was originally used in the derivation of the Level One relationships found in the Arizona Department of Water Resources State Standard for System Sediment Balance (SS 5-96). The state standard was developed by Tetra Tech, Inc. (formerly Simons Li and Associates). A chart of the estimation method can be found in the Appendix I.4.

Table I-9 Unit Discharge versus Scour Depth

Unit Discharge (Q/T)	Scour Depth (Straight Reach)
10	1.5
50	4.3
100	6.8
200	10.8
300	14.1
500	19.8

Since it is based upon total discharge and the flow width, this method can be used in both determining the toe down depth for the proposed restoration vegetation and the scour potential at the bridges.

5.7 RISK ANALYSIS

As one element in the determination of the risk associated with the Agua Fria River Restoration Project and the selection of a level of protection for the riparian strips, Table I-10 lists the annual recurrence

probability versus probability or risk of exceeding that occurrence for a project life expectancy of 50 years.

From Table I-10, it is apparent that any flood with a probability of occurrence greater than 0.2 percent (i.e., a 500-year flood) will have an exceedance probability in excess of 10 percent for a project life expectancy of 50 years. For a 100-year flood, there are approximately 4 chances out of 10 (i.e., 39 percent) that exceedance will occur during the 50-year life expectancy of the project. For a 200-year flood, there is still approximately 1 chance out of 5 (i.e., 22 percent) that exceedance will occur during the 50-year life expectancy of the project. For a 10-year flood it is likely that exceedance will occur during the 50-year life of the project.

Table I-10 Probability of Occurrence versus Exceedance for 50-year Project Life

Probability of Occurrence (%)	Storm Return Frequency	Exceedance Probability (%)
50	2-Year	100
20	5-Year	100
10	10-Year	99
4	25-Year	87
2	50-Year	64
1	100-Year	39
0.5	200-Year	22
0.2	500-Year	10
0.1	1000-Year	5

Another element for making a decision as to what constitutes acceptable risk can be based upon the Least Total Expected Cost (LTEC) associated with the life of a project. In order to determine LTEC, detailed cost figures must be available to compare costs of implementation, operation, and maintenance versus potential damages, should failure occur.

A third element for making a decision as to what constitutes acceptable risk can be based upon a qualitative evaluation of the consequences of failure of the project when viewed from social, political, and environmental perspectives, rather than purely upon technical and economic considerations.

Given the preceding, and the lack of sufficient data to conduct a detailed LTEC analysis—yet knowing the intended configuration and purpose of the Agua Fria River Ecosystem Restoration Project, as well as the consequences of either partial or total failure during the project life expectancy of 50 years—it is the opinion of Tetra Tech that the Agua Fria River Ecosystem Restoration Project should be based upon a flood design that has an annual recurrence probability of no greater than 1 percent (i.e., a 100-year flood). As stated above, there are approximately 4 chances out of 10 during the 50-year life expectancy of the project that exceedance will occur as a consequence of the occurrence of a 100-year flood.

However, protecting the riparian strips against a 100-year event would require building bank protection approximately 9 feet above grade, which would be cost prohibitive, incompatible with natural conditions and aesthetically unpleasing. Therefore, the banks were designed to a 10 year level of protection, which means that there is a 9.9 out of 10 chance that the protection will be exceeded during the life of the project.

5.7 CONCLUSIONS AND RECOMMENDATIONS

The results presented only reflect areas of change in the hydraulic parameters. Any area upstream of river mile 6.2 and downstream of river mile 4.0 did not change. The maximum increase in water-surface elevation (WSEL) due to the proposed changes is about 1.0 foot for the "Old SPF" discharge event. This maximum increase occurs about half way between Interstate-10 and Van Buren at river mile 5.02. The available river conveyance in this area is decreased by the fill material that will be placed to support the different vegetation types. The amount of freeboard in this area is also decreased by one foot. In the area of maximum WSEL increase, the amount of freeboard provided by the levees is still above 3 feet. Other hydraulic parameters change only slightly. There is no significant increase in flow velocity or the Froude Number.

The project will not produce any adverse scouring effects at the bridge locations. As stated, the hydraulic characteristics change very little under the proposed conditions and will not produce a greater scouring potential. We estimate that maximum scouring depth will be approximately 6.5 feet during the 100-year storm event. This reflects 4.5 feet from single-event scour and a standard 2 feet from scouring of the low flow channel. There are grade control structures downstream from the I-10 bridges and between Van Buren Street and the Buckeye Road bridges that will control long-term scouring.

We estimate that the 10-year scouring depth along the toe down to the proposed vegetation will be four feet. This reflects two feet of single-event scour and two feet of low flow channel scour. Again, two feet of low flow channel scouring is very conservative considering that the low flow channel would have to migrate several hundred feet to scour at the toe of the bank protection supporting the proposed vegetation.

6. REFERENCES

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RISK ASSOCIATED WITH
AGUA FRIA RIVER ECOSYSTEM RESTORATION PROJECT

As one element in the determination of the risk associated with the Agua Fria River Restoration Project, the following table has been prepared which lists the annual recurrence probability versus exceedance probability for a project life expectancy of 50 years:

Annual Recurrence Probability (percent)	Exceedance Probability (percent)
50	100
20	100
10	99
4	87
2	64
1	39
0.5	22
0.2	10
0.1	5

From the preceding table, it is apparent that any flood with a recurrence probability of greater than 0.2 percent (i.e., a 500-year flood) will have an exceedance probability in excess of 10 percent for a project life expectancy of 50 years. For a 100-year flood, there are approximately 4 chances out of 10 (i.e., 39%) that exceedance will occur during the 50-year life expectancy of the project. For a 200-year flood, there is still approximately 1 chance out of 5 (i.e., 22%) that exceedance will occur during the 50-year life expectancy of the project.

Another element for making a decision as to what constitutes acceptable risk can be based upon the Least Total Expected Cost (LTEC) associated with the life of a project. In order to determine LTEC, though, detailed cost figures must be available to compare costs of implementation, operation, and maintenance versus potential damages, should failure occur.

A third element for making a decision as to what constitutes acceptable risk can be based upon a qualitative evaluation of the consequences of failure of the project when viewed from social, political, and environmental perspectives, rather than purely upon technical and economic considerations.

Given the preceding, and given the lack of sufficient data to conduct a detailed LTEC analysis—yet knowing the intended configuration and purpose of the Agua Fria River Ecosystem Restoration Project, as well as the consequences of either partial or total failure during the project life expectancy of 50 years—it is the opinion of Tetra Tech that the Agua Fria River Ecosystem Restoration Project should be based upon a design flood which has an annual recurrence probability of no greater than 1 percent (i.e., a 100-year flood). As stated above, there are approximately 4 chances out of 10 during the 50-year

life expectancy of the project that exceedance will occur as a consequence of the occurrence of a 100-year flood.

APPENDIX I.1

HYDRAULIC RESULTS FOR ALTERNATIVES 2 THROUGH 4

AGUA FRIA RIVER RESTORATION HYDRAULIC ANALYSIS

The purpose of the Agua Fria River Restoration hydraulic analysis was to understand and quantify the hydraulic impacts of the various proposed alternatives for river restoration. Any proposed river restoration changes will require the maintenance of the minimum freeboard of three feet at the levees. The increased scour potential at any of the bridge structures must also be minimized. Another purpose of the hydraulic analysis was to determine the necessary toe down depth for the bank protection that will be placed to anchor the toe of the fill material used for addition of the riparian vegetation.

Alternative Descriptions

Six Agua Fria River Restoration alternatives were analyzed as a part of the study: Alternative2-7. Alternative 2 calls for changes on both banks of the river. Xeric Riparian Vegetation will be installed on the west bank of the river, where a 75-foot wide strip will be placed between McDowell Road and a grade control structure that is nearly 2000 feet north of the Buckeye road. New fill material will be imported to support the Xeric vegetation. This will soften the hardened trapezoidal cross-section of the river and will also reduce conveyance capacity. Hydric and Mesic Riparian vegetation with a protected side channel will be installed on the east bank of the river. Width of this segment varies, but has a maximum width of about 300 feet. A 2-foot shallow layer of fill will be imported to support the Hydric and Mesic Riparian vegetation.

In addition to the same features from Alternative 2, Alternative 3 calls for the installation of a 20000-foot long Hydric and Mesic Riparian vegetation section on the west bank of the floodplain south of Lower Buckeye Road.

Alternative 4 also has the same features described in Alternative 2 as well as additional Hydric and Mesic Riparian vegetation with a protected side channel on the west bank of the floodplain that extends from one-half mile upstream of Lower Buckeye Road to about the Broadway Road alignment. Because there is no hardened levee on the west bank the width of proposed vegetation varies from 200 to 600 feet.

Alternatives 5, 6 and 7 are the same as Alternatives 2,3 and 4 with the exception of the Xeric vegetation and fill that will be installed along the western bank. In alternatives 5, 6 and 7 proposed changes will be limited to the area adjacent to the eastern riverbank.

HYDRAULIC ANALYSIS

The water-surface profile model used in this study was based upon the model developed by Kimley-Horn and Associates (KHA) for the Agua Fria River Watercourse Master Plan. KHA and their associates converted the effective FIS HEC-2 model to HEC-RAS. In the water surface profile models created for this analysis, the areas beyond the scope of the proposed vegetative changes were not altered. All hydraulic characteristics, roughness characteristics and channel geometry were unchanged. The existing

characteristics were established by the planning model created during the approved Agua Fria Watercourse Master plan

Topography and Channel Geometry

In Alternatives 2-4, the river restoration proposes that two feet of fill be added to the areas designated Hydric and Mesic Riparian vegetation areas. The design of Xeric Riparian vegetation areas call for new fill material that will be placed in a 75-foot wide strip at varying depths on the west bank. Elevation and channel geometry information in the water-surface profile models were adjusted to reflect the placement of the fill for the three vegetation types. In all areas of proposed Hydric and Mesic vegetation, the channel geometry was increased by two feet to reflect the fill that will be placed to support the vegetation.

Fill placed for the Xeric Vegetation area on the west bank will not have a uniform shape such as the east bank. The channel geometry on the west bank was adjusted using the graphic cross-section editor feature in HEC-RAS. The trapezoidal shape of the channel bed and levee was softened and altered to reflect the intent of the Xeric Vegetation areas as found in the exhibit of cross-section type D.

It was assumed that the protected side channels have insignificant hydraulic capacity in any flow event, so their shape was not hard coded into the Hydric and Mesic Vegetation areas. All other channel geometry and elevation data were not altered from the existing conditions model.

Alternatives 5-7 have the same geometric changes as Alternatives 2-4 with the exception of the changes on the West Bank. Alternatives 5-7 have no plans for Xeric Riparian vegetation.

***n*-Value Assessment**

n-values for the proposed vegetation were found following the guidelines set forth in the USGS report, 'Estimated Manning's Roughness Coefficients for Stream Channels and Flood Plains in Maricopa County, Arizona.' (USGS, 1991). This is a variation on the procedure developed by Cowan as found in Chow (Chow, 1959). The procedure for determining the composite n-values is founded on the selection of a base *n*-value for the channel bed material assuming a straight uniform channel. Adjustments for channel irregularities, obstructions, vegetation and channel cross-section variation are then added to the base *n*-valve. This value is then multiplied by a factor based upon the degree of meandering. Roughness values outside the areas of proposed changes were not altered. *n*-values in the protected side channels were assumed to be the same as in the Hydric Vegetation areas.

Composite n-values developed Agua Fria River Restoration are in Table 1.

Vegetation Type	*n*-value
Hydric Riparian Vegetation	0.11
Mesic Riparian Vegetation	0.07
Xeric Vegetation	0.05

Depending on the frequency of the discharge in the river, n-valve vary greatly. The proposed vegetation amounts will create a greater friction resistance to flow during lower discharge events than during larger events. Channel irregularities, obstructions, channel cross-section variation and the degree of meandering all have a greater effect on flow resistance at lower discharge rates; thus increasing the *n*-value.

Hydraulic analyses at several discharge rates were important for this study. The USACOE requires the SPF for all hydraulic analysis for the minimum freeboard requirement. The floodplain and floodway hydraulics are based upon the 100-year discharge event and the toe down depth necessary for the proposed vegetation bank protection upon the 10-year hydraulics. Different *n*-values can be determined for each of these return frequencies. As this analysis would be prohibitive, the *n*-values determined for this study are based upon the 100-year return frequency discharge, but the values that would be used in a 10-year discharge event were also considered. A balance between the two return frequencies was found by choosing the *n*-value components from the upper range of possible values for the 100-year event. This will ensure a more realistic analysis at the lower discharge rates and a more conservative analysis at the higher discharge rates.

Flow Rates

The same flow rates were used in all of the alternatives. These flow rates were extracted from the Agua Fria River Watercourse Master Plan study. The SPF hydrology is based upon analysis developed for the US Army Corps of Engineers prior to the construction of the New Waddell Dam on the Agua Fria River. All other hydrology is based on analysis developed after the construction of the dam. In many of the results, the term 'Old SPF' refers to the SPF discharge rates before the construction of the dam.

CONCLUSIONS

In Alternative 2, the maximum increase in water-surface elevation (WSEL) due to the proposed changes is about 1.7 feet for the SPF discharge event. This maximum increase occurs between the Van Buren Street and the grade control structure north of the Buckeye Road crossing. This section of the river has levees on both banks. The available river conveyance area in this area is decreased by the fill material that will be placed to support the different vegetation types. Downstream of the grade control structure, there are no changes in WSEL. There are no proposed vegetative changes downstream of the grade

control structure, so this was expected. In the area of maximum WSEL increase, the amount of freeboard provided by the levees is still above 3 feet.

The same maximum WSEL increase of 1.7 feet was experienced in Alternative 3 between Van Buren Street and the grade control structure. The proposed changes south of Lower Buckeye Road cause a maximum increase of 0.5 feet during the SPF Discharge event and 0.4 feet during the 100-years discharge event. The west bank of the river has a levee and the amount of freeboard during the SPF event is still above 3 feet.

In Alternative 4, the maximum WSEL increase was also 1.7 feet, which occurred between Van Buren Street and the grade control structure. The proposed changes south of Lower Buckeye Road cause a maximum increase of 1.3 feet during the SPF discharge event and 1.1 feet during the 100-year discharge event. The west bank of the river has a levee and the amount of freeboard during the SPF event is still above 3 feet with the exception of one minor violation of 0.1 feet at river Station 2.02.

In Alternative 5, the maximum WSEL increase during the PMF event was 1.6 feet and occurred between the Van Buren Street crossing and the grade control structure. As in Alternative 2, the amount of freeboard in this area is still above 3 feet. The maximum WSEL increase is lower than that in Alternative 2. As no fill will be placed on the West Bank, a lower WSEL maximum increase was expected.

In Alternative 6, the maximum increase in WSEL is 1.6 feet, as in Alternative 5. In the area of proposed changes south of Buckeye Road, the maximum WSEL increase during the 100-uear event is 0.5 feet.

Alternative 7 has the same maximum WSEL increase of 1.6 feet between Van Buren the grad control structure and has an increase in the 100-year SWEL of 1.1 feet in the area south of Lower Buckeye Road. In this area, the west bank of the river has a levee and the amount of freeboard during the SPF event is still above 3 feet with the exception of one minor violation of 0.1 feet at River Station 2.02.

At the Buckeye Road crossing, the same freeboard violation that occurs under the existing conditions occurs under the proposed conditions. The magnitude of the freeboard violation at Buckeye Road does not change in any alternative. The graphs shown in the Appendix also show apparent violations at the McDowell Road crossing, but in reality no violation occurs because this is the confluence of the I-10 storm drain channel and the Agua Fria River.

Scour

The proposed vegetative changes will only cause minor differences in the contraction and pier scour potential at the bridge crossing structures.

The necessary toe down depth for the bank protection is approximately 15 feet. This is based upon a 10-year return frequency discharge event. This includes both the single

event scour and long-term scour components. As the descriptions indicate, the single event scour occurs during a single event or close series of events. Long-term scour occurs over time and is the depth the river will seek to achieve equilibrium and create an armor layer.

The long-term scour component that accounts for over 75% of the total scour depth. In further analysis, the significance of the long-term scour event should be analyzed. The fact that grad control structures are located in the project area and that an active maintenance program damage may limit the ability of the watercourse to reach the significant armor depths.

RECOMMENDATIONS

Under the existing conditions, the minimum levee requirement of three feet is violated at the Buckeye Road Bridge. The proposed riparian vegetation restoration designs clearly avoid the vicinity of the Buckeye Road Bridge and do not affect any of the hydraulic parameters at the Buckeye Road Bridge. The violation may be rectified by increasing the conveyance area just downstream of the bridge, but this may be outside the scope of this project.

We also estimate that the maximum scour depth of the main channel will be approximately 15 feet. This is conservative as it assumes the main channel of the river could laterally migrate to the toe of the bank protection that fortifies the fill material used in the vegetation restoration. We recommend that an aggressive maintenance program be included with any proposed riparian vegetation design. This could negate the destructive long-term scour effects and consequently decrease the toe down depth of the bank protection.

For the more detailed design features we recommend that more accurate one-foot topography be obtained. This will allow a more detailed hydraulic analysis to be completed along the entire river reach of the project.

APPENDIX I.2

HYDRAULIC RESULTS FOR ALTERNATIVE 8 (RECOMMENDED PLAN)

AGUA FRIA RIVER RESTORATION HYDRAULIC ANALYSIS

INTRODUCTION

The purpose of the Agua Fria River Restoration hydraulic analysis was to understand and quantify the hydraulic impacts of the proposed ecosystem restoration. Any proposed river restoration changes will require the maintenance of the minimum freeboard of three feet along the levees. The increased scour potential at any of the bridge structures due to changing hydraulic parameters must also be minimized. Another purpose of the hydraulic analysis was to determine the necessary toe down depth for the bank protection that will be placed to anchor the toe of the fill material used for addition of the riparian vegetation.

Alternative Description

The final alternative calls for changes on both banks of the river. Xeric Riparian Vegetation will be installed on the west bank of the river, where a 75-foot wide strip will be placed from Interstate-10 to the south side of Van Buren Avenue. New fill material will be imported to support the Xeric vegetation. This will soften the hardened trapezoidal cross-section of the river. Placement of the fill will reduce flow conveyance capacity of the river and placement of the proposed vegetation will increase friction head losses, which cause and increase in the water-surface elevation.

Hydric and Mesic Riparian vegetation with a protected side channel will be installed on the east bank of the river. Width of this segment varies, but has a maximum width of about 325 feet. A 2-foot shallow layer of fill will be imported to support the Hydric and Mesic Riparian vegetation.

HYDRAULIC ANALYSIS

The water-surface profile model used in this study was based upon the model developed by Kimley-Horn and Associates (KHA) for the Agua Fria River Watercourse Master Plan. KHA and their associates converted the effective FIS HEC-2 model to HEC-RAS.

In the water-surface profile models created for this analysis, the areas outside the of the proposed design restoration reaches were not altered. All hydraulic characteristics, roughness characteristics, and channel geometry were unchanged in these areas. The existing or base characteristics were established by the planning model created during the approved Agua Fria Watercourse Master plan.

Topography and Channel Geometry

The river ecosystem restoration proposes that two feet of fill be added to the areas designated Hydric and Mesic Riparian vegetation areas. The design of Xeric Riparian

vegetation areas calls for new fill material that will be placed in a 75-foot wide strip at varying depths on the west bank. Elevation and channel geometry information in the water-surface profile models were adjusted to reflect the placement of the fill for the three vegetation types.

In all areas of proposed Hydric and Mesic vegetation, the channel geometry was increased by two feet to reflect the fill that will be placed to support the vegetation.

Fill placed for the Xeric Vegetation area on the west bank will not have a uniform shape. The channel geometry on the west bank was adjusted using the graphic cross-section editor feature in HEC-RAS. The trapezoidal shape of the channel bed and levee was softened and altered to reflect the intent of the Xeric Vegetation areas as found in the exhibit of cross-section type D.

It was assumed that the protected side channels have insignificant hydraulic capacity in any flow event, so their shape was not hard coded into the topographical data in the Hydric and Mesic Vegetation areas. All other channel geometry and elevation data were not altered from the base conditions model.

Roughness Coefficient Assessment

The roughness coefficient, *or n*-values, for the proposed vegetation were found following the guidelines set forth in the USGS report, 'Estimated Manning's Roughness Coefficients for Stream Channels and Flood Plains in Maricopa County, Arizona.' (USGS, 1991). This is a variation on the procedure developed by Cowan as found in Chow (Chow, 1959). The procedure for determining the composite n-values is founded on the selection of a base *n*-value for the channel bed material assuming a straight uniform channel. Adjustments for channel irregularities, obstructions, vegetation, and channel cross-section variation are then added to the base *n*-value. This value is then multiplied by a factor based upon the degree of meandering. Roughness values outside the areas of proposed changes were not altered. *n*-values in the protected side channels were assumed to be the same as in the Hydric Vegetation areas.

Composite *n*-values developed Agua Fria River Restoration are in Table 1.

Vegetation Type	***n*-value**
Hydric Riparian Vegetation	0.11
Mesic Riparian Vegetation	0.07
Xeric Vegetation	0.05

Depending on the frequency of the discharge in the river, *n*-values vary greatly. The proposed vegetation amounts will create a greater friction resistance to flow during lower discharge events than during larger events. Channel irregularities, obstructions, channel cross-section variation, and the degree of meandering all have a greater effect on flow resistance at lower discharge rates; thus increasing the *n*-value.

Hydraulic analyses at several discharge rates were important for this study. The USACOE requires the SPF for all hydraulic analysis for the minimum freeboard requirement. The flood insurance study floodplain and floodway hydraulics are based upon the 100-year discharge event and the toe down depth necessary for the proposed vegetation bank protection is based upon the 10-year hydraulics. Different *n*-values can be determined for each of these return frequencies. As this analysis would be prohibitive during the conceptual stage, the *n*-values determined for this study are based upon the 100-year return frequency discharge, but the values that would be used in a 10-year discharge event were also considered. A balance between the two return frequencies was found by choosing the *n*-value components from the upper range of possible values for the 100-year event. This will ensure a more realistic analysis at the lower discharge rates and a more conservative analysis at the higher discharge rates.

Flow Rates

These flow rates were extracted from the Agua Fria River Watercourse Master Plan study. The SPF hydrology is based upon analysis developed for the US Army Corps of Engineers prior to the construction of the New Waddell Dam on the Agua Fria River. All other hydrology is based on analysis developed after the construction of the dam. In many of the results, the term 'Old SPF' refers to the SPF discharge rates before the construction of the dam.

Scour

The single event scour was based upon a level one method developed by Tetra Tech, Inc. The method uses the unit discharge to estimate the potential single event scour depth. The method was originally used in the derivation of the Level One relationships found in the Arizona Department of Water Resources State Standard for System Sediment Balance (SS 5-96). The state standard was developed by Tetra Tech, Inc. (formerly Simons Li and Associates). A chart of the estimation method can be found in the Appendix.

Since it is based upon total discharge and the flow width, this method can be used in both determining the toe down depth for the proposed restoration vegetation and the scour potential at the bridges.

Unit Discharge (Q/T)	Scour Depth (Straight Reach)
10	1.5
50	4.3
100	6.8
200	10.8
300	14.1
500	19.8

Risk Analysis

As one element in the determination of the risk associated with the Agua Fria River Restoration Project, the following table has been prepared which lists the annual recurrence probability versus exceedance probability for a project life expectancy of 50 years:

Annual Recurrence Probability (%)	Storm Return Frequency	Exceedance Probability (%)
50	2-Year	100
20	5-Year	100
10	10-Year	99
4	25-Year	87
2	50-Year	64
1	100-Year	39
0.5	200-Year	22
0.2	500-Year	10
0.1	1000-Year	5

From the preceding table, it is apparent that any flood with a recurrence probability of greater than 0.2 percent (i.e., a 500-year flood) will have an accidence probability in excess of 10 percent for a project life expectancy of 50 years. For a 100-year flood, there are approximately 4 chances out of 10 (i.e., 39%) that accidence will occur during the 50-year life expectancy of the project. For a 200-year flood, there is still approximately 1 chance out of 5 (i.e., 22%) that exceedance will occur during the 50-year life expectancy of the project.

Another element for making a decision as to what constitutes acceptable risk can be based upon the Least Total Expected Cost (LTEC) associated with the life of a project. In order to determine LTEC, though, detailed cost figures must be available to compare costs of implementation, operation, and maintenance versus potential damages, should failure occur.

A third element for making a decision as to what constitutes acceptable risk can be based upon a qualitative evaluation of the consequences of failure of the project when viewed from social, political, and environmental perspectives, rather than purely upon technical and economic considerations.

Given the preceding, and given the lack of sufficient data to conduct a detailed LTEC analysis—yet knowing the intended configuration and purpose of the Agua Fria River Ecosystem Restoration Project, as well as the consequences of either partial or total failure during the project life expectancy of 50 years—it is the opinion of Tetra Tech that the Agua Fria River Ecosystem Restoration Project should be based upon a design flood which has an annual recurrence probability of no greater than 1 percent (i.e., a 100-year flood). As stated above, there are approximately 4 chances out of 10 during the 50-year

life expectancy of the project that exceedance will occur as a consequence of the occurrence of a 100-year flood.

CONCLUSIONS AND RECOMMENDATIONS

Overall, the ecosystem restoration will not have adverse affects on the hydraulic capacity of the Agua Fria River. The proposed changes do not cause any levee freeboard violations.

Areas upstream of River Mile 6.26 and downstream of River Mile 4.52 did not change. The maximum increase in water-surface elevation (WSEL) due to the proposed changes is about 3.3 feet for the Old SPF discharge event. This maximum increase occurs at the grade control structure, which is River Mile 5.203. The changes in water-surface elevation are from the increase in friction resistance caused by the additional vegetation in the river and by the decrease in flow conveyance area. The majority of WSEL increase is caused by the increase in friction resistance. The weighted coefficient of friction in the restoration areas increases from an average of 0.03 to 0.05 (67%). Even with the significant increase in WSEL, there is still over six feet of freeboard on the levees in the reach of the proposed restoration.

Other hydraulic parameters changed as well. The velocity of the flow and the Froude Number both decrease in the areas of WSEL increase. The effects are positive as the scour potential at the bridges will decrease.

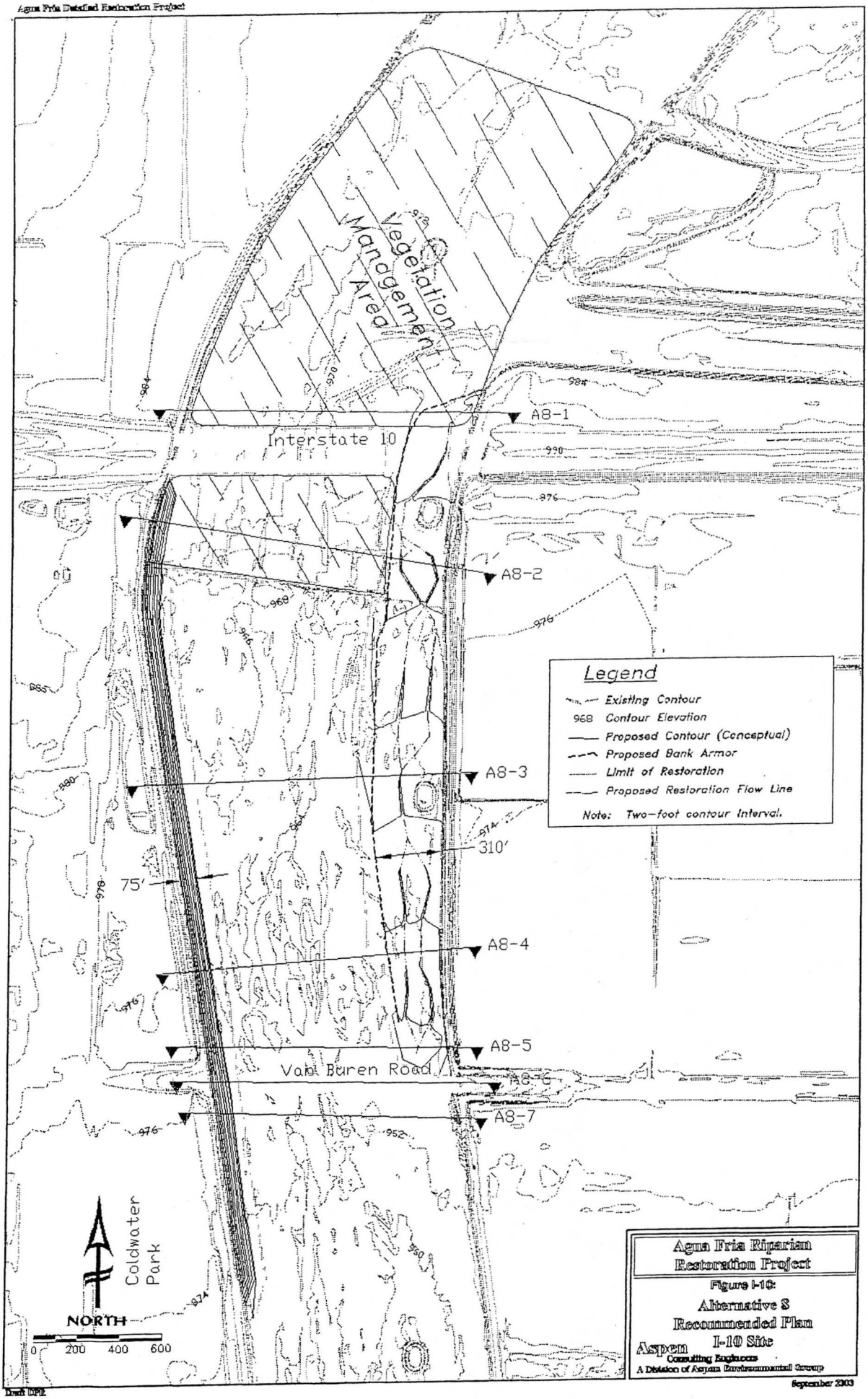
The maximum scouring depth will be nearly 6.5 feet during the 100-year storm event. This reflects 4.5 feet from single event scour and a standard 2 feet from scouring of the low flow channel. The flow discharge rate during the 100-year storm event is 52,000 cfs. Minimum top width of flow, assuming a generally rectangular shape is 1,100 feet. The ratio of discharge to top width is nearly 50, resulting in a single event scour depth of 4.3 feet as seen in the Scour Table. There are grade control structures downstream from the I-10 bridges and the Van Buren Avenue Bridge that will eliminate significant long-term scouring.

We estimate that the 10-year scouring depth along the toe down to the proposed vegetation will be 4 feet. This reflects two feet of single event scour and two feet of low flow channel scour. Again, two feet of low flow channel scouring is very conservative considering that the low flow channel would have to migrate several hundred feet to scour at the toe of the bank protection supporting the proposed vegetation.

At future design phases, we recommend that more accurate one-foot topography be obtained. This will allow a more detailed hydraulic and sediment analysis to be completed along the entire river reach of the project.

APPENDIX I.3

GRAPHICS FOR HYDRAULIC ANALYSIS OF ALTERNATIVE 8 (RECOMMENDED PLAN)



Agua Fria Riparian Restoration Project

Figure 1-10:

Alternative 8 Recommended Plan I-10 Site

Aspen Consulting Engineers
A Division of Aspen Environmental Group

September 2003

Draft DPR

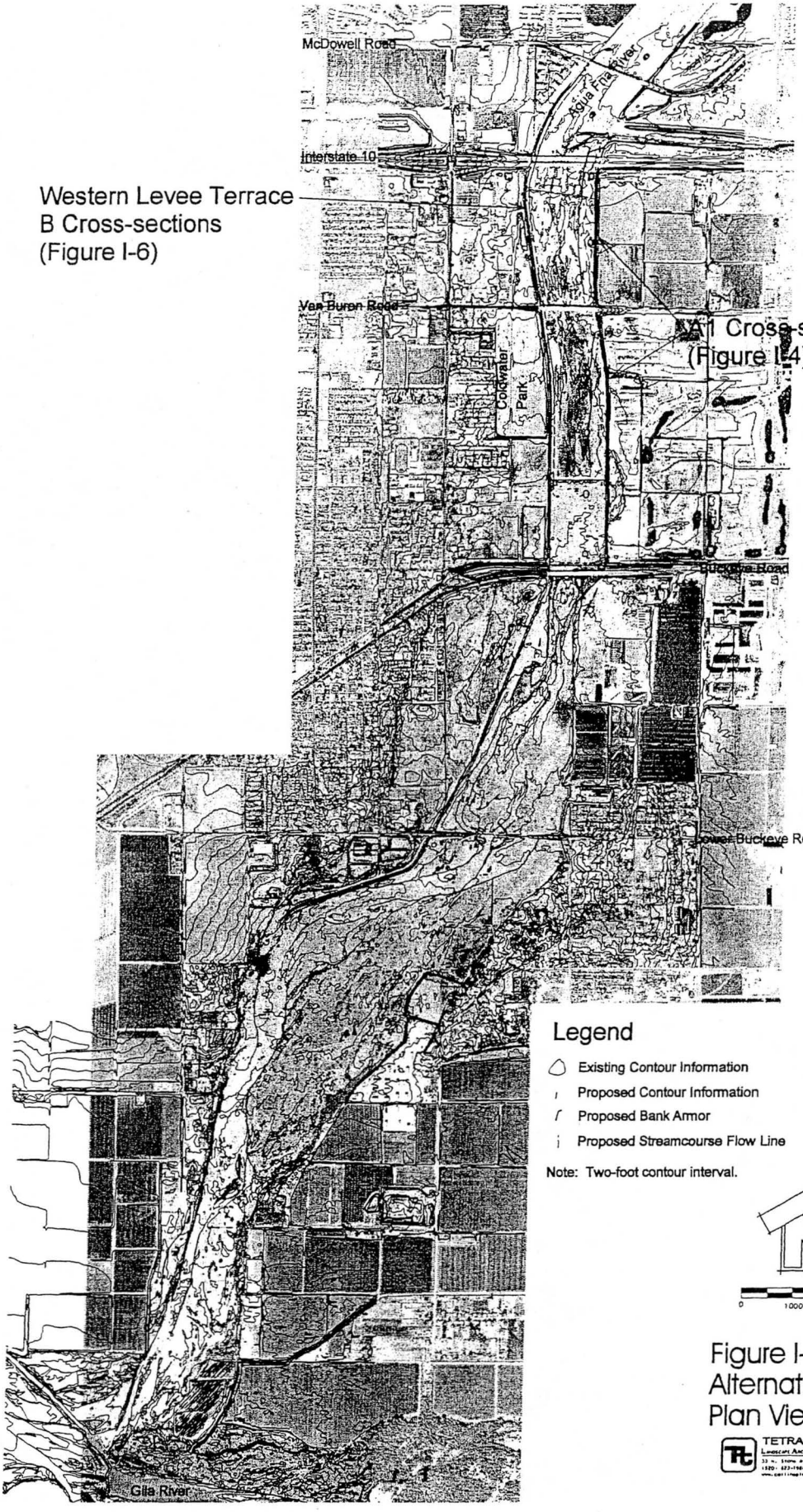


Figure I-1
Alternative 2
Plan View

TETRA TECH, INC.

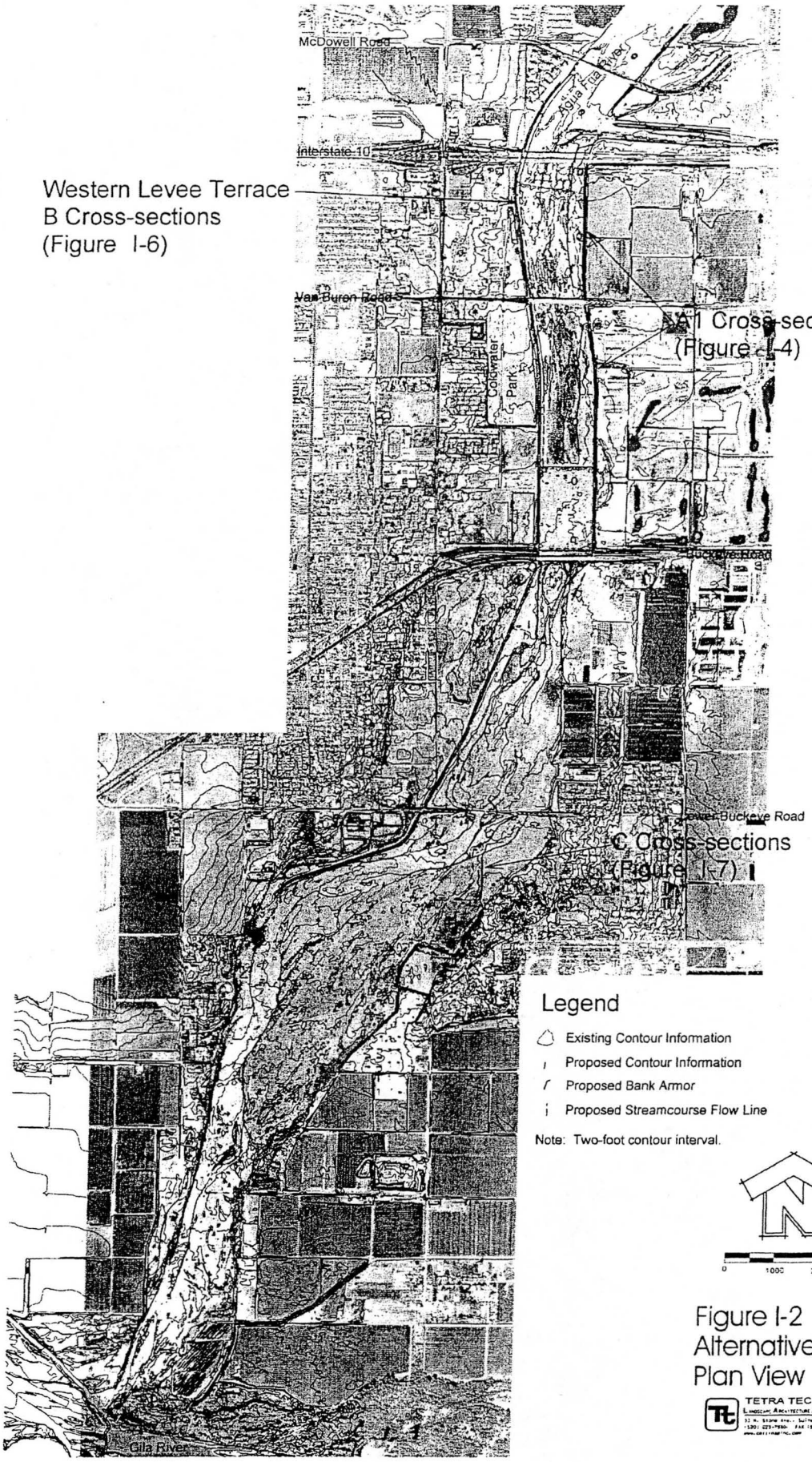


Figure I-2
Alternative 3
Plan View

TETRA TECH, INC.

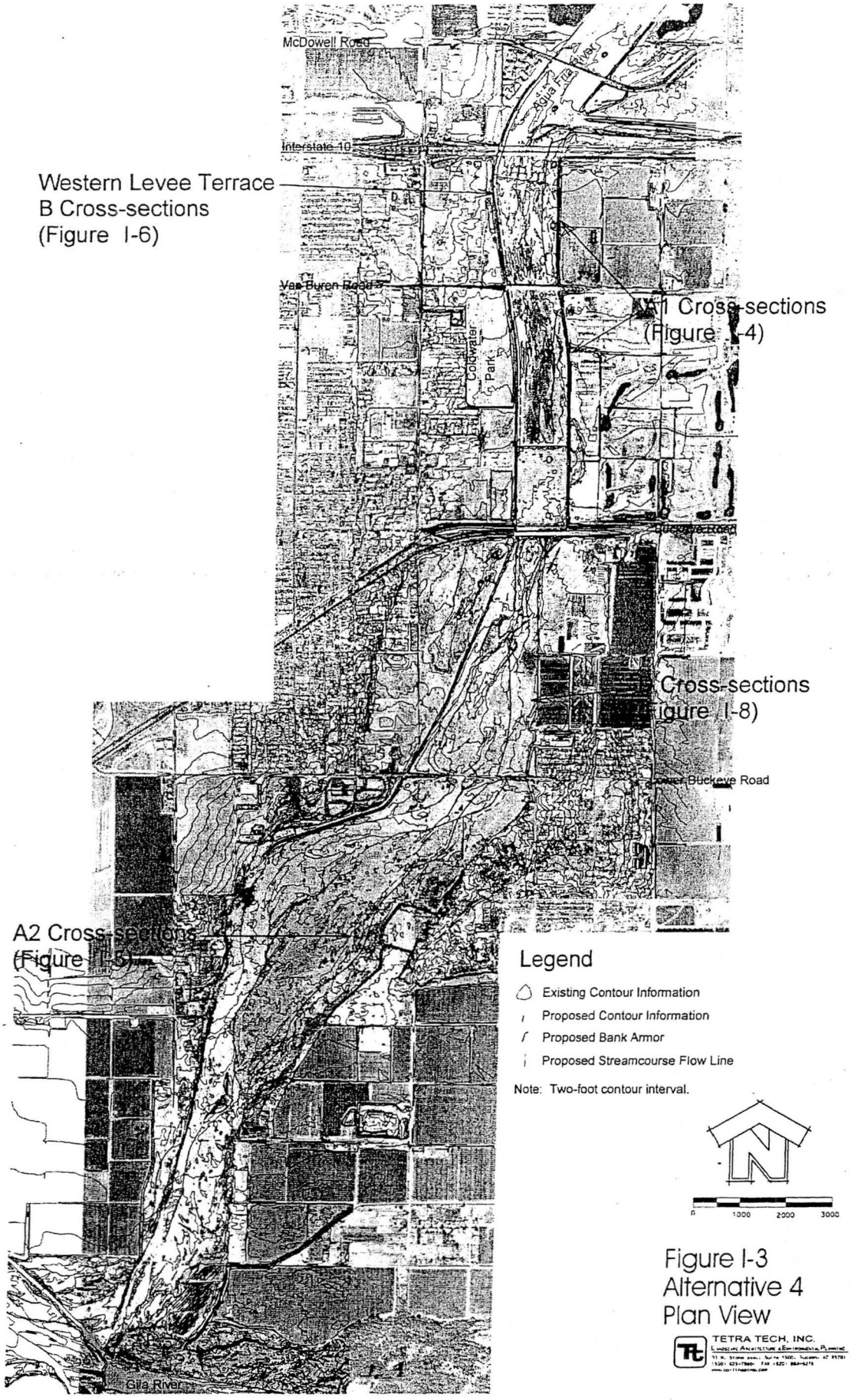
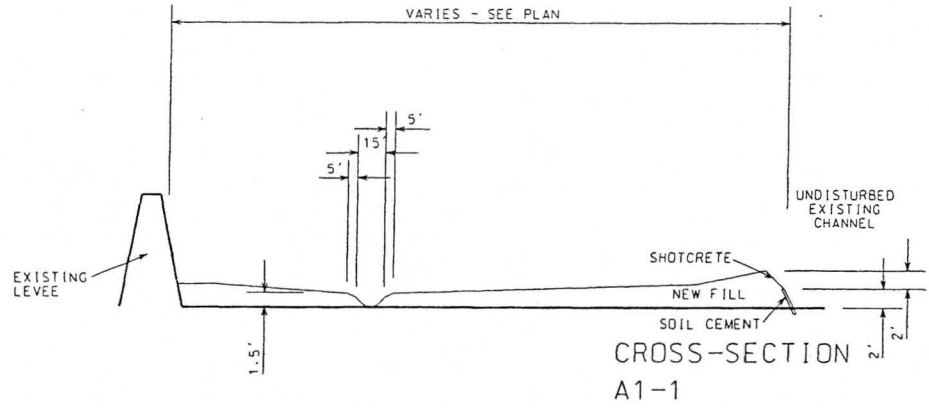
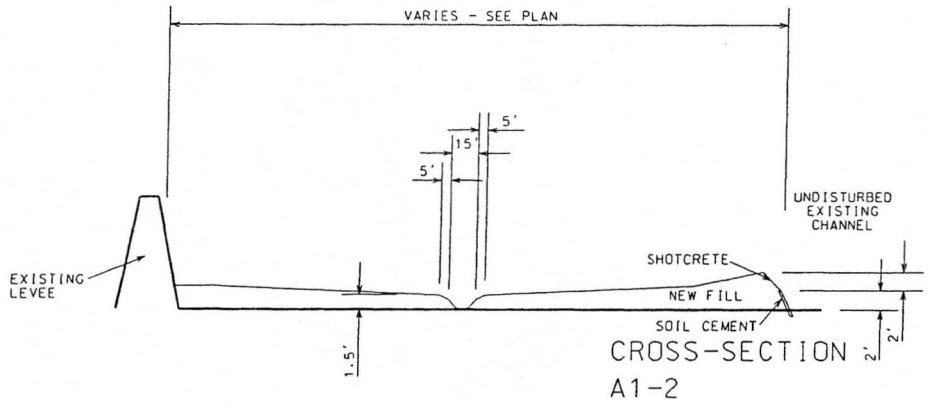


Figure I-3
Alternative 4
Plan View

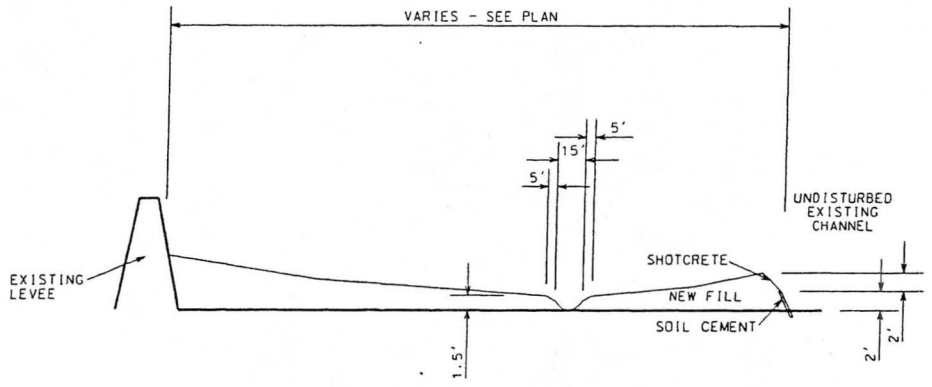
TETRA TECH, INC.



CROSS-SECTION
A1-1



CROSS-SECTION
A1-2



CROSS-SECTION
A1-3

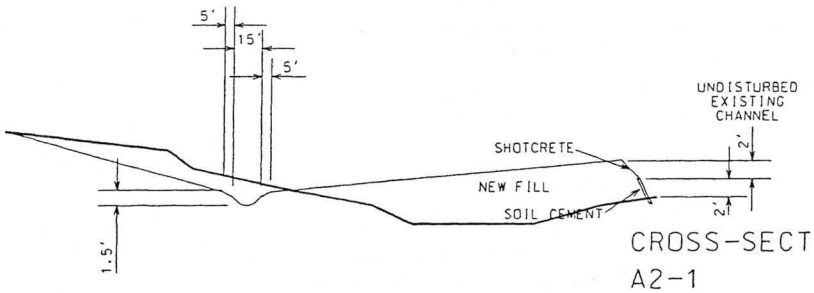
Slope of soil cement bank armor is 1:1
Toe down is 10' below surface

*Note: These are typical cross sections and are not location specific

SCALE:
HORZ: 1" = 100'
VERT: 1" = 20'

Figure I-4
A1 Cross-sections

TETRA TECH, INC.
Landscape Architecture & Environmental Planning
33 N. Stone Ave., Suite 1500, Tucson, AZ 85701
(520) 623-7980 FAX (520) 884-5278
www.collinspring.com



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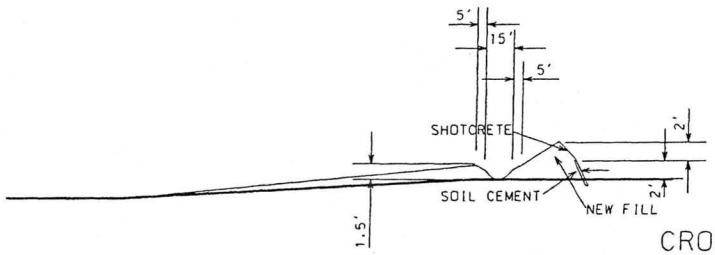

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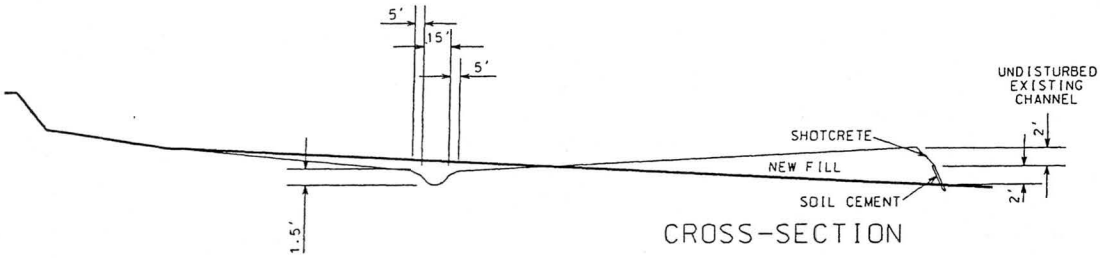
A2-2



CROSS-SECTION
A2-3

Slope of soil cement bank armor is 1:1
Toe down is 10' below surface

*Note: These are typical cross sections and are not location specific

SCALE:
HORZ: 1" = 100'
VERT: 1" = 20'

Figure I-5
A2 Cross-sections

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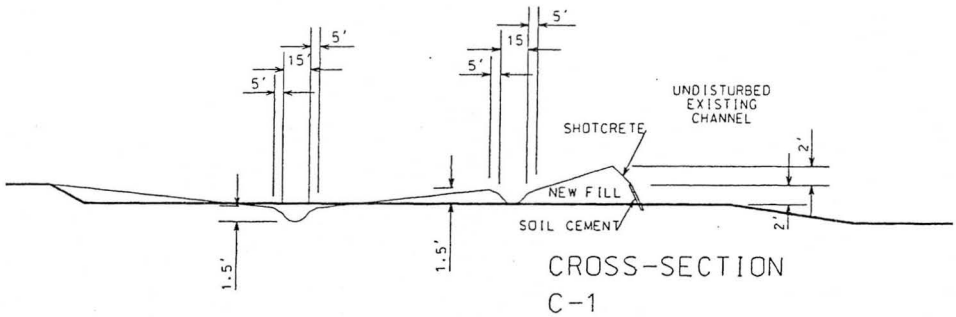

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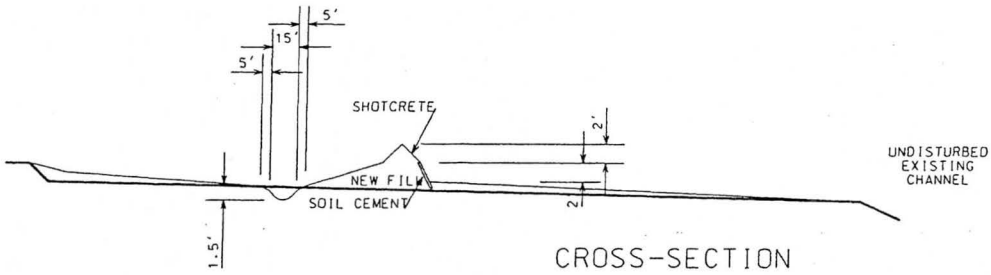
C-1



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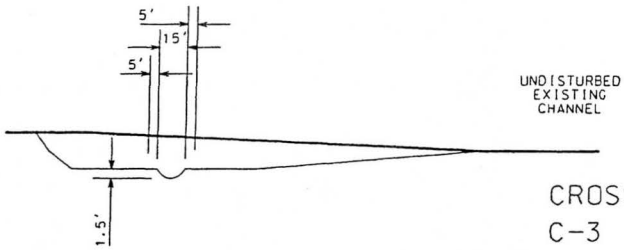

CROSS-SECTION
C-3

Slope of soil cement bank armor is 1:1
Toe down is 10' below surface

*Note: These are typical cross sections and are not location specific

SCALE:
HORZ: 1" = 100'
VERT: 1" = 20'

Figure I-7
C Cross-sections

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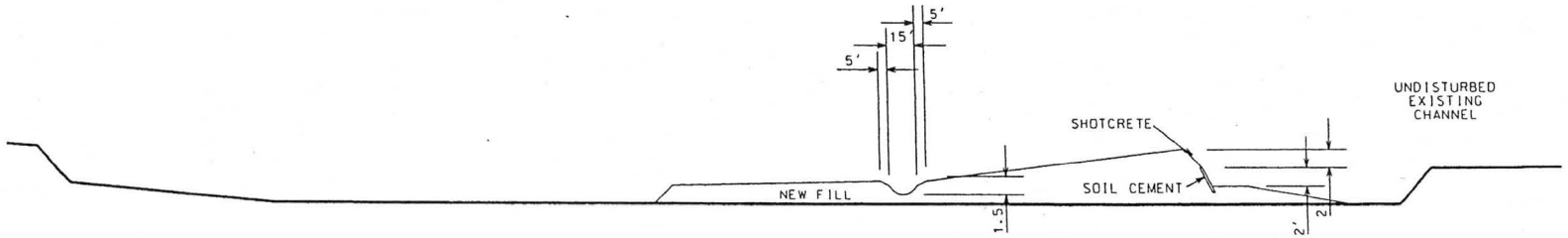
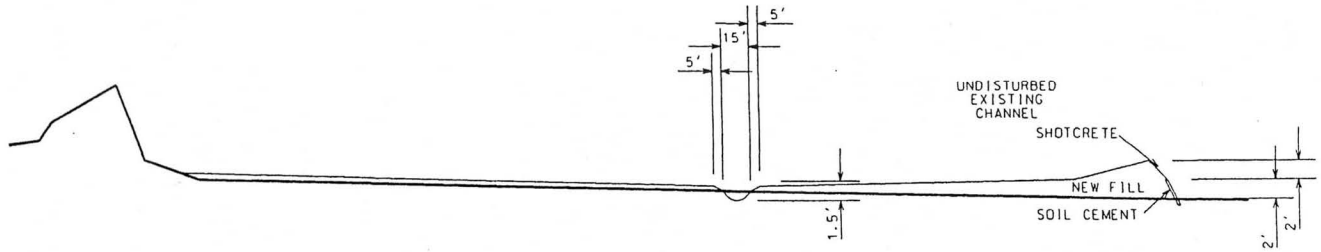


CROSS-SECTION
D-1



CROSS-SECTION
D-2

Slope of soil cement bank armor is 1:1
Toe down is 10' below surface

*Note: These are typical cross sections
and are not location specific

SCALE:
HORZ: 1" = 100'
VERT: 1" = 20'

Figure I-8
D Cross-sections

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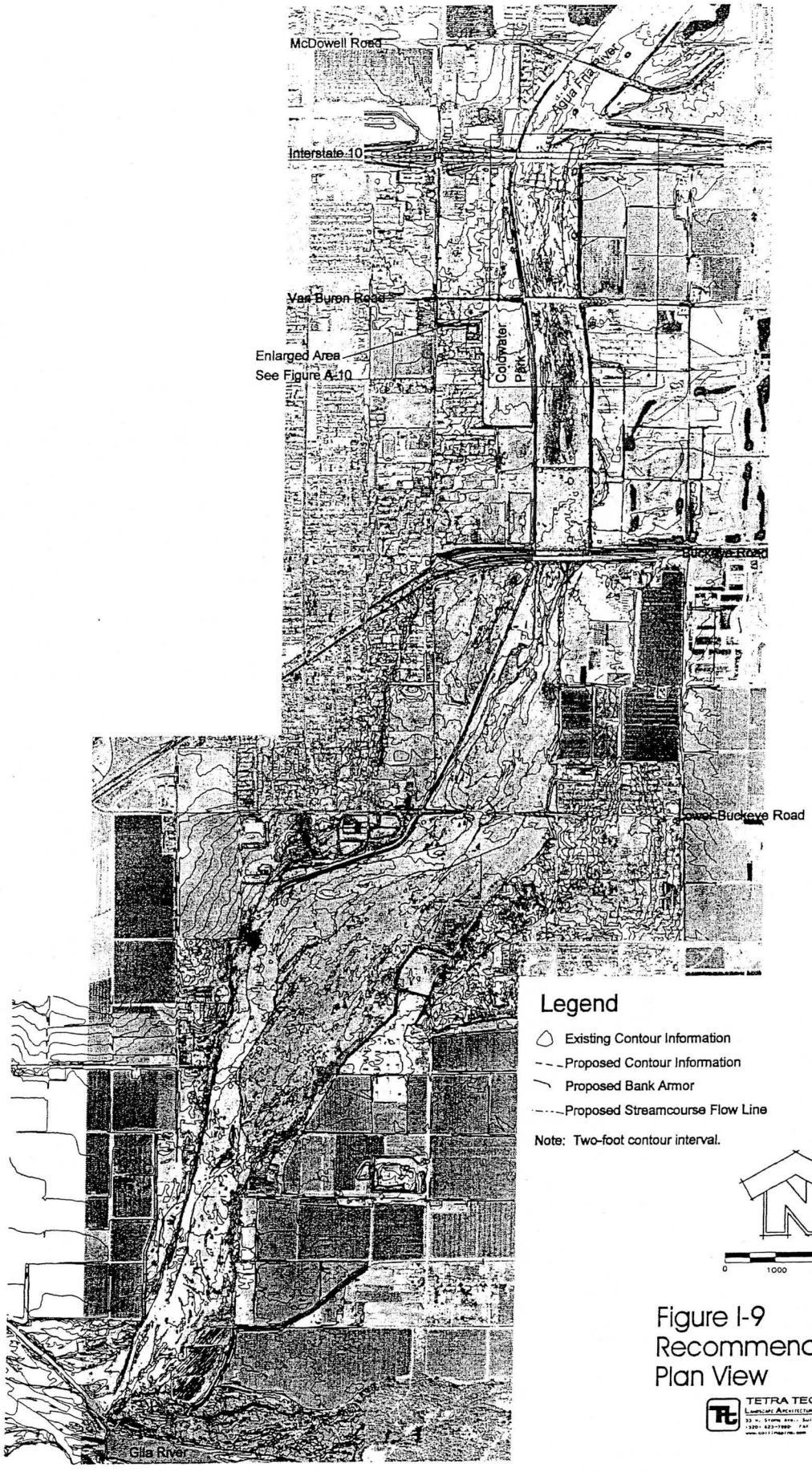
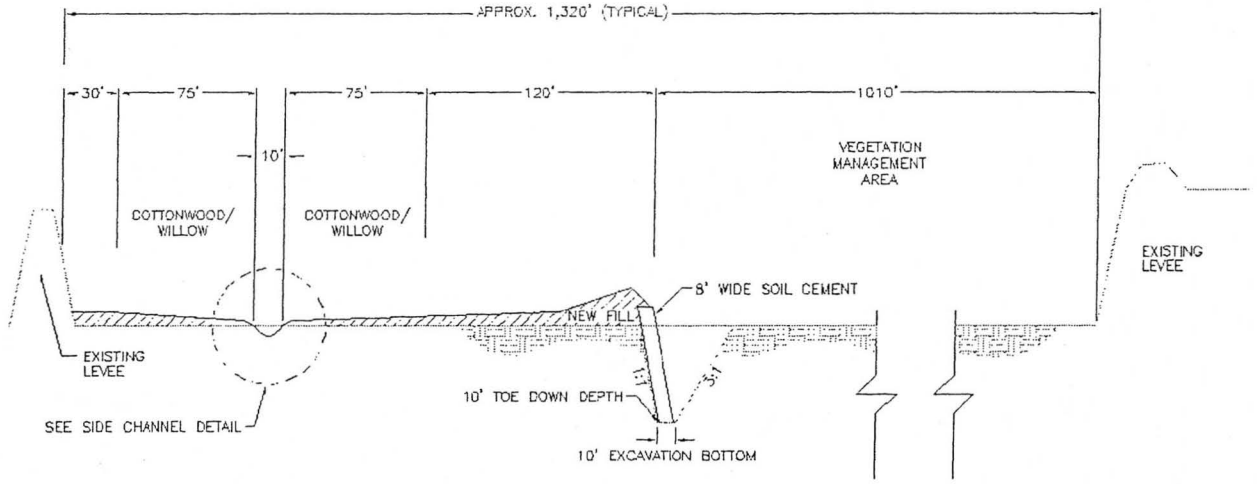
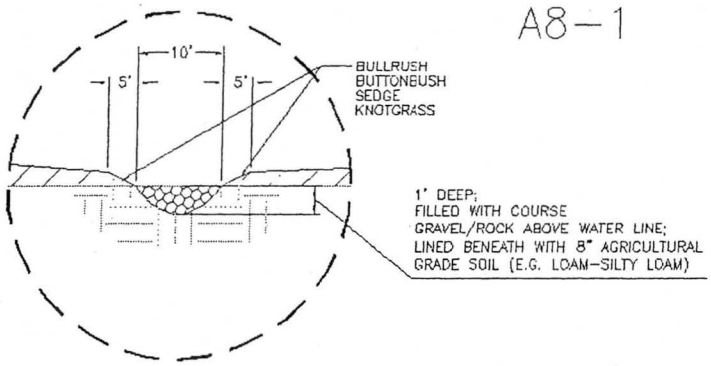


Figure I-9
Recommended Plan
Plan View

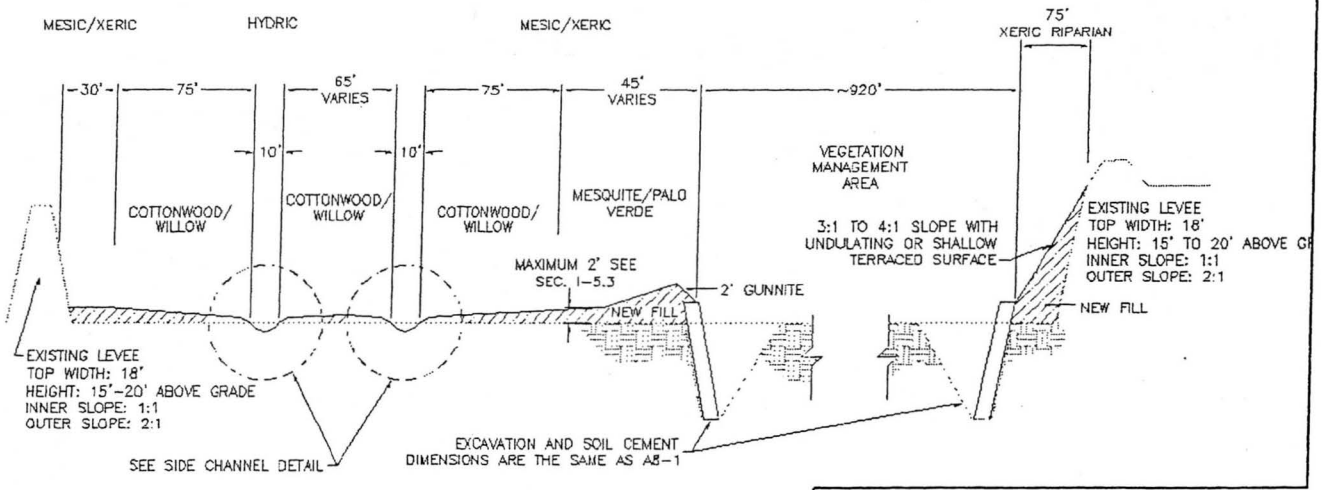
TETRA TECH, INC.
Landscape Architecture & Environmental Planning



A8-1



SIDE CHANNEL DETAIL



A8-2

* SEE SEC. 3.6 OF APPENDIX I FOR WELL INFORMATION
* VIEW IS FACING SOUTH, DOWNSTREAM
* NOT TO SCALE

Agua Fria Riparian Restoration Project

Figure I-11:

Cross Sections A8-1 & A8-2

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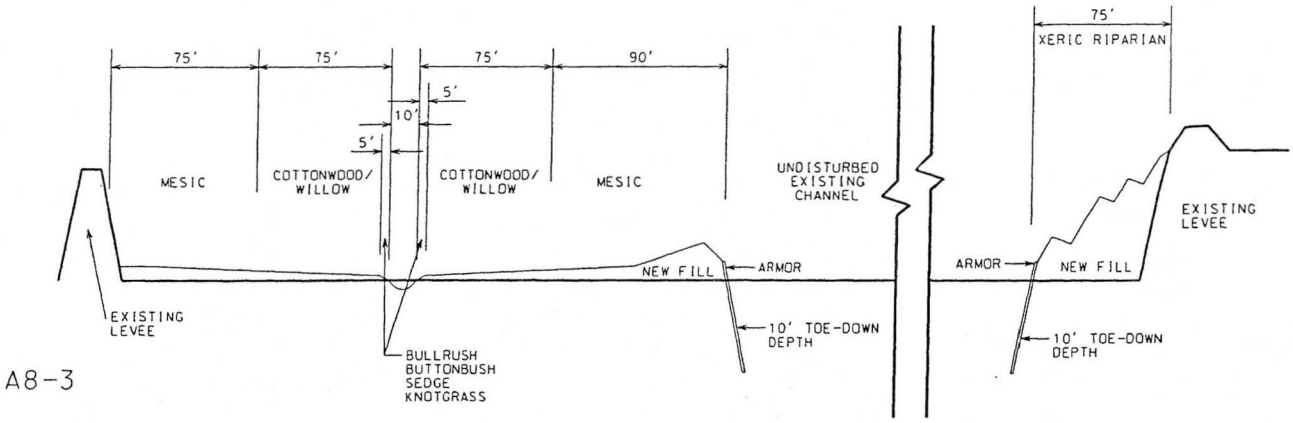
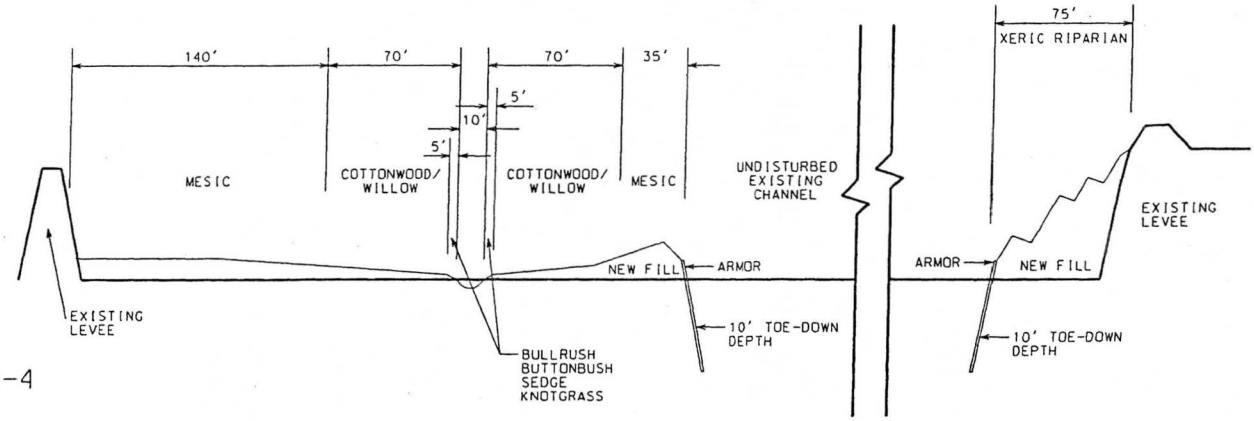
A Division of Aspen Environmental Group



A8-3



A8-4

SCALE:
HORZ: 1" = 100'
VERT: 1" = 20'

Figure I-12
Cross-sections
A8-3 & A8-4

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33 N. Stone Ave., Suite 1500, Tucson, AZ 85701
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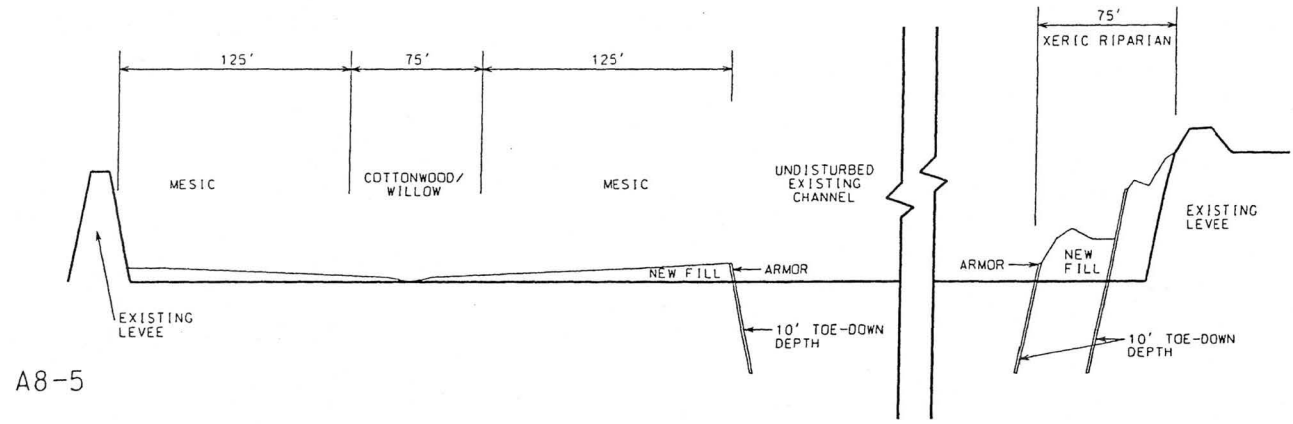
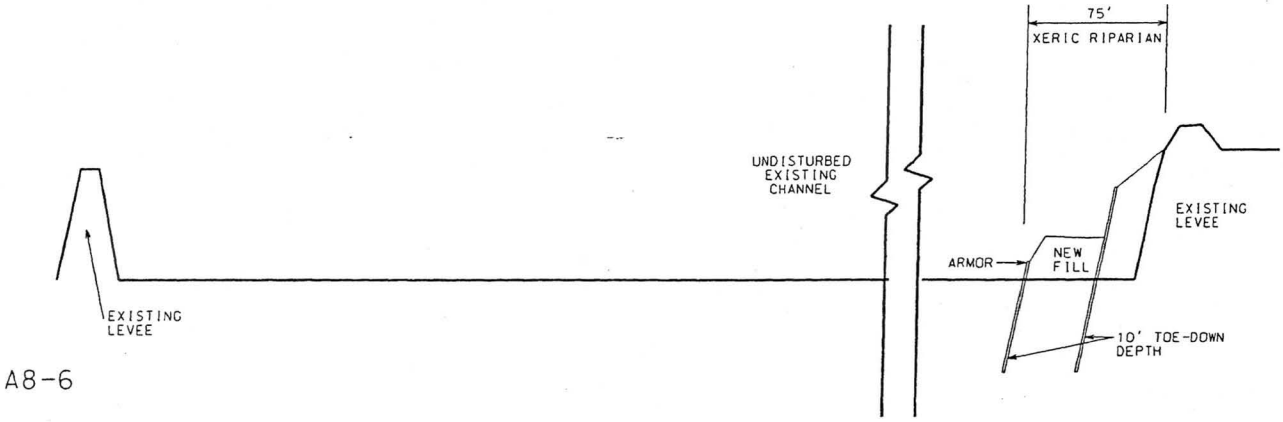


A8-5



A8-6

SCALE:
HORZ: 1" = 100'
VERT: 1" = 20'

Figure I-13
Cross-sections
A8-5 & A8-6

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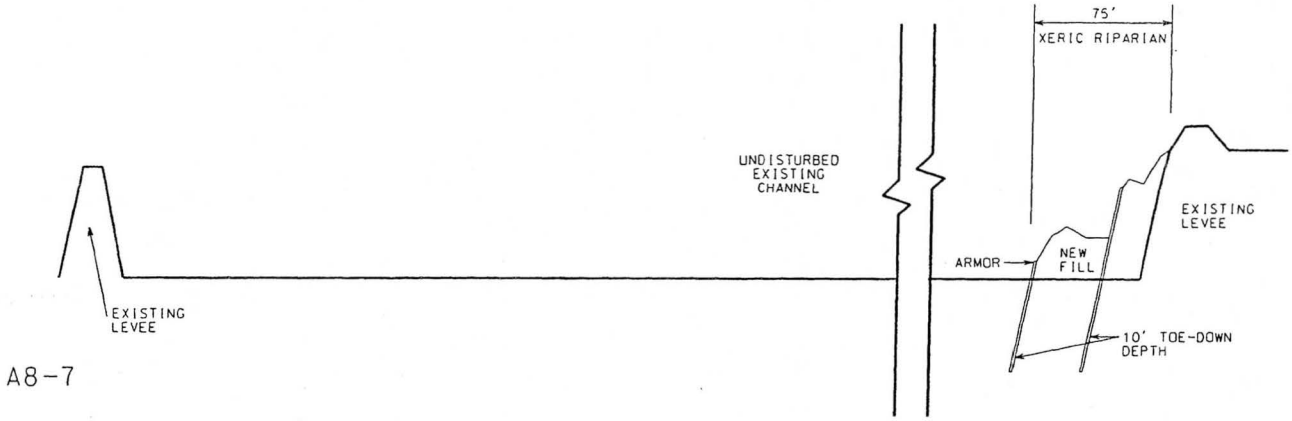

SCALE:
HORZ: 1" = 100'
VERT: 1" = 20'

Figure I-14
Cross-section
A8-7

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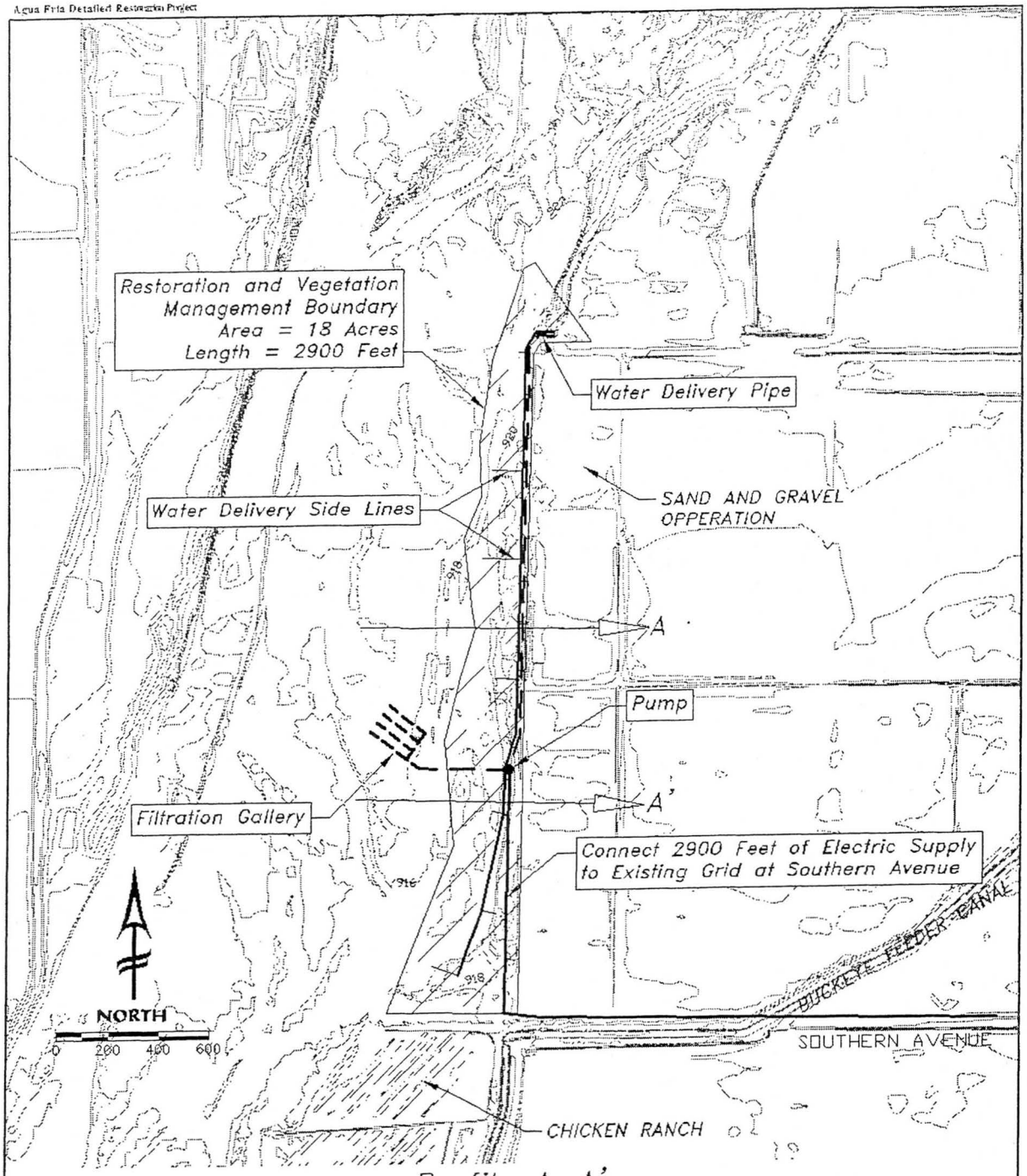
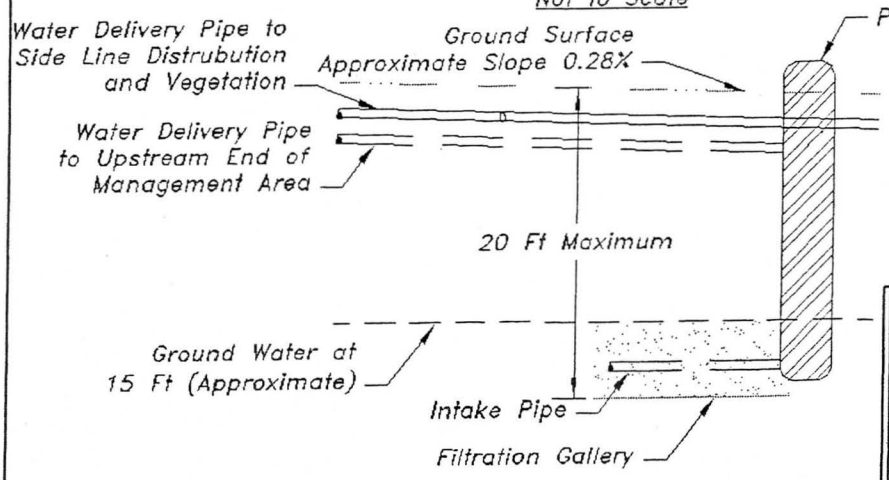


Profile A–A'

Not to Scale



Agua Fria Riparian Restoration Project

Figure I-15
Alternative 8
Recommended Plan
AWWTP Site

Aspen Consulting Engineers
A Division of Aspen Environmental Group

APPENDIX I.4

SINGLE EVENT SCOUR ANALYSIS FOR ALTERNATIVE 8 (RECOMMENDED PLAN)

Single Event Scour

The following procedure was used in the derivation of the "Level-One" relationships found in the ADWR State Standard for System Sediment Balance. All values are presented in English units.

C The wide-channel approximation is valid, such that R =. Y.

C The General-Scour Equation found on Page 6.09 of the City of Tucson "Drainage Standards Manual" applies. That is:

$$Z_{gs} = Y_m * ((0.685 * V_m^{0.8}) / (Y_h^{0.4} * S_c^{0.3})) - 1).$$

Where, Y_{max} and $Y_h = Y$ (for wide channels); and $S_e = S_c$ (for uniform flow).

C For alluvial channels, flow cannot sustain a supercritical state, but will tend toward minimum energy. Maximum scour will occur when F = 1.0 (at critical flow).

C Blodgett's Equation for Manning's "n" in sandbed channels applies. That is:

$$n = 0.0185Y^{1/6}$$

C At critical flow conditions, $V^2/2g = 0.5Y$. Therefore, $V = (gY)^{1/2}$.

C Also at critical flow conditions, $n = 0.2619S^{1/2}Y^{1/6}$. Substituting Blodgett's Equation into this relationship yields: S = .005 ft/ft. So, under these assumptions, any sandbed channel with a slope equal to or greater than 0.005 ft/ft will be at a critical state of flow during runoff events.

Now, substituting S = 0.005 ft//ft and $V = (gY)^{1/2}$ into the equation for Z_{gs} yields:

$$Z_{gs} = Y_{max} (1.3463 - 1) =. \underline{0.35Y}.$$

Standing waves or anti-dunes form at or near the critical state of flow in sandbed channels. The "scour" from these bedforms can be quantified as:

$$Z_{bf} = \tfrac{1}{2}\,[0.14(2B/g)V^2].$$

Again, substituting $V = (gY)^{1/2}$ yields:

$$Z_{bf} = \tfrac{1}{2}\,[0.8796Y] \,.\, \underline{0.44Y}.$$

Now, adding a factor of safety of 1.3 to account for non-uniform flow distribution, the combined scour from these two components becomes:

$$Z_{cs} = 1.3(0.35Y + 0.44Y) = 1.027Y \;\; = .\, \underline{1.0Y}.$$

At critical-flow conditions the combined scour from these two elements is approximately equal to the depth of flow. Now the depth of flow at critical-flow conditions can be computed as follows:

$Q = q/T$; $q = VY$; $V = (gY)^{1/2}$. Therefore, $q = (gY)^{1/2}(Y) = 5.6745Y^{3/2}$. Consequently, $Y_s = 0.3145q^{2/3}$; or approximately:

$$\boxed{Y_s = 0.315(Q/T)^{2/3}.}$$

Therefore, the only parameters needed are the flow top width, T, and the discharge, Q, in order to determine the depth of scour, in feet. It is recommended that the channel top width, in feet, and the 100-year peak discharge, in cfs, be used in the preceding equation, but any other discharge and corresponding top width can be used (e.g., 10-year). However, *if stream geometry deviates significantly from basically a rectangular shape, the channel bottom width should be substituted for channel top width* in order to maximize the "Level-One" scour estimate.

For the Agua Fria River Restoration Conceptual Design and usingQ_{10}=16,00cfs,T=1200ft

Ys= 1.74 ft.

The preceding equation should only be applied along straight channel reaches. Along channel reaches, which exhibit curvature (i.e., $R_c/T<10$), the following relationship should be applied:

$$Y_{sb} = 0.630(Q/T)^{2/3}(R_c/T)^{-3/10}.$$

Where R_c = Centerline Radius of Curvature of the Channel Top Width, in feet.

Some example results for a "forced bend" are provided:

Unit Discharge (Q/T)	Scour Depth (Straight Reach)	Bend Scour ($R_c/T = 3$)
10	1.5	2.1
50	4.3	6.1
100	6.8	9.8
200	10.8	15.5
300	14.1	20.3
500	19.8	28.5

You can see that reasonable "Level-One" answers result from applying this methodology to alluvial channels. Of course, *you would still want to add in a low-flow thalweg component of from 1.0 to 2.0 feet* on top of the values computed from the use of these equations. In addition, *a long-term degradation component should also be included* where no nearby grade controls exist in the downstream reaches of the fluvial system.

APPENDIX I.5

DETERMINATION OF DOMINANT DISCHARGE

APPENDIX I-5
ESTIMATE OF DISCHARGE FOR BERMS PROTECTING RIPARIAN STRIPS
(TERRACE BANK ARMOR)

"The dominant discharge is that value which is predominantly responsible for the geometric characteristics of the channel" as defined in Arizona Department of Water Resources "Design Manual for Engineering Analysis of Fluvial Systems" (ADWR, 1985).The reference goes on to state that the dominant discharge for a perennial stream occurs between the 2- and 5-year storm frequencies. For intermittent or ephemeral streams, such as the Agua Fria, the value generally lays between the 5- and 10-year storm frequencies.

The geometric characteristics of the Agua Fria channel in the study reach are set by the soil cement banks and grade control structures, not a "dominant discharge." However, the concept of a dominant discharge can be used as a guide for designing in-channel restoration that could be damaged by flows of sufficient magnitude. The proposed project includes protection of the restored areas using armored berms. The dominant discharge concept was used to determine an appropriate discharge for design of these protection structures.

The following procedure was used to determine an appropriate discharge for design of erosion protection features.

Step 1: **Review Flow Records.** Table 1 gives peak discharges measured by the U.S.G.S. for the Agua Fria River at Avondale for the years 1959 to 1982. Although this period is prior to the revisions to the Waddell Dam, they are considered representative of the types of flows that have occurred on the Agua Fria River at the project site.

Many of the years have no flow recorded. The average and median peak flows recorded, considering positive flow years only, are 9,200 and 5,090 cfs, respectively. These correspond to approximately 2 to 5 year floods.

Step 2: **Probability Weighting of Peak Discharges.** A rough estimate of the dominant discharge can be made based on a probability weighting of annual peak discharge. This is done by plotting annual peak discharge from Table 2 against annual flood probability as shown in Figure 1. The area under the curve represents the average annual discharge of 7,608 cfs. This discharge is approximately a 3 to 4-year flood.

Step 3: **Risk of Occurrence During the Project Life.** The risk of a discharge as large or greater than a given discharge occurring during the life of a project can be calculated by the formula:

$$R = 1 - (1 - 1/RP)^n$$

where, R = Probability, or risk, of occurrence during the life of the project, represented as a decimal fraction or percentage;

RP = Flood return period, in years; and,

n = Number of years of project life (in this case, 50).

Table 3 shows the results of this calculation for various return period floods. The table shows that the 2 to 5 year floods, as indicated in the analysis under #1 and #2 above, have virtually a 100% chance of occurrence during the 50-year project life (the chance is actually slightly less than 100%, but represented as 100% because of rounding). The 10-year to 15-year floods have near 100% risk, with decreasing risk with greater return period.

Based on the above analysis, it was determined that the dominant discharge on the Agua Fria ranges from a 2 to 5 year flood, as indicated by ADWR (1985). However, the Table 3 analysis shows that 10-year to 15-year floods have a very high risk of occurrence during the project life. Based on this high level of risk, the 10-year to 15-year flood was chosen as the discharge for design of above-ground restoration protection. Flows exceeding these return periods would have the potential to overflow into the restoration area, potentially resulting in damage. However, this is considered a natural occurrence and an acceptable level of risk for the restoration plants. The below-ground protection (toedown) was designed for a higher level of protection (100-year) for the reason that this would allow the protection to remain in place during most floods likely to occur during the project life. With the erosion protection intact, restored areas could be easily revived after the flood passes.

References:

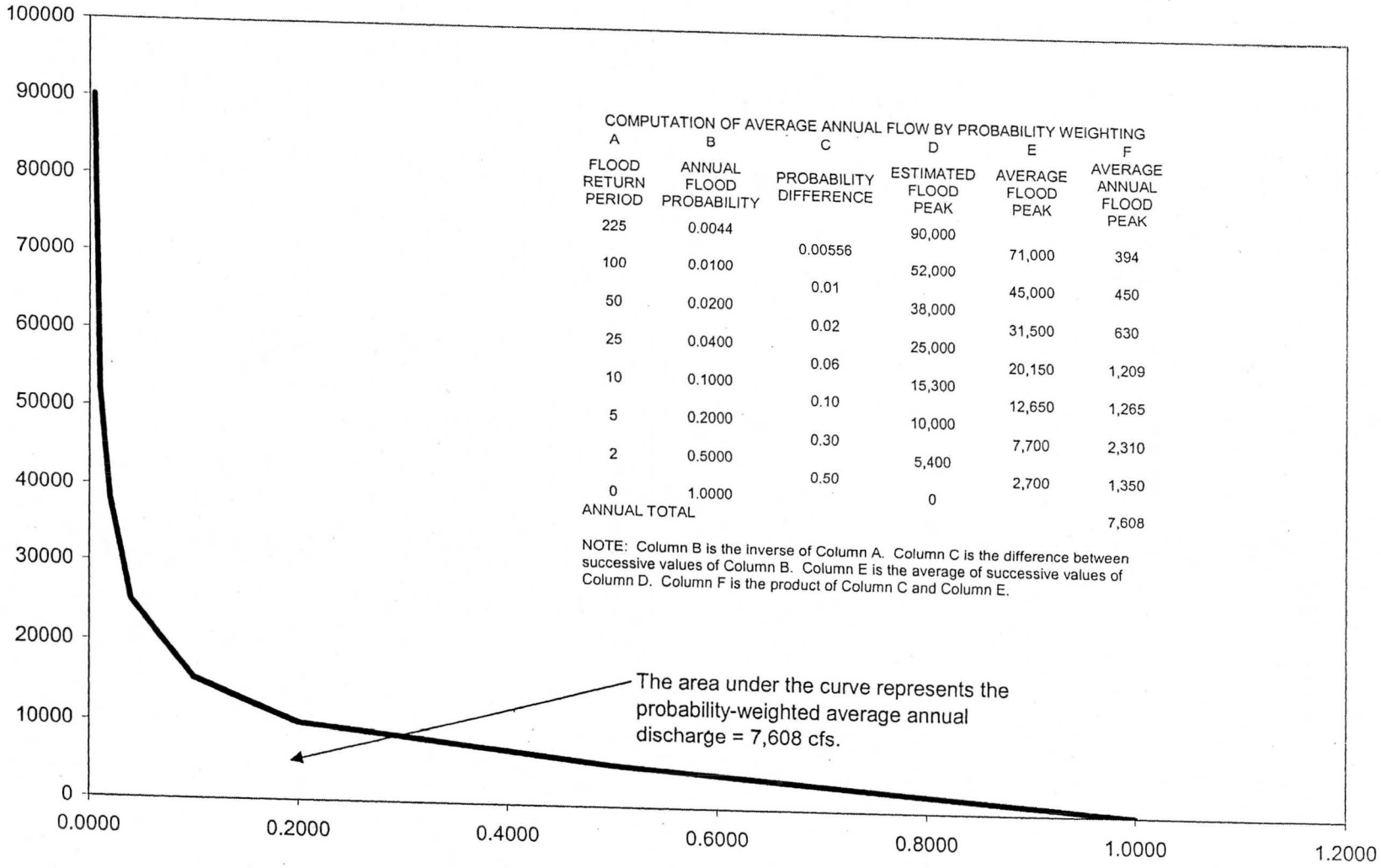
ADWR. 1985. Arizona Department of Water Resources. "Design Manual for Engineering Analysis of Fluvial Systems".

Table 1. Recorded Annual Peak Discharges on the Agua Fria River at Avondale.	
YEAR	PEAK DISCHARGE, IN CFS
1959	4,700
1961	0
1962	0
1963	63
1964	3,000
1965	460
1966	800
1967	0
1968	20,000
1969	0
1970	20,600
1971	8,200
1972	5,180
1973	5,000
1974	0
1975	0
1976	0
1977	0
1978	13,100
1979	29,300
1980	0
1981	0
1982	0

Table 2. Agua Fria River Peak Discharge Rates for Restoration Project Site.	
Flood Return Period, in Years	Flood Peak Discharge, in cubic feet per second (cfs)
225	90,000
100	52,000
50	38,000
25	25,000
10	15,300
5	10,000
2	5,400

Table 3. Risk of Occurrence of Various Return Period Floods During a 50-Year Project Life.		
FLOOD RETURN PERIOD, IN YEARS	FLOOD PEAK DISCHARGE RATE, IN CFS	RISK OF OCCURRENCE IN 50-YEAR PROJECT LIFE
2	5,400	100%
5	10,000	100%
10	15,300	99%
15	19,000	97%
25	25,000	87%
50	38,000	64%
100	52,000	39%
225	90,000	20%

Figure 1. Computation of Average Annual Flow by Probability Weighting



COMPUTATION OF AVERAGE ANNUAL FLOW BY PROBABILITY WEIGHTING

A	B	C	D	E	F
FLOOD RETURN PERIOD	ANNUAL FLOOD PROBABILITY	PROBABILITY DIFFERENCE	ESTIMATED FLOOD PEAK	AVERAGE FLOOD PEAK	AVERAGE ANNUAL FLOOD PEAK
225	0.0044		90,000		
		0.00556		71,000	394
100	0.0100		52,000		
		0.01		45,000	450
50	0.0200		38,000		
		0.02		31,500	630
25	0.0400		25,000		
		0.06		20,150	1,209
10	0.1000		15,300		
		0.10		12,650	1,265
5	0.2000		10,000		
		0.30		7,700	2,310
2	0.5000		5,400		
		0.50		2,700	1,350
0	1.0000		0		
ANNUAL TOTAL					7,608

NOTE: Column B is the inverse of Column A. Column C is the difference between successive values of Column B. Column E is the average of successive values of Column D. Column F is the product of Column C and Column E.

APPENDIX J.

COST ESTIMATE ANALYSIS

APPENDIX J. COST ESTIMATES

Construction Costs

Conceptual cost estimates are presented for each alternative in Figures J-1 through J-7, located at the end of this appendix. Table J-1 summarizes the results. The following text defines some of the cost estimate items. Alternatives 5 and 8 fall within the authorized expenditure level for the Corps; the others do not and would require either special Congressional authorization for additional funds, or more monetary contribution from the local sponsor.

- **Mobilization:** The act of bringing heavy equipment to the site that will be used to perform the construction.
- **Clearing and Grubbing:** Removal of elements of the landscape that would be in the way of grading equipment. This includes trees, shrubs, boulders, and miscellaneous debris. The area is the product of the length and width of each riparian strip. It is roughly equivalent to the restored area within the riparian strips; although this is an overestimate since the western riparian strip only requires clearing in the restoration area that extends beyond the toe of the levee. Note that clearing in the area needed to construct the toe down for the terrace bank armor is included in the unit cost of the soil cement.
- **Rough Grading:** Movement of imported fill within the channel. Research for this phase of the project indicates that no excavation of hazardous materials, debris or solid waste is required for this project.
- **Import Material:** Any soil or fill material needed during the grading process that is not available on-site. The quantity included in the estimate assumes a maximum depth of approximately 3 feet for Alternatives 2 to 7, and a minimum fill depth of one foot for Alternative 8 along both the east and west riparian strips at the I-10 site. In other words, for Alternative 8 the fill is overestimated for a depth of one foot, but the volume is kept low enough so that the project cap was not exceeded. During the design phase if other project costs are lower, then the opportunity for increasing fill, especially on the western levee should be considered so that the 4:1 slope that was conceptualized for this side of the project can be achieved.
- **Wells & Distribution System:** Wells, reservoir tanks, piping, electrical hookups, etc.
- **Irrigation System:** Water connection, meter, valves, piping, emitters, etc.
- **I-10, Liner for 2 Side Channels:** 8" of silt or silty loam to reduce, but not eliminate, infiltration from 2 side channels constructed to be 1' deep X 10' wide, that extend along the eastern riparian strip and ensure water delivery to downstream habitat. Volume is proportional to length of eastern riparian strip.
- **I-10, Fill for 2 Side Channels:** 12" of very coarse material like rocks to fill 2 side channels 1' deep X 10' wide, along eastern levee to reduce surface water area, but allow flow. Volume is proportional to length of eastern riparian strip.
- **AWWTP, Pump, Power Supply, etc.:** Materials for construction of filtration galleries, power line to run pumps, and water distribution of shallow groundwater and infiltrated effluent at the AWWTP site.
- **Bank Armor Construction:** For Alternatives 2 to 7 this includes construction of soil cement to approximately 2' above grade on the eastern and western riparian strips, construction of gunnite an additional 2' above soil berm above the bank protection along eastern riparian strip, construction of a 10' toedown along eastern and western riparian strips. For Alternative 8 it is assumed that gunnite is replaced by gabions, which can be planted, but the unit cost was not changed. Unit cost includes clearing, excavation of toe and placement of materials. Excavated materials are disposed of by the contractor. The unit cost for this item is taken from cost examples for soil cement construction produced by the City of Phoenix.
- **Exotics Removal in Vegetation Management Areas:** Use of heavy equipment, cutting or spraying for initial control of exotic, invasive species at vegetation management areas.
- **Plant Material & Other Habitat Components:** Plants, boulders, and other items necessary to create microhabitats within the habitat areas.

- **Establishment & Maintenance:** Initial monitoring of plant materials and irrigation systems to assure survival or replacement of dead, stolen, or damaged materials.
- **LERRDS (Lands, Easements, Rights-of-Way, Relocation and Disposal Areas):** Local sponsor is responsible for all LERRDS. This item distinguishes among: (1) acquisition of private lands by local sponsor; (2) the value of lands already owned by the FCDMC, Maricopa County and the City of Avondale; and (3) the administrative costs to obtain easements or permits on other public or private lands. Administrative costs for easements are based on a unit cost per entity. For Alternatives 2 to 7 these entities are other public agencies. For Alternative 8, Recommended Plan, this includes one additional entity, the Buckeye Irrigation District, to cover the cost of negotiating an easement for the power line to run the pump that operates the filtration galleries.

Table J-1 – Cost Estimate Summary (rounded to nearest dollar)

	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8 Recommended Plan
LERRDs	$868,000	$1,302,000	$3,328,000	$528,000	$962,000	$2,173,000	$1,115,000
Subtotal *	$ 10,394,986	$14,858,933	$22,777,643	$ 4,624,479	$ 7,115,503	$16,357,639	$5,589,000
P,E,&D (Plans, Specs, Etc.)	$ 300,000	$ 300,000	$ 300,000	$ 300,000	$ 300,000	$ 300,000	$ 446,200
S.I.O.H. (6.5%)	$ 695,174	$ 985,331	$ 1,500,047	$ 320,091	$ 482,008	$ 1,082,747	$ 290,000
TOTAL	**$ 11,390,160**	**$16,144,264**	**$24,577,690**	**$5,244,570**	**$ 7,897,511**	**$17,740,386**	**$6,325,200**

*Subtotal includes all construction costs + LERRDS + 10% contingency.

OMRR&R Costs

Operation and maintenance costs are estimated to range from $78,932 to $673,597 per year. Table J-2 summarizes the costs presented in Figure J-8 at the end of this appendix. Maintenance is assumed to include weeding and dead plant replacement, miscellaneous litter and debris removal, exotic species control, localized sediment releases to facilitate natural establishment of native species, irrigation system maintenance, water pump system maintenance and electricity.

Table J-2 – Annual OMRR&R Costs (rounded to nearest dollar)

	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8 Recommended Plan
Annual Cost	$ 120,822	$ 144,857	$ 673,597	$ 78,932	$ 128,607	$ 318,992	$ 129,166
Annual Cost per Acre	$ 1,694	$ 1,590	$ 7,527	$ 1,683	$ 1,906	$ 1,415	$ 1,123

Water for the habitat restoration is provided by the local sponsor and is not included in the estimate of operation and maintenance costs. Water for the I-10 site is assumed to come from an existing City of

Avondale well. Water for the AWWTP site will come partially from 1 mGPD of effluent from the water treatment plan and from shallow groundwater obtained at less than 20 feet from the surface. The source of the water for either site may change as long as the local sponsors can satisfy the water needs of the project. During the establishment period, water needs for the project are expected to be somewhat higher.

CESPL-ED-DS 19 July 2004
Subject: Agua Fria Ecosystem Restoration DPR MCACES on Alt 8.

Time and funding precluded the team from preparing MCACES estimates for the non-preferred alternatives. In view that neither time nor funding were available, Planning Division instructed Cost Engineering to prepare an MCACES estimate for the preferred alternative (Alt #8).

Detailed qtys were not submitted. Several detailed qtys were computed based on narratives and conversations.

Assumed diversion and control of water as well as dewatering are not an issue.

Mob/Demob. Bring heavy equip to the site, including soil cement processing plant. Work site located in Maricopa County, AZ
Rough Grading. Work consists on knocking off the high points and filling in the valleys. Import Material from an unidentified off-site source.
I-10 Water Distribution System. No drawings or details provided. Assumed construction of a 12" PVC line for 2,500 lf using PACES. System conveys water to the Eastern Strip.
I-10 Irrigation System. No drawings or details provided. Use PACES to create a parametric estimate to irrigate 6.5 acres.
I-10 Liner for 2 side channels – Fine Material. 8" of silt or silty loam.
I-10 Fill for 2 side channels – Coarse Material. 12" of coarse material. Assumed material is obtained from within the site. Material price was zeroed out.

The following items belong to the water recirculation system. The system encompasses a filtration gallery for 18 acres of "vegetation management areas"; the remaining 63 acres does not get water (see table 4.3-1).
Avondale Waste Water Treatment Plant (AWWTP), 2 mgd pump.
Avondale Waste Water Treatment Plant (AWWTP), Power Supply. Connect 2,900 feet of electric supply as per I-15 of DPR.
Avondale Waste Water Treatment Plant (AWWTP), Control Panel
Avondale Waste Water Treatment Plant (AWWTP), Well. Assumed well is 100 feet deep.
Avondale Waste Water Treatment Plant (AWWTP), 12" slotted drain. Trench is 20' deep as per Fig I-15 of DPR.
Avondale Waste Water Treatment Plant (AWWTP), 18" CMP. Trench is 20' deep as per Fig I-15 of DPR.
Avondale Waste Water Treatment Plant (AWWTP), 6" Filter

FOOH, HOOH and Profit were computed based on standard percentages due to the preliminary level of work and amount of planning detail available.

Contingencies were set at the 3rd level in the MCACES estimate. See notes in the MCACES report.

Schedule of work: 8 hrs/day, 5 days/week.

FIGURE J-8
OMRR COSTS

	ITEM	DESCRIPTION	UNIT	UNIT COST	QUAN.	TOTAL COST	PER ACRE COST
ALTERNATIVE 1 - NO ACTION							
	Maintenance Labor		HR		0	$ -	$ -
	Equipment		EA		0	$ -	$ -
	Plant Replacement & Removal		LS		0	$ -	$ -
	Irrigation & Water Dist. System Depreciation		LS		0	$ -	$ -
	Pump Operation		EA		0	$ -	$ -
	Environmental Monitoring		HR		0	$ -	$ -
						$ -	$ -

	ITEM	DESCRIPTION	UNIT	UNIT COST	QUAN.	TOTAL COST	PER ACRE COST
ALTERNATIVE 2	72	acres					
	Maintenance Labor	2 laborers, 20 hrs/week each	HR	$ 16	2080	$ 33,280.00	$ 462.22
	Equipment	1/2 maintenance vehicle	EA	$ 15,000	0.5	$ 7,500.00	$ 104.17
	Plant Replacement & Removal	5% per year	LS	$ 810,000	0.05	$ 40,500.00	$ 562.50
	Irrigation & Water Dist. System Depreciation	5% per year	LS	$ 400,000	0.05	$ 20,000.00	$ 277.78
	Pump Operation	Electricity Cost	LS	$ 6,230	1	$ 6,230.00	$ 102.13
	Environmental Monitoring	1 biologist, 8 hrs/week	HR	$ 32	416	$ 13,312.00	$ 184.89
						$ 120,822.00	$ 1,693.69

	ITEM	DESCRIPTION	UNIT	UNIT COST	QUAN.	TOTAL COST	PER ACRE COST
ALTERNATIVE 3	94	acres					
	Maintenance Labor	2 laborers, 20 hrs/week each	HR	$ 16	2080	$ 33,280.00	$ 354.04
	Equipment	1/2 maintenance vehicle	EA	$ 15,000	0.5	$ 7,500.00	$ 79.79
	Plant Replacement & Removal	5% per year	LS	$ 1,095,000	0.05	$ 54,750.00	$ 582.45
	Irrigation & Water Dist. System Depreciation	5% per year	LS	$ 550,000	0.05	$ 27,500.00	$ 292.55
	Pump Operation	Electricity Cost	LS	$ 8,515	1	$ 8,515.00	$ 139.59
	Environmental Monitoring	1 biologist, 8 hrs/week	HR	$ 32	416	$ 13,312.00	$ 141.62
						$ 144,857.00	$ 1,590.04

	ITEM	DESCRIPTION	UNIT	UNIT COST	QUAN.	TOTAL COST	PER ACRE COST
ALTERNATIVE 4	304	acres					
	Maintenance Labor	4 laborers, 26 hrs/week each	HR	$ 16	5408	$ 86,528.00	$ 284.63
	Equipment	1 maintenance vehicle	EA	$ 15,000	1	$ 15,000.00	$ 49.34
	Plant Replacement & Removal	5% per year	LS	$ 2,670,000	0.05	$ 133,500.00	$ 439.14
	Irrigation & Water Dist. System Depreciation	Water Cost (western riparian strip and veg. mgt. areas)	acre foot	$ 202	1902.2	$ 384,354.73	$ 6,300.90
	Pump Operation	Electricity Cost	LS	$ 20,934	1	$ 20,934.00	$ 343.18
	Environmental Monitoring	1 biologist, 20 hrs/week	HR	$ 32	1040	$ 33,280.00	$ 109.47
						$ 673,596.73	$ 7,526.67

FIGURE J-8
OMRR COSTS

	ITEM	DESCRIPTION	UNIT	UNIT COST	QUAN.	TOTAL COST	PER ACRE COST
ALTERNATIVE 5	46	acres					
	Maintenance Labor	1 laborers, 20 hrs/week each	HR	$ 16	1040	$ 16,640.00	$ 361.74
	Equipment	1/4 maintenance vehicle	EA	$ 15,000	0.25	$ 3,750.00	$ 81.52
	Plant Replacement & Removal	5% per year	LS	$ 480,000	0.05	$ 24,000.00	$ 521.74
	Irrigation & Water Dist. System Depreciation	5% per year	LS	$ 300,000	0.05	$ 15,000.00	$ 326.09
	Pump Operation	Electricity Cost	LS	$ 6,230	1	$ 6,230.00	$ 102.13
	Environmental Monitoring	1 biologist, 8 hrs/week	HR	$ 32	416	$ 13,312.00	$ 289.39
						$ 78,932.00	$ 1,682.61

	ITEM	DESCRIPTION	UNIT	UNIT COST	QUAN.	TOTAL COST	PER ACRE COST
ALTERNATIVE 6	68	acres					
	Maintenance Labor	2 laborers, 20 hrs/week each	HR	$ 16	2080	$ 33,280.00	$ 489.41
	Equipment	1/2 maintenance vehicle	EA	$ 15,000	0.5	$ 7,500.00	$ 110.29
	Plant Replacement & Removal	5% per year	LS	$ 870,000	0.05	$ 43,500.00	$ 639.71
	Irrigation & Water Dist. System Depreciation	5% per year	LS	$ 450,000	0.05	$ 22,500.00	$ 330.88
	Pump Operation	Electricity Cost	LS	$ 8,515	1	$ 8,515.00	$ 139.59
	Environmental Monitoring	1 biologist, 8 hrs/week	HR	$ 32	416	$ 13,312.00	$ 195.76
						$ 128,607.00	$ 1,905.65

	ITEM	DESCRIPTION	UNIT	UNIT COST	QUAN.	TOTAL COST	PER ACRE COST
ALTERNATIVE 7	278	acres					
	Maintenance Labor	4 laborers, 26 hrs/week each	HR	$ 16	5408	$ 86,528.00	$ 311.25
	Equipment	1 maintenance vehicle	EA	$ 15,000	1	$ 15,000.00	$ 53.96
	Plant Replacement & Removal	5% per year	LS	$ 2,415,000	0.05	$ 120,750.00	$ 434.35
	Irrigation & Water Dist. System Depreciation	5% per year	LS	$ 850,000	0.05	$ 42,500.00	$ 152.88
	Pump Operation	Electricity Cost	LS	$ 20,934	1	$ 20,934.00	$ 343.18
	Environmental Monitoring	1 biologist, 20 hrs/week	HR	$ 32	1040	$ 33,280.00	$ 119.71
						$ 318,992.00	$ 1,415.33

	ITEM	DESCRIPTION	UNIT	UNIT COST	QUAN.	TOTAL COST	PER ACRE COST
ALTERNATIVE 8	115	acres					
	Maintenance Labor	3 laborers, 20 hrs/week each	HR	$ 16	3120	$ 49,920.00	$ 434.09
	Equipment	1 maintenance vehicle	EA	$ 15,000	1	$ 15,000.00	$ 130.43
	Plant Replacement & Removal	5% per year	LS	$ 435,000	0.05	$ 21,750.00	$ 189.13
	Irrigation & Water Dist. System Depreciation	5% per year	LS	$ 190,000	0.05	$ 9,500.00	$ 82.61
	Pump Operation	Electricity Cost	LS	$ 3,186	2	$ 6,372.00	$ 55.41
	Environmental Monitoring	1 biologist, 16 hrs/week	HR	$ 32	832	$ 26,624.00	$ 231.51
						$ 129,166.00	$ 1,123.18

Agua Fria Ecosystm Restrn, Alt 8
Price level 1 Oct '04

Designed By: Tetratech and Aspen
Estimated By: Juan Dominguez

Prepared By: U.S. Army Corps of Engineers

Preparation Date: 07/19/04
Effective Date of Pricing: 10/01/04

Sales Tax: 0.00%

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Time and funding precluded the team from preparing MCACES estimates for the non-preferred alternatives. In view that neither time nor funding were available, Planning Division instructed Cost Engineering to prepare an MCACES estimate for the preferred alternative (Alt #8).

Detailed qtys were not submitted. Several detailed qtys were computed based on narratives and conversations.

Assumed diversion and control of water as well as dewatering are not an issue.

Mob/Demob. Bring heavy equip to the site, including soil cement processing plant. Work site located in Maricopa County, AZ
Rough Grading. Work consists on knocking off the high points and filling in the valleys.
Import Material from an unidentified off-site source.
I-10 Water Distribution System. No drawings or details provided. Assumed construction of a 12" PVC line for 2,500 lf using PACES. System conveys water to the Eastern Strip.
I-10 Irrigation System. No drawings or details provided. Use PACES to create a parametric estimate to irrigate 6.5 acres.
I-10 Liner for 2 side channels - Fine Material. 8" of silt or silty loam.
I-10 Fill for 2 side channels - Coarse Material. 12" of coarse material. Assumed material is obtained from within the site. Material price was zeroed out.

The following items belong to the water recirculation system. The system encompasses a filtration gallery for 18 acres of "vegetation management areas"; the remaining 63 acres does not get water (see table 4.3-1).
Avenue West Water Treatment Plant (AWWTP), 2 mgd pump.
Avenue West Water Treatment Plant (AWWTP), Power Supply. Connect 2,900 feet of electric supply as per I-15 of DPR.
Avenue West Water Treatment Plant (AWWTP), Control Panel
Avenue West Water Treatment Plant (AWWTP), Well. Assumed well is 100 feet deep.
Avenue West Water Treatment Plant (AWWTP), 12" slotted drain. Trench is 20' deep as per Fig I-15 of DPR.
Avenue West Water Treatment Plant (AWWTP), 18" CMP. Trench is 20' deep as per Fig I-15 of DPR.
Avenue West Water Treatment Plant (AWWTP), 6" Filter

FOOH, HOOH and Profit were computed based on standard percentages due to the preliminary level of work and amount of planning detail available.

Contingencies were set at the 3rd level in the MCACES estimate. See notes in the MCACES report.

Schedule of work: 8 hrs/day, 5 days/week.

1. Site Preparation. Contingency set at 5% since direct cost clearly account for the bulk of the work.
2. Water distribution system. Contingency set at 10% since prices seem to be slightly inflated.
3. Habitat Construction. Soil cement cost seems to be above average and the rest of the work consists of landscaping. Contingency set at 8%

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Tri-Service Automated Cost Engineering System (TRACES)
PROJECT FRIA01: Agua Fria Ecosystm Restrn,. Alt 8 - Price level 1 Oct '04
Feasibility Government Estimate
** PROJECT OWNER SUMMARY - Contract **

		QUANTY	UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL CST	UNIT	NOTES
01	LERRDS	1.00	EA	1,115,000	0	0	1,115,000	1115000	
09	Agua Fria Ecosystem Restoration	1.00	EA	4,145,641	316,437	0	4,462,077	4462077	
30	Planning, Engineering and Design	1.00	EA	446,200	0	0	446,200	446200	
31	Construction Management	1.00	EA	290,000	0	0	290,000	290000	
TOTAL	Agua Fria Ecosystm Restrn, Alt 8	1.00	EA	5,996,841	316,437	0	6,313,277	6313277	

	QUANTY	UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL CST	UNIT	NOTES
01 LERRDS								
01.23 Real Estate								
01.23.03 Real Estate Analysis	1.00	EA	1,115,000	0	0	1,115,000	1115000	
TOTAL Real Estate	1.00	EA	1,115,000	0	0	1,115,000	1115000	
TOTAL LERRDS	1.00	EA	1,115,000	0	0	1,115,000	1115000	
09 Agua Fria Ecosystem Restoration								
09.02 Riparian Restoration								
09.02.01 Site Preparation	1.00	EA	829,432	41,472	0	870,903	870903	1
09.02.05 Habitat Construction	1.00	EA	2,832,789	226,623	0	3,059,412	3059412	2
09.02.99 Water Distribution System	1.00	EA	483,420	48,342	0	531,762	531762	3
TOTAL Riparian Restoration	1.00	EA	4,145,641	316,437	0	4,462,077	4462077	
TOTAL Agua Fria Ecosystem Restoration	1.00	EA	4,145,641	316,437	0	4,462,077	4462077	
30 Planning, Engineering and Design	1.00	EA	446,200	0	0	446,200	446200	
31 Construction Management	1.00	EA	290,000	0	0	290,000	290000	
TOTAL Agua Fria Ecosystm Restrn, Alt 8	1.00	EA	5,996,841	316,437	0	6,313,277	6313277	

	QUANTY	UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL CST	UNIT	NOTES
01 LERRDS								
01.23 Real Estate								
01.23.03 Real Estate Analysis								
01.23.03.16 Value of FCDMC & City Lands	37.00	ACR	740,000	0	0	740,000	20000	
01.23.03.17 Acquisition of Private Lands	18.00	ACR	360,000	0	0	360,000	20000	
01.23.03.18 Admin Costs to Obtain Easements	3.00	SET	15,000	0	0	15,000	5000.00	
TOTAL Real Estate Analysis	1.00	EA	1,115,000	0	0	1,115,000	1115000	
TOTAL Real Estate	1.00	EA	1,115,000	0	0	1,115,000	1115000	
TOTAL LERRDS	1.00	EA	1,115,000	0	0	1,115,000	1115000	
09 Agua Fria Ecosystem Restoration								
09.02 Riparian Restoration								
09.02.01 Site Preparation								
09.02.01.10 Mob/Demob	1.00	EA	103,998	5,200	0	109,198	109198	
09.02.01.20 Clearing and Grubing	29.00	ACR	39,731	1,987	0	41,718	1438.55	
09.02.01.30 Rough Grading	80000	CY	234,714	11,736	0	246,449	3.08	
09.02.01.40 Import Material	80000	CY	450,988	22,549	0	473,538	5.92	
TOTAL Site Preparation	1.00	EA	829,432	41,472	0	870,903	870903	1
09.02.05 Habitat Construction								
09.02.05.10 Bank Armor Construction	24940	CY	1,822,835	145,827	0	1,968,662	78.94	
09.02.05.20 Exotic Rmvl in Veg Mgt Area	81.00	ACR	450,241	36,019	0	486,260	6003.22	
09.02.05.30 Plant Material & Habitat Compnts	1.00	EA	511,752	40,940	0	552,692	552692	
09.02.05.40 Establishment and Maintenance	1.00	EA	47,961	3,837	0	51,798	51798	
TOTAL Habitat Construction	1.00	EA	2,832,789	226,623	0	3,059,412	3059412	2
09.02.99 Water Distribution System								
09.02.99.10 I-10 Water Distribution System	2500.00	LF	117,123	11,712	0	128,835	51.53	
09.02.99.20 I-10 Irrigation System	6.50	ACR	98,615	9,861	0	108,476	16689	
09.02.99.30 I-10 Liner for 2 Side Channels	1864.00	CY	21,437	2,144	0	23,581	12.65	
09.02.99.40 I-10 Fill for 2 Side Channels	2318.00	CY	14,801	1,480	0	16,281	7.02	
09.02.99.50 AWWTP 2MGD Pump	1.00	EA	15,403	1,540	0	16,944	16944	
09.02.99.60 AWWTP Power Supply	1.00	EA	34,056	3,406	0	37,461	37461	
09.02.99.65 AWWTP Control Panel	1.00	EA	2,600	260	0	2,860	2859.95	

		QUANTY	UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL CST	UNIT	NOTES
09.02.99.70	AWWTP Well	1.00	EA	11,285	1,129	0	12,414	12414	
09.02.99.75	AWWTP 12" Slotted Drain	900.00	LF	47,107	4,711	0	51,818	57.58	
09.02.99.80	AWWTP 18" CMP	1750.00	LF	107,125	10,712	0	117,837	67.34	
09.02.99.85	AWWTP 6" Filter Material	250.00	CY	13,868	1,387	0	15,255	61.02	
	TOTAL Water Distribution System	1.00	EA	483,420	48,342	0	531,762	531762	3
	TOTAL Riparian Restoration	1.00	EA	4,145,641	316,437	0	4,462,077	4462077	
	TOTAL Agua Fria Ecosystem Restoration	1.00	EA	4,145,641	316,437	0	4,462,077	4462077	
30	Planning, Engineering and Design	1.00	EA	446,200	0	0	446,200	446200	
31	Construction Management	1.00	EA	290,000	0	0	290,000	290000	
	TOTAL Agua Fria Ecosystm Restrn, Alt 8	1.00	EA	5,996,841	316,437	0	6,313,277	6313277	

Tri-Service Automated Cost Engineering System (TRACES)
PROJECT FRIA01: Agua Fria Ecosystm Restrn, Alt 8 - Price level 1 Oct '04
Feasibility Government Estimate
** PROJECT INDIRECT SUMMARY - Contract **

		QUANTY	UOM	DIRECT	FIELD OH	HOME OFC	PROFIT	BOND	PRIVTAX	TOTAL CST	UNIT
01	LERRDS	1.00	EA	1,115,000	0	0	0	0	0	1,115,000	1115000
09	Agua Fria Ecosystem Restoration	1.00	EA	3,189,008	318,901	127,560	275,932	39,085	195,154	4,145,641	4145641
30	Planning, Engineering and Design	1.00	EA	446,200	0	0	0	0	0	446,200	446200
31	Construction Management	1.00	EA	290,000	0	0	0	0	0	290,000	290000
TOTAL	Agua Fria Ecosystm Restrn, Alt 8	1.00	EA	5,040,208	318,901	127,560	275,932	39,085	195,154	5,996,841	5996841
										316,437	
	TOTAL INCL OWNER COSTS									6,313,277	

	QUANTY	UOM	DIRECT	FIELD OH	HOME OFC	PROFIT	BOND	PRIVTAX	TOTAL CST	UNIT
01 LERRDS										
01.23 Real Estate										
01.23.03 Real Estate Analysis	1.00	EA	1,115,000	0	0	0	0	0	1,115,000	1115000
TOTAL Real Estate	1.00	EA	1,115,000	0	0	0	0	0	1,115,000	1115000
TOTAL LERRDS	1.00	EA	1,115,000	0	0	0	0	0	1,115,000	1115000
09 Agua Fria Ecosystem Restoration										
09.02 Riparian Restoration										
09.02.01 Site Preparation	1.00	EA	638,035	63,804	25,521	55,207	7,820	39,045	829,432	829432
09.02.05 Habitat Construction	1.00	EA	2,179,105	217,910	87,164	188,549	26,708	133,352	2,832,789	2832789
09.02.99 Water Distribution System	1.00	EA	371,868	37,187	14,875	32,176	4,558	22,757	483,420	483420
TOTAL Riparian Restoration	1.00	EA	3,189,008	318,901	127,560	275,932	39,085	195,154	4,145,641	4145641
TOTAL Agua Fria Ecosystem Restoration	1.00	EA	3,189,008	318,901	127,560	275,932	39,085	195,154	4,145,641	4145641
30 Planning, Engineering and Design	1.00	EA	446,200	0	0	0	0	0	446,200	446200
31 Construction Management	1.00	EA	290,000	0	0	0	0	0	290,000	290000
TOTAL Agua Fria Ecosystm Restrn, Alt 8	1.00	EA	5,040,208	318,901	127,560	275,932	39,085	195,154	5,996,841	5996841
									316,437	
TOTAL INCL OWNER COSTS									6,313,277	

	QUANTY	UOM	DIRECT	FIELD OH	HOME OFC	PROFIT	BOND	PRIVTAX	TOTAL CST	UNIT
01 LERRDS										
01.23 Real Estate										
01.23.03 Real Estate Analysis										
01.23.03.16 Value of FCDMC & City Lands	37.00	ACR	740,000	0	0	0	0	0	740,000	20000
01.23.03.17 Acquisition of Private Lands	18.00	ACR	360,000	0	0	0	0	0	360,000	20000
01.23.03.18 Admin Costs to Obtain Easements	3.00	SET	15,000	0	0	0	0	0	15,000	5000.00
TOTAL Real Estate Analysis	1.00	EA	1,115,000	0	0	0	0	0	1,115,000	1115000
TOTAL Real Estate	1.00	EA	1,115,000	0	0	0	0	0	1,115,000	1115000
TOTAL LERRDS	1.00	EA	1,115,000	0	0	0	0	0	1,115,000	1115000
09 Agua Fria Ecosystem Restoration										
09.02 Riparian Restoration										
09.02.01 Site Preparation										
09.02.01.10 Mob/Demob	1.00	EA	80,000	8,000	3,200	6,922	981	4,896	103,998	103998
09.02.01.20 Clearing and Grubing	29.00	ACR	30,563	3,056	1,223	2,644	375	1,870	39,731	1370.04
09.02.01.30 Rough Grading	80000	CY	180,552	18,055	7,222	15,622	2,213	11,049	234,714	2.93
09.02.01.40 Import Material	80000	CY	346,920	34,692	13,877	30,018	4,252	21,230	450,988	5.64
TOTAL Site Preparation	1.00	EA	638,035	63,804	25,521	55,207	7,820	39,045	829,432	829432
09.02.05 Habitat Construction										
09.02.05.10 Bank Armor Construction	24940	CY	1,402,204	140,220	56,088	121,327	17,186	85,809	1,822,835	73.09
09.02.05.20 Exotic Rmvl in Veg Mgt Area	81.00	ACR	346,345	34,635	13,854	29,968	4,245	21,195	450,241	5558.53
09.02.05.30 Plant Material & Habitat Compnts	1.00	EA	393,662	39,366	15,746	34,062	4,825	24,090	511,752	511752
09.02.05.40 Establishment and Maintenance	1.00	EA	36,894	3,689	1,476	3,192	452	2,258	47,961	47961
TOTAL Habitat Construction	1.00	EA	2,179,105	217,910	87,164	188,549	26,708	133,352	2,832,789	2832789
09.02.99 Water Distribution System										
09.02.99.10 I-10 Water Distribution System	2500.00	LF	90,096	9,010	3,604	7,796	1,104	5,514	117,123	46.85
09.02.99.20 I-10 Irrigation System	6.50	ACR	75,859	7,586	3,034	6,564	930	4,642	98,615	15171
09.02.99.30 I-10 Liner for 2 Side Channels	1864.00	CY	16,490	1,649	660	1,427	202	1,009	21,437	11.50
09.02.99.40 I-10 Fill for 2 Side Channels	2318.00	CY	11,386	1,139	455	985	140	697	14,801	6.39
09.02.99.50 AWWTP 2MGD Pump	1.00	EA	11,849	1,185	474	1,025	145	725	15,403	15403
09.02.99.60 AWWTP Power Supply	1.00	EA	26,197	2,620	1,048	2,267	321	1,603	34,056	34056
09.02.99.65 AWWTP Control Panel	1.00	EA	2,000	200	80	173	25	122	2,600	2599.96

		QUANTY	UOM	DIRECT	FIELD OH	HOME OFC	PROFIT	BOND	PRIVTAX	TOTAL CST	UNIT
09.02.99.70	AWWTP Well	1.00	EA	8,681	868	347	751	106	531	11,285	11285
09.02.99.75	AWWTP 12" Slotted Drain	900.00	LF	36,237	3,624	1,449	3,135	444	2,218	47,107	52.34
09.02.99.80	AWWTP 18" CMP	1750.00	LF	82,405	8,240	3,296	7,130	1,010	5,043	107,125	61.21
09.02.99.85	AWWTP 6" Filter Material	250.00	CY	10,668	1,067	427	923	131	653	13,868	55.47
	TOTAL Water Distribution System	1.00	EA	371,868	37,187	14,875	32,176	4,558	22,757	483,420	483420
	TOTAL Riparian Restoration	1.00	EA	3,189,008	318,901	127,560	275,932	39,085	195,154	4,145,641	4145641
	TOTAL Agua Fria Ecosystem Restoration	1.00	EA	3,189,008	318,901	127,560	275,932	39,085	195,154	4,145,641	4145641
30	Planning, Engineering and Design	1.00	EA	446,200	0	0	0	0	0	446,200	446200
31	Construction Management	1.00	EA	290,000	0	0	0	0	0	290,000	290000
	TOTAL Agua Fria Ecosystm Restrn, Alt 8	1.00	EA	5,040,208	318,901	127,560	275,932	39,085	195,154	5,996,841	5996841
										316,437	
	TOTAL INCL OWNER COSTS									6,313,277	

	QUANTY	UOM	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL CST	UNIT
01 LERRDS	1.00	EA	0	0	0	0	1115000	1,115,000	1115000
09 Agua Fria Ecosystem Restoration	1.00	EA	52,879	1,354,884	965,981	571,058	297,085	3,189,008	3189008
30 Planning, Engineering and Design	1.00	EA	0	0	0	0	446,200	446,200	446200
31 Construction Management	1.00	EA	0	0	0	0	290,000	290,000	290000
TOTAL Agua Fria Ecosystm Restrn, Alt 8	1.00	EA	52,879	1,354,884	965,981	571,058	2148285	5,040,208	5040208
Prime Contractor's Field Overhead								318,901	
SUBTOTAL								5,359,109	
Prime's Home Office Expense								127,560	
SUBTOTAL								5,486,669	
Prime Contractor's Profit								275,932	
SUBTOTAL								5,762,601	
Prime Contractor's Bond								39,085	
SUBTOTAL								5,801,687	
Privilege Tax								195,154	
TOTAL INCL INDIRECTS								5,996,841	
								316,437	
TOTAL INCL OWNER COSTS								6,313,277	

	QUANTY	UOM	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL CST	UNIT
01 LERRDS									
01.23 Real Estate									
01.23.03 Real Estate Analysis	1.00	EA	0	0	0	0	1115000	1,115,000	1115000
TOTAL Real Estate	1.00	EA	0	0	0	0	1115000	1,115,000	1115000
TOTAL LERRDS	1.00	EA	0	0	0	0	1115000	1,115,000	1115000
09 Agua Fria Ecosystem Restoration									
09.02 Riparian Restoration									
09.02.01 Site Preparation	1.00	EA	8,852	242,265	325,770	0	70,000	638,035	638035
09.02.05 Habitat Construction	1.00	EA	40,292	992,708	594,830	379,846	211,721	2,179,105	2179105
09.02.99 Water Distribution System	1.00	EA	3,735	119,912	45,380	191,212	15,364	371,868	371868
TOTAL Riparian Restoration	1.00	EA	52,879	1,354,884	965,981	571,058	297,085	3,189,008	3189008
TOTAL Agua Fria Ecosystem Restoration	1.00	EA	52,879	1,354,884	965,981	571,058	297,085	3,189,008	3189008
30 Planning, Engineering and Design	1.00	EA	0	0	0	0	446,200	446,200	446200
31 Construction Management	1.00	EA	0	0	0	0	290,000	290,000	290000
TOTAL Agua Fria Ecosystm Restrn, Alt 8	1.00	EA	52,879	1,354,884	965,981	571,058	2148285	5,040,208	5040208
Prime Contractor's Field Overhead								318,901	
SUBTOTAL								5,359,109	
Prime's Home Office Expense								127,560	
SUBTOTAL								5,486,669	
Prime Contractor's Profit								275,932	
SUBTOTAL								5,762,601	
Prime Contractor's Bond								39,085	
SUBTOTAL								5,801,687	
Privilege Tax								195,154	
TOTAL INCL INDIRECTS								5,996,841	
								316,437	
TOTAL INCL OWNER COSTS								6,313,277	

	QUANTY	UOM	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL CST	UNIT
01 LERRDS									
01.23 Real Estate									
01.23.03 Real Estate Analysis									
01.23.03.16 Value of FCDMC & City Lands	37.00	ACR	0	0	0	0	740,000	740,000	20000
01.23.03.17 Acquisition of Private Lands	18.00	ACR	0	0	0	0	360,000	360,000	20000
01.23.03.18 Admin Costs to Obtain Easements	3.00	SET	0	0	0	0	15,000	15,000	5000.00
TOTAL Real Estate Analysis	1.00	EA	0	0	0	0	1115000	1,115,000	1115000
TOTAL Real Estate	1.00	EA	0	0	0	0	1115000	1,115,000	1115000
TOTAL LERRDS	1.00	EA	0	0	0	0	1115000	1,115,000	1115000
09 Agua Fria Ecosystem Restoration									
09.02 Riparian Restoration									
09.02.01 Site Preparation									
09.02.01.10 Mob/Demob	1.00	EA	0	0	20,000	0	60,000	80,000	80000
09.02.01.20 Clearing and Grubing	29.00	ACR	300	8,545	12,018	0	10,000	30,563	1053.90
09.02.01.30 Rough Grading	80000	CY	3,872	109,512	71,040	0	0	180,552	2.26
09.02.01.40 Import Material	80000	CY	4,680	124,208	222,712	0	0	346,920	4.34
TOTAL Site Preparation	1.00	EA	8,852	242,265	325,770	0	70,000	638,035	638035
09.02.05 Habitat Construction									
09.02.05.10 Bank Armor Construction	24940	CY	23,986	642,162	521,968	238,073	0	1,402,204	56.22
09.02.05.20 Exotic Rmvl in Veg Mgt Area	81.00	ACR	2,436	65,482	69,192	16,200	195,471	346,345	4275.87
09.02.05.30 Plant Material & Habitat Compnts	1.00	EA	13,034	266,835	1,254	125,573	0	393,662	393662
09.02.05.40 Establishment and Maintenance	1.00	EA	836	18,228	2,416	0	16,250	36,894	36894
TOTAL Habitat Construction	1.00	EA	40,292	992,708	594,830	379,846	211,721	2,179,105	2179105
09.02.99 Water Distribution System									
09.02.99.10 I-10 Water Distribution System	2500.00	LF	986	38,082	2,277	49,737	0	90,096	36.04
09.02.99.20 I-10 Irrigation System	6.50	ACR	675	25,584	269	50,006	0	75,859	11671
09.02.99.30 I-10 Liner for 2 Side Channels	1864.00	CY	112	3,164	2,142	7,456	3,728	16,490	8.85
09.02.99.40 I-10 Fill for 2 Side Channels	2318.00	CY	97	2,785	3,964	0	4,636	11,386	4.91
09.02.99.50 AWWTP 2MGD Pump	1.00	EA	19	766	0	6,083	5,000	11,849	11849
09.02.99.60 AWWTP Power Supply	1.00	EA	432	13,095	2,519	10,584	0	26,197	26197
09.02.99.65 AWWTP Control Panel	1.00	EA	0	0	0	0	2,000	2,000	2000.00

		QUANTY	UOM	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL CST	UNIT
09.02.99.70	AWWTP Well	1.00	EA	100	2,659	2,896	3,126	0	8,681	8681.23
09.02.99.75	AWWTP 12" Slotted Drain	900.00	LF	400	10,410	10,497	15,330	0	36,237	40.26
09.02.99.80	AWWTP 18" CMP	1750.00	LF	892	22,814	20,700	38,891	0	82,405	47.09
09.02.99.85	AWWTP 6" Filter Material	250.00	CY	23	552	116	10,000	0	10,668	42.67
	TOTAL Water Distribution System	1.00	EA	3,735	119,912	45,380	191,212	15,364	371,868	371868
	TOTAL Riparian Restoration	1.00	EA	52,879	1,354,884	965,981	571,058	297,085	3,189,008	3189008
	TOTAL Agua Fria Ecosystem Restoration	1.00	EA	52,879	1,354,884	965,981	571,058	297,085	3,189,008	3189008
30	Planning, Engineering and Design	1.00	EA	0	0	0	0	446,200	446,200	446200
31	Construction Management	1.00	EA	0	0	0	0	290,000	290,000	290000
	TOTAL Agua Fria Ecosystm Restrn, Alt 8	1.00	EA	52,879	1,354,884	965,981	571,058	2148285	5,040,208	5040208
	Prime Contractor's Field Overhead								318,901	
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	Prime Contractor's Bond								39,085	
	SUBTOTAL								5,801,687	
	Privilege Tax								195,154	
	TOTAL INCL INDIRECTS								5,996,841	
									316,437	
	TOTAL INCL OWNER COSTS								6,313,277	

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APPENDIX K.

HABITAT EVALUATION PROCEDURE ANALYSIS (HEP)

APPENDIX K. HABITAT EVALUATION PROCEDURE

1. INTRODUCTION

This Appendix provides a habitat evaluation analysis of alternatives proposed for the ecosystem restoration of the lower 5.5 miles of the Agua Fria River located west of Phoenix, AZ, within the City of Avondale (see Figure 1; all figures are in Appendix A). The overall goal of the Agua Fria Riparian Restoration Project is to restore degraded portions of the Agua Fria River to conditions characteristic of natural riparian watersheds and alluvial channels. The habitat benefits created by the restoration effort are limited by permanent alterations to the watershed caused by hydrologic controls, loss of habitat and fragmentation. Development of restoration alternatives was based on the following restoration goals.

General Goals:

- Enhance the structure, diversity, and quality of riparian habitat to promote ecological resiliency and self-sustaining qualities
- Enhance foraging, nesting, and resting opportunities for wildlife associated with riparian habitats
- Establish riparian vegetative communities that represent historic and optimal conditions in the project area.

Specific Goals:

- Limit the abundance of invasive and exotic plant species in the environment
- Minimize future disruption or degradation of the riparian ecosystem
- Improve connectivity between the Agua Fria River and the Gila River by restoring more natural conditions
- Identify functional characteristics of the ecosystem that are critical for defining restoration opportunities and constraints. How does the current ecologic condition of the site affect what can or cannot be accomplished? What are the causes of changes from pre-development times and can they be reversed or improved?
- Identify opportunities for maximizing the availability of surface water and ground water inputs to biota. Characterize the depth to saturated soils, streamflow and channel morphology.
- Develop the recovery effort from a watershed perspective. Ensure continuity with restoration and conservation efforts within the Gila River. Ensure that the flood control capacity of the channel is maintained consistent with existing and future conditions within the watershed.
- Motivate adjacent communities to view the restoration project as a means of reclaiming the cultural and natural history of the area. Maximize the participation and commitment from the adjacent community.
- Create a plan that is compatible with the local trail and park system without compromising the opportunities to maximize habitat output (i.e., emphasize perimeter recreational use of the area only).
- Minimize the need for complicated operation and maintenance measures. Among other strategies, facilitate processes of natural regeneration and that are self-sustaining, develop an adaptive management plant for post-implementation.
- Utilize knowledge gained from existing restoration efforts in the region and minimize experimentation.
- Emphasize critical habitat elements for wildlife in addition to water and vegetation (e.g., soil flora and fauna, substrate for burrowing animals, soil chemistry woody debris, etc.).

2. SITE DESCRIPTION

The project modifications boundaries are located in the Agua Fria River in the southwestern region of the Phoenix metropolitan area, within Maricopa County, Arizona, in the City of Avondale (Figures 1 and 2). Within the city limits of Avondale, the project reach is bounded to the north (upstream) by McDowell Road and to the south by the confluence of the Gila River.[1] Within this reach of the river, the width varies from approximately 1200 feet in the narrowest portions at the northern end of the project site, to roughly 2,500 feet at the widest portions at the southern sections; however, flowage easements extend beyond this width. The average elevation in the project area ranges from approximately 894 to 1,019 feet above sea level.

Soil cement levees provide flood control protection along the east and west banks of the Agua Fria River, from approximately Indian School Road (north of McDowell Road) to Buckeye Road. The western levee extends farther south to 1/4-mile south of Lower Buckeye Road for a total length of approximately 3-1/2 miles within the project area, while the eastern levee within the project area is approximately 2 miles. There are other bank protection structures associated with private developments or bridge crossings (such as a 1/4-mile levee around a residential neighborhood on the east side of the river at Lower Buckeye Road). See Figure 4 for an illustration of the levees in the study area.

Significant changes have occurred in the watershed since the beginning of the last century beginning with a long period of agricultural development and hydrologic controls for the purpose of irrigation. Residential land use will replace much of the historically agricultural lands surrounding the project area (Figure 20). Sand and gravel mining within the lower reaches of the Agua Fria River still occurs from Indian School Road to Camelback Road and further downstream near lower Buckeye Road. The project area is also used informally by birders, hikers, equestrians, and off-road vehicles.

The regional climate is semi-arid, with mean monthly temperatures ranging from around 50°F in December-January to around 85-90°F between July and August. Scarce rainfall occurs in a bimodal pattern during the months of January-February and July-August. The Agua Fria River watershed covers approximately 2,250 mi^2, but 83 percent of this area is controlled upstream by several manmade structures, including the New Waddell Dam, dams along the New River and Skunk Creek, and the Arizona Diversion Canal. The watershed is located within the Sonoran floristic province of the Lower Colorado River Valley subdivision, described by Shreve in 1951 and Brown in 1994. Vegetation within and adjacent to the restoration project area consists of disturbed/ruderal, early successional, riparian, upland and agricultural. The Agua Fria River at its confluence with the Gila River is within the Pacific Flyway and in general, provides resting, foraging and nesting habitat for a variety of migratory and non-migratory birds.

The Agua Fria River flood control project was constructed for the pre-New Waddell Dam Standard Project Flood of 92,000 to 102,000 cubic feet (cfs) through the project reach. This discharge is approximately three percent to nine percent higher than the pre-New-Waddell Dam 100-year discharge. The New Waddell Dam, constructed in 1991, reduced the Standard Project Flood to approximately 83,000 to 94,000 cfs through the project reach. The 100-year discharge was reduced to approximately half the Standard Project Flood. In

[1] The following boundaries have been used for the purpose of data research: (1) Latitude 33° 30' 00" and 33° 23' 30"; Longitude 112° 21 30 and 112° 18' 30"; and (2) T1N: R1W: Sections 02, 03, 10, 11, 14, 15, 16, 21, 22, 23, 26, 27, 28, 33, 34, and 35.

addition to ephemeral surface flow from the upper reach of the Agua Fria River, there are tributaries entering the project reach from the east at Interstate 10 and at Buckeye Road. The discharge of more frequent flows have been reduced to a lesser extent.

Average stream flow on the Agua Fria River is close to zero. There is generally no flow at all for the months of April, May, June, October, and November. Sporadic flows occur in the remaining months depending upon rainfall. On average, there is no measurable flow on the Agua Fria River 99 days out of one hundred. There are several discharges or drainages to the Agua Fria River from the Avondale Wastewater Treatment Plant (AWWTP), the I-10 channel outflow (north of I-10), the Durango Channel outflow (north of Buckeye Road), and smaller irrigation and storm water runoff drains.

Arizona is continuing to experience a significant loss of riparian habitat. The Agua Fria River is one of three primary river corridors in the Phoenix area that have been subjected to significant development pressures. Within the channel of the Agua Fria River, existing riparian habitat is limited to a few isolated areas, which are determined by surface water discharges and shallow ground water. Overall, the habitats are of low value and declining because of chronic disturbance and alteration of basic ecosystem processes. Future without-project conditions will continue to follow this trend of declination. Without restoration, the sparse condition of plant life in the project area would not adequately support quality habitat, which would continue to decline and be threatened. Figure 3 illustrates these gradual habitat changes over time. Although the resolution of the photographs from 1959, 1985 and 2001 does not allow identification of specific vegetation types, it does illustrate significant changes in project area, including the changes in vegetated areas versus unvegetated areas, the canalization of the river, and the conversion of agricultural and flood plain zones to residential and commercial uses. The darkest (most densely vegetated areas) in the 2001 photograph are associated with known discharges of effluent or nuisance runoff.

3. STUDY OBJECTIVES

3.1 PURPOSE OF THE HABITAT EVALUATION PROCEDURE (HEP)

The USACE's guidance for ecosystem restoration in the Civil Works Program is provided in Engineer Circular (EC) 1005-2-210. The purpose of this guidance is to assure that civil work investments in ecosystem restoration have the intended beneficial effects, are consistent with administrative policy, and would be conducted in the most cost effective manner.

Sections 13.b(1) and (20) of EC 1005-2-210 require that the ecosystem outputs of proposed alternatives be subjected to detailed cost effectiveness and incremental cost analysis, allowing an explicit comparison of the additional costs and outputs associated with the alternatives. Consequently, it is necessary that the environmental outputs of the alternatives be based on some quantifiable unit, such as habitat units (HUs). Comparing the alternatives in this manner facilitates the determination of the most cost-effective restoration alternative that meets restoration goals. The Habitat Evaluation Procedure (HEP) is a method of quantifying ecological values in the form of HUs.

The following evaluation utilizes a habitat-based approach to quantitatively characterize the ecological and habitat value associated with the restoration alternatives proposed for the Agua Fria Riparian Restoration

Project. Current site conditions, adjacent land uses and variability in environmental conditions along the river channel make it difficult to consistently develop habitat for a single vegetation type or group of wildlife; however the following groups of animals would be benefited by the alternatives:

- Migratory and resident songbirds
- Raptors (in some segments)
- Reptiles
- Small and medium mammals (coyote size and smaller)
- Amphibians (for some alternatives).

The alternatives do not include the addition of open water areas beyond those that already exist ephemerally at the I-10 discharge and Durango Channel at Buckeye Road, and perennially at the Avondale Wastewater Treatment Plant (AWWTP) effluent discharge.

3.2 GENERAL HEP BACKGROUND

The USFWS originally developed the standard Habitat Evaluation Procedure (HEP) to document the quality and quantity of available habitat for selected wildlife species and/or habitat elements. The HEP analysis provides information for two general types of wildlife comparisons: the relative values of different areas and habitat conditions at the same point in time, and the relative values of the same areas at different points in time. By combining the two types of comparisons, the impact of proposed or anticipated land and water use changes on wildlife habitat can be quantified (USFWS, 1981).

A traditional HEP analysis supposes that there are known quantifiable relationships between the reproductive success of a target species (or guilds, meaning groups of species with similar habitat requirements) and a particular habitat characteristic, e.g., the relationship between dissolved oxygen levels or temperature of water and abundance of trout in a freshwater stream. The HEP analysis is based on the assumption that this relationship can be quantified and the optimum habitat condition can be determined from this relationship. The comparison of existing or projected habitat conditions to optimum habitat conditions is defined in the form of a Habitat Suitability Index (HSI). HSIs can be determined for one critical or several important physical and biological requirements of the target species. Each HSI is comprised of one or more variable suitability indices. The several HSI values can then be input into an appropriate algorithm (e.g., the most simple form would be taking an average) to define an overall HSI value.

$$HSI = \frac{\text{Habitat Conditions in the Study Area}}{\text{Optimum Habitat Conditions}}$$

Regardless of whether the final HSI value is determined from a single or several HSIs, it is based on a 0 to 1 scale where 0.1 is low restoration value in comparison to optimal conditions and 1.0 indicates optimal habitat value for the target species (or guild) with restoration. The HSIs are assigned to each habitat type by alternative and multiplied by the restored area of the respective habitat type to yield habitat units [HSI x Area = Habitat Units (HUs)].

The resulting values, in HUs, are summed across each alternative for an overall habitat value score i.e., Σ(HSI x Area) = total HUs. HUs are the basic units of habitat value upon which a biological evaluation may

be made with respect to future conditions or with other areas of similar habitat. The reliability of a HEP analysis and the significance of HUs are directly dependent on the ability of the user to assign a well-defined and accurate HSI to selected habitat elements that the target species or guilds rely on. Documented criteria for determining the HSIs increase their reliability (USFWS, 1980). These scores then serve as a basis for comparison among the alternatives.

3.3 MODIFIED HEP

The USACE has modified this standard HEP analysis to evaluate habitat conditions without emphasizing the habitat requirements of a single target species. The purpose of developing the modified approach was to minimize the time and cost inherent in developing detailed site-specific information about the habitat requirements of individual species and the relationship between species success, habitat requirements, and measurable characteristics of the habitat. The modified HEP evaluates the community or ecosystem as a whole to calculate habitat value for each of the environmental restoration alternatives. This method has been conducted for Cucamonga Creek (USACE, 2001) and the Tucson (Ajo) Detention Basin in Arizona (USACE, 1998), among others.

With this approach, community or vegetation types considered by the restoration alternatives are evaluated based on the relative amount of habitat resources they provide major wildlife groups or guilds of species that have similar habitat requirements. General characteristics of the biological community that would be created under each restoration alternative are looked at collectively with respect to wildlife goals as opposed to looking at specific characteristics in relation to a single target species. Evaluations are made against the highest attainable value (HSI = 1.0) based on an undisturbed reference site, historical reference, or applicable scientific literature. It should be noted however, that the optimum habitat conditions are typically not achieved until the end of the period of analysis span and may not be attainable at all in most settings where there have been permanent, anthropogenically induced changes to the environment. The values also may not be representative of those that could be achieved in another setting, albeit with similar habitat types. To define what optimal conditions might be at this site, a combination of sources have been used to evaluate the site, including field surveys and literature on historical flora (Brown, 1994).

The HSIs determined from the Modified HEP analysis are then treated numerically in the same way as for the traditional HEP analysis described above.

Because the Modified HEP analysis is designed to look at the characteristics of a habitat type in meeting the requirements of guilds or groups of wildlife species, the evaluation process for assigning HSIs tends to be more qualitative instead of quantitative and general. This makes the decision process difficult to document or reproduce. For that reason, in the present analysis some of the variable subindices considered in the Hydrogeomorphic Method (HGM) (USACE, 1995) of analysis have been incorporated into the Modified HEP analysis. The HGM looks at function-based standards for determining the value or success of an ecosystem and can be applied to the assessment of riparian restoration (Sudol, 1996). Despite the fact that the function based standards are not focused on particular wildlife species, the definition and attainment of ecosystem functions important in riparian systems would suppose creation of optimal habitat conditions for wildlife groups or guilds normally associated with these ecosystems.

There are many similarities in the numerical concepts applied to the HEP and HGM analyses. The metric used to measure function in the HGM approach is the Functional Capacity Index (FCI)[2]. The FCI estimates the capacity of a community or ecosystem to perform a specific function relative to other ecosystems from similar or reference ecosystems within the region. The FCI ranges from 0.0 to 1.0, with 1.0 representing a level of functional capacity comparable to the best attainable conditions in the reference domain and 0.0 representing the absence of functional capacity. The FCI can be multiplied by the area being assessed to generate Functional Capacity Units (FCU). Because ecosystems are more than "bundles of functions," the HGM approach does not combine FCIs or FCUs for multiple functions into an aggregate functional capacity for an ecosystem. Rather, to maintain the resolution of the assessment each function is assessed individually and a distinct FCI is generated for each function.

Each function is defined by a series of variables, which are factors necessary for functions to occur. For example the capacity of a riverine wetland to store and convey surface water (i.e., the dynamic surface water storage function) is governed by the frequency and duration of flooding out of the channel banks and the complexity and roughness of the flood plain surface area on which water is temporarily detained. Therefore, the dynamic surface water storage function would be defined by variables such as "width of the flood-prone area," "topographic complexity," and "tree density." To determine the FCI, the pertinent variables are combined in equations or models. The reference standards represent the highest level of sustainable functioning in the landscape. These are the conditions used to calibrate the models so that the maximum score for both variables and the FCI are set at 1.0.

Some of the variables used in the HGM approach were incorporated into the definition of HSIs. While this is not intended to be an HGM analysis, these standards (or variables) have been incorporated into the analysis to provide a minimal level or consistency and biological relevance to the analysis. Instead of assigning a single HSI value to each community type based on a general evaluation as with the Modified HEP, a set of function-based standards were defined based on physical, microbiological, vegetation or other ecosystem characteristics, i.e., the method does not focus on the requirements of a single wildlife species. The several HSI values are then averaged into a combined HSI value and multiplied by the acreage of the affected area. Adapting the concept of variables that represent ecosystem function from the HGM to the HEP analysis was also used for the USACE's Old San Jose Creek restoration project.

It is important to note that regardless of the HEP method that is used, the number of HUs converted to Average Annual Habitat Units (AAHU) for each alternative is used as input into the incremental cost analysis that determines HUs/unit cost and is used to make decisions on which alternative is the most cost-effective.

[2] There are parallels between the HEP and HGM methodologies insofar as both apply the concept of variables that make up suitability indices (HSIs or FCIs) and units that are derived from multiplying the index by the area assessed (HUs or FCUs). A major difference between the two methodologies is the focus on species habitat requirements in the HEP versus ecosystem or community level functions in the HGM. The HEP analysis evaluates variables and derives indices for each cover type, whereas the HGM considers stands, polygons or assessment areas.

4. STUDY AND METHODOLOGY ASSUMPTIONS AND CONSTRAINTS

Due to its agricultural and urban setting, and the hydrological alterations that the channel has undergone since the beginning of the last century, there are several constraints that have been considered in defining alternatives and assessing how these alternatives can achieve the objectives listed above.

Primarily agricultural and residential, with some commercial and light industrial land uses, border the channel. In addition to the levees, these land uses have restricted the flood plain. Private or public ownership by entities other than the Flood Control District of Maricopa County (FCDMC) and the City of Avondale also limit the area available for restoration. Addition of vegetation and fill cannot reduce flood capacity below the standard project flood under the pre-New Waddell dam condition. Areas where this capacity is limited are therefore, precluded from revegetation with anything but herbaceous species. These are important determinants in the acreage of each community type in the HEP analysis and more importantly the spatial and structural diversity that can be attained, as well as the quality of riparian habitat in terms of characteristics such as the relationship between interior versus edge space.

Because of the lack of existing water in the system, it has also been assumed that additional inputs are necessary to gain habitat benefits. Varying water inputs are the primary basis for each of the alternatives.

Additional assumptions relevant to the HEP methodology used in this document are:

- There is a direct or indirect relationship between optimal ecosystem function based on geologic, hydrologic, biogeochemical and biological characteristics and the habitat requirements of wildlife species that are likely to be found in the restored habitats.
- The functional standards defined for this analysis are suitable for determining the success of the project post-implementation. It is presumed that the functions are indicative of a healthy ecosystem, which is the focus of the HGM methodology; and if the ecosystem is functioning properly it will provide suitable habitat for target wildlife, which is the focus of the HEP methodology. It also presumes that these functions can be measured in the field to determine project success. In the present, except for the no-action alternative, the values are being predicted based on preliminary design of alternatives.
- The functional standards defined for the site are generally applicable to native ecosystems for this region. The present study does not consider development of site-specific standards or indices.
- Hydrological conditions that are extremely important to riparian/riverine ecosystems have been irreversibly altered throughout most of the project area, and therefore, restoration of historical conditions is not feasible. With additional water inputs however, species suitable to riparian ecosystems in arid environments have been considered.
- Some of the function-based indices defined in Section 5 are linear; ecological relationships are generally not linear (i.e., a 50 percent increase in native versus exotic vegetation cover does not necessarily mean a 50 percent increase in the index), and so these indices approximate the real biological condition.
- The overall HSI values are obtained from the average of the individual HSIs, which assumes that all of the functions have equal importance in the ecosystem.
- Development, transportation and infrastructure projects occurring within or adjacent to the restoration project would have a uniform negative effect on all the alternatives.

5. HABITAT ANALYSIS METHODOLOGY

The final alternatives consider development of riparian habitat with inclusions of other plant communities that would be successful under the existing physical and biological conditions. For this ecosystem, functional standards were defined to determine how closely each alternative would attain optimum function for a desert riparian ecosystem and hence maximum wildlife habitat value for those species typically associated with this ecosystem. It is important to reiterate that former hydrological conditions could not be attained for any of the alternatives because of irreversible modifications to the watershed. This alteration would limit the maximum value of HSIs assigned to the alternatives for function-based standards directly or indirectly related to hydrological characteristics.

The function-based standards provided in Table K-1 illustrate the criteria used to assign HSI values of 0.0 to 1.0 for each standard. The standards are applicable to desert riparian ecosystems and were selected to demonstrate differences among the alternatives. In general these relationships are linear, insofar as the maximum measured characteristic is assigned an index of 1.0, the absence of or lowest measurable value is assigned a 0.0 and the index is proportional for measured values within this range. The numbers assigned to each functional-standard are only those for which criteria have been defined, i.e., if criteria are defined for a structural diversity index of 0.1, 0.25, 0.5, etc., then the index cannot be assigned a value in between (e.g., 0.3). These standards do not represent all important riparian functions, but rather those most applicable to the goals, opportunities, and constraints present in the Agua Fria project area, i.e., functions that would not be affected or distinguished by the alternatives were not included (USACE, 1999). The standards are also readily measurable in the field and can be incorporated into a post-implementation monitoring program.

In the HEP analysis, some consideration was given to looking at the entire project area from McDowell Road to the Gila River as a single assessment unit. However, the alternatives are such that restoration areas are added sequentially and these areas are distinguished in the analysis.

The average of the HSI values assigned to each of the functional standards was calculated for each alternative under each alternative (under more rigorous conditions, a more suitable algorithm should be developed to prioritize the standards, instead of taking a simple average). Subsequently the average HSI values were multiplied by the appropriate acreages to arrive at the number of HUs. Finally these were summed across all segments to get an overall number of HUs for each alternative.

Table K-1 Function-Based Standards Used for Assigning HSI Values

Function	Index Criteria *	Definition
Structural diversity of vegetation	0 – area supports one stratum 0.25 - area supports 2 strata 0.5 - area supports 3 strata 0.75 - area supports 4 strata (must include seedlings, saplings and/or mature trees) 1.0 - area supports 5 or 6 strata (must include seedlings, saplings and mature trees)	Definition: The maximum number of strata in the assessment area. Rationale: A greater number of strata provide more niches for different species than fewer strata. Representation of all age categories among woody species indicates that species are regenerating and the populations are self-sustaining.
Plant species richness	Desert riparian systems with 50 or more species are scored a 1 (based on vegetation surveys in the Agua Fria). Those with less are scored proportionally to 1 (number of species/50). Includes non-native species.	Definition: The total number of plant species present, regardless of whether they are native or exotic. Rationale: The number of plant species is an indicator of the potential number of habitats for insects, other invertebrates, and other microfauna. This is independent of native or non-native status; however, this relationship would be reflected in areas where non-native invasives that establish as mono-cultures would also result in reduced species richness.
Invasive exotic vegetation	0 – no vegetation 0.2 - % exotic species >75% 0.4 -% exotic species 50-75% 0.6 - % exotic species 25-49% 0.8 - % exotic species 10-24% 1.0 - % exotic species 0-9%	Definition: The ratio of native to non-native species in each stratum. Rationale: A healthy plant community comprises a high percentage of native, non-exotic, invasive species.
Contiguous vegetation cover	0 – connected to adjacent areas and to up- and down gradient reaches through plant communities dominated by native species along 0% of its boundary; variable is not recoverable and sustainable through natural processes under assessed conditions 0.1 - ....along 0-9% of its boundary; variable is recoverable and sustainable through natural process under current conditions 0.25 - ....along 10-24% of its boundary; plant communities must extend at least 100 feet beyond the assessment area boundary 0.50 - ....along 25-49% of its boundary; idem previous 0.75 - ....along 50-75% of its boundary; idem previous 1.0 - ....≥75% of its boundary; idem previous	Definition: Contiguous cover and corridors between waters, wetlands, uplands, channels, and upstream and downstream areas. Rationale: One of the greatest threats to wildlife habitat is fragmentation and loss of even the most minimal habitat for movement between and among suitable habitat areas.
Surface water persistence	0 – area provides no features that could pond water. 0.5 - area has evidence of surface water ponding for greater than hours but less than a day. 1.0 - area has evidence of surface water ponding in ponds and/or pits for greater than one day.	Definition: Duration of surface water ponding after flows recede. Rationale: Still water habitat within the riverine system offers important habitat for vertebrate and invertebrate species.
Micro/macro topographic complexity	0 - area characterized by steep banks that limit development of macro- and microtopographic features. 0.25 - area characterized by relatively homogeneous surfaces that lack both macro- and microtopographic relief. 0.5 - area is characterized by the presence of both macro- and microtopographic relief (alluvial terraces, ponds, pits hummocks, depositional bars, cobble or boulder clusters, log/brush/rock shelters) but the predominant condition is relatively homogeneous surfaces that lack both macro- and microtopographic relief. 1.0 - area characterized by complex macro- and microtopographic relief.	Definition: Macrotopographic relief generally refers to large-scale features such as secondary channels and in-channel ponds. Microtopographic generally refers to small-scale features such as pit-and-mound and hummock-and-hollow patterns, meanders, and terraces. Rationale: Topological complexity offers a variety of ecozones and ecotones that supply the habitat needs of upland, wetland, and edge adapted species.

Source: Adapted from Santa Margarita Watershed Handbook and USACE, 1999. Similar adaptation was applied to the USACE's Old San Jose Creek Restoration Project.

Definitions for Index Criteria:

Types of vegetation strata

1. Ground cover
2. Herbaceous – non-woody vegetation, usually less than 6 feet tall.
3. Shrub – Multi-stemmed woody vegetation taller than 6 feet consisting of shrubs or young trees. Rarely exceeds 20 feet in height.
4. Sub-canopy – Young or small trees growing under a canopy that range between 20 and 40 feet in height.
5. Canopy – Large trees that may extend over other strata, usually higher than 40 feet in height.
6. Vines – creeping and/or climbing vines that range in size from less than 3 feet to greater than 6 feet.

The nature of the incremental cost analysis and the time required for development of the restored habitat requires that HUs timeline analysis begins at a base year (T0). A baseline year is the point in time before changes in land and water use result in habitat alterations in the study area. Target year 1 (T1) is one year after construction, T15 after 15 years of function and T50 after 50 years of function. The HUs were derived for year 15 presuming that the first 15 years of operation would require the most intensive adaptive management effort.

6. ALTERNATIVES

6.1 SELECTION OF RESTORATION ALTERNATIVES

Several management measures, some contemplating two or more options, were defined during development of the baseline conditions report. The management measures identified in this report were presented at a technical workshop attended by the USACE, City of Avondale, FCDMC, Arizona Department of Game and Fish and local experts. As a result of the discussions at that workshop additional considerations were emphasized in the comments of the participants and these became the basis for defining additional management measures and formulating the final alternatives. The final alternatives met the goals of the restoration project, were technically feasible and provided the best opportunity for restoring and maintaining the riparian channel environment. The major management measures included in the alternatives and their environmental benefits are summarized as follows:

- Restore historical biological conditions as much as current hydrological and other limitations would permit
- Contribute to local and regional habitat connectivity
- Consider a management strategy for establishing native vegetation that includes invasive and exotic species control, revegetation and creation of sites where natural seeding and growth can occur
- Provide some areas of protected habitat with minimization of urban or other human impacts
- Create a variety of habitat resources for wildlife which typically inhabit or use desert riparian corridors
- Take advantage of additional and existing water inputs by creating low flow channels and small areas where water can accumulate long enough to increase soil moisture available to plants, instead of losing the majority of water through evaporation, infiltration or flows of short duration
- Balance the desire to construct stable vegetation and habitat within a system that is naturally dynamic and subject to unpredictable events by constructing riparian strips that are protected from frequent flows and additional areas for management under uncontrolled conditions
- Maintain sufficient capacity for the standard project flood while attaining restoration goals.

A general description of each of the alternatives is provided below. They are described in greater detail in Section 4 (Alternatives) of the DPR, including a description of water needs and a potential plant palette.

6.2 ALTERNATIVE 1 – NO ACTION ALTERNATIVE

The state of Arizona, as a whole, is continuing to experience a significant loss of riparian habitat. The Agua Fria River is one of three primary river corridors in the Phoenix area. Within the channel of the Agua Fria River, existing riparian habitat is limited to a few isolated areas. The overall habitats are of low value and are declining in extent and quality. Table K-2 summarizes the acreage of existing habitats and those created

under each of the alternatives. Although vegetation types identified under current conditions are similar to those projected for the restoration alternatives, the value of habitat under current conditions is less than that projected under the future with project condition. The projected future without-project condition will continue to follow the current trend of decline.

Table K-2 Summary Estimate of the Acreage of Each Major Vegetation/Habitat Type by Alternative

Alternative/Location	Riparian scrubland/ woodland (xeric)[1]	Riparian scrubland/woodland (mesic)	Riparian scrubland/woodland (hydric) [2]	Riparian wetland/herbaceous (hydric) [2]	TOTAL
Alternative 1 – No Action[3]					
TOTAL	95.8	137.9	59.5	10.7	303.9
Alternative 2 – Low water use					
Eastern riparian strip (6110' X 310')[4]	0	12.3	22.5	4.4[5]	39.2
Western riparian strip (8773' X 75')	15.8	0	0	0	15.8
Vegetation management areas	0	0	0	0	0
Construction Areas[6] (14,883' X 50')	17.1	0	0	0	17.1
Restored Subtotal	32.9	12.3	22.5	4.4	72.1
Unaffected	62.9	125.6	37.0	6.3	231.8
TOTAL	95.8	137.9	59.5	10.7	303.9
Alternative 3 – Moderate water use					
Eastern riparian strip (8820' X 310)	0	23.6	27.6	6.6	57.8
Western riparian strip (8773' X 75)	15.8	0	0	0	15.8
Vegetation management areas	0	0	0	0	0
Construction Areas (17,594' X 50')	20.2	0	0	0	20.2
Restored Subtotal	36.0	23.6	27.6	6.6	93.8
Unaffected	59.8	114.3	31.7	4.1	210.1
TOTAL	95.8	137.9	59.5	10.7	303.9
Alternative 4 – High water use w / Vegetation Management Areas					
Eastern riparian strip (18,690' X 310')	0	89.4	57.5	8.8	155.7
Western riparian strip (8773' X 75')	15.8	0	0	0	15.8
Vegetation management areas[6]	48.5	48.5	2	1.9	100.9
Construction Areas (27,463' X 50')	31.5	0	0	0	31.5
Restored Subtotal	95.8	137.9	59.5	10.7	303.9
Unaffected	0	0	0	0	0
TOTAL	95.8	137.9	59.5	10.7	303.9
Alternative 5 – Low water use w/o western riparian strip					
Eastern riparian strip (6110' X 310')	0	12.3	22.5	4.4	39.2
Western riparian strip	0	0	0	0	0
Vegetation management areas	0	0	0	0	0
Construction Areas (6110' X 50')	7.0	0	0	0	7.0
Restored Subtotal	7.0	12.3	22.5	4.4	46.2
Unaffected	88.8	125.6	37	6.3	257.7
TOTAL	95.8	137.9	59.5	10.7	303.9
Alternative 6 – Moderate water use w/o western riparian strip					
Eastern riparian strip (8820' X 310')	0	23.6	27.6	6.6	57.8
Western riparian strip	0	0	0	0	0
Vegetation management areas	0	0	0	0	0
Construction Areas (8820' X 50')	10.1	0	0	0	10.1
Restored Subtotal	10.1	23.6	27.6	6.6	67.9

Alternative/Location	Riparian scrubland/ woodland (xeric)[1]	Riparian scrubland/woodland (mesic)	Riparian scrubland/woodland (hydric)[2]	Riparian wetland/herbaceous (hydric)[2]	TOTAL
Unaffected	85.7	114.3	31.9	4.1	236.0
TOTAL	95.8	137.9	59.5	10.7	303.9
Alternative 7 – High water use, w / Vegetation Management Areas, w/o western riparian strip					
Eastern riparian strip (18,690' X 310')	0	89.4	57.5	8.8	155.7
Western riparian strip	0	0	0	0	0
Vegetation management areas	48.5	48.5	2	1.9	100.9
Construction Areas (18,690' X 50')	21.4	0	0	0	21.4
Restored Subtotal	69.9	137.9	59.5	10.7	278
Unaffected	25.9	0	0	0	25.9
TOTAL	95.8	137.9	59.5	10.7	303.9
Alternative 8 – Moderate water use, w / reduced Vegetation Management Areas, w / reduced western riparian strip					
Eastern riparian strip (3130' X 310')	0	6	11	2.2	19.2
Western riparian strip (3885' X 75')	6.5	0	0	0	6.5
Vegetation management areas	38.8	38.8	2	1.4	81
Construction Areas (7015' X 50')	8.0	0	0	0	8.0
Restored Subtotal	53.3	44.8	13	3.6	114.7
Unaffected	42.5	93.1	46.5	7.1	189.2
TOTAL	95.8	137.9	59.5	10.7	303.9

1 Includes species common to upper Sonoran desert scrub and species found under xeric conditions typical of upper flood plains or, as in the present case, alluvial systems deprived of water because of hydrological controls. The total acreage for this habitat type is based on the western levee restoration area.

2 Woodland/scrubland hydric: dominated by woody species with a high hydrologic component (inflexible species); wetland/herbaceous hydric: dominated by herbaceous species with a low hydrologic component (flexible species).

3 The total acreage for this alternative corresponds to the maximum restoration acreage under Alternative 4. For the other alternatives, the restored acreage would be less.

4 Maximum dimensions for each strip. The restored acreage, i.e., revegetated area along the levees may be slightly more or less, depending on the alternative.

5 Approximates the acreage occupied by two low flow channels that would deliver water along the extent of the eastern riparian strip; it would support wetland or facultative wetland species (i.e., there would not be permanent surface water to support an aquatic environment.)

6 Located along the riparian strips towards the interior of the channel. These are sparsely or unvegetated areas within the channel that are dominated by nonnative vegetation. Affected areas that are vegetated at the construction phase will be reseeded with native species. It is assumed the area will have greater habitat value than the existing condition. The construction area is approximately 50 feet wide along the length of the terrace bank armor (i.e., eastern and western riparian strips).

7 Vegetation management areas around I-10, Durango Regional Outfall Channel and the AWWTP support predominantly mesic to xeric riparian conditions, depending on the time of year. The marsh and adjacent areas at the AWWTP discharge are the exception.

The control of water resources on a watershed level, as well as localized changes to the groundwater and surface water drainage and surrounding land development have already had a significant irreversible effect on the site. Some of the negative factors described above perpetuate and accelerate this trend (e.g., full development of adjacent areas, diversion and channelization of runoff, floodplain encroachments). Others will tend to have low-grade chronic or local effects, such as increased recreational development that will encourage more pedestrian and off-road use of the channel. The sum of these factors will result in continued habitat degradation and little opportunity for the growth of vegetation or increase in wildlife habitat.

With the exception of the area fed by effluent from the AWWTP, these factors will not result in a complete loss of existing vegetated areas within the channel. Some encroachments may occur in the remaining unleveed portions where levees, dikes, or buildings are elevated to allow for some development. Maintenance at the I-10 channel repeatedly disturbs vegetation and favors establishment of non-natives. In addition there will be continued degradation of the channel bed resulting in coarser substrate than already exists. Some species like Fremont cottonwood depend on finer materials for germination and establishment of seedlings. Burrowing mammals prefer sandy substrate to coarse sand and gravel. Under these conditions it will become more difficult for vegetation and wildlife to reestablish after significant flood events.

Low magnitude, chronic disturbances have subtle and long-lasting effects. Natural recovery is a long process, especially in arid ecosystems. Without the ecosystem restoration project there will not be an impetus to look for ways to preserve, enhance and restore habitat in this section of the Agua Fria River and minimize the negative effects of the factors described above.

6.3 ALTERNATIVE 2 – LOW WATER ALTERNATIVE

This alternative extends over the smallest area (Table K-2), estimated at 72.1 acres. It requires the smallest input of water (an average of 1.1 mGPD), which will come from approximately two wells and some irrigation from existing City supplies during construction. The configuration consists of a riparian strip along the western levee from McDowell Road to Coldwater Park (also near the second grade control structure), and along the eastern levee from the I-10 outfall to the second grade control structure. The vegetation and planting scheme would be similar to that described for Alternative 4 (see text under Section 6.5 below).

Relative to Alternative 4, the activities that make up construction of Alternative 2 would be less in magnitude and duration. In general most of the construction requiring heavy equipment will take place over 3 months; however, as with any construction in natural areas this schedule must be compatible with the timing for invasive, exotics control, revegetation and seeding, as well as the nesting period for any sensitive species that may occur in the area. Operation and maintenance measures would also be similar to those under Alternative 4, but of lesser magnitude.

6.4 ALTERNATIVE 3 - MODERATE WATER USE

This alternative extends over a slightly greater area than Alternative 2, (Table K-2). It also requires a slightly greater input of water (an average of 1.5 mGPD), which will come from approximately two wells and some irrigation from existing City supplies during construction. The configuration consists of a riparian strip along the western levee from McDowell Road to Coldwater Park (also near the second grade control structure), and along the eastern levee from the I-10 outfall to the second grade control structure. Relative to Alternative 2, there is an additional area of restoration south Lower Buckeye in an unleveed portion of the river, resulting in a total estimated restored area of 93.8 acres.

6.5 ALTERNATIVE 4 – HIGH WATER USE

This alternative extends the restoration effort along the greatest length of the 5.5-mile project reach and occupies the greatest area, estimated at 303.9 acres, without affecting the SPF condition (Table K-2). It requires the greatest input of water (an average of 5.2 mGPD), which will come from approximately five

wells located throughout the project reach and some irrigation from existing City supplies. The configuration consists of a riparian strip along various segments of the eastern and western sides of the channel over three miles long that varies in width from 200 to 600 feet with an average of 310 feet. The eastern riparian strip extends down below the Durango Channel at Buckeye Road. Within the riparian strip there are one to two slightly meandering low flow channels. Frequent flows of up to 15-year events will be partially excluded from the riparian strip to reduce the chances of significant losses; however, larger flows will still pass through and it is presumed that some losses of vegetation will occur.

Along the west side of the channel from approximately McDowell Road to the second grade control structure between Van Buren and Buckeye Roads, the interior slope of the levee will be filled to a slope of approximately 4:1 and vegetated with more xeric vegetation. This xero-riparian or upper floodplain strip of vegetation on the west side would also be protected, but not to the same extent of as the east side because most of the planting will be along the levee, elevated from frequent flood events.

Areas in the interior of the channel, outside of the protected strips have been designated as vegetation management areas to indicate that no structural changes will be carried out in these areas. These areas are identified near the I-10 outfall, the Durango Channel at Buckeye Road and the AWWTP, covering approximately 100.9 acres. Pumped groundwater may be directed to these areas on a seasonal basis. Invasive species will be controlled to encourage establishment of native species and survival of plantings.

The area around the AWWTP is worth special mention. In this area the combination of a perennial source of surface water and relatively shallow groundwater currently sustains a small marsh and a vegetated strip downstream. Under this high water alternative, it is assumed that there is no change to the input of 3.5 mgpd of effluent from the AWWTP, and that this effluent will continue to sustain existing vegetation within that area. For that reason the protected riparian strip along the east side is not extended to this area. In the workshop discussion, participants tended to agree that if the current effluent could be maintained, restoration efforts in this area should be limited. Under natural circumstances one would expect greater species diversity in this system. Two general ideas did emerge: (1) although complete removal of non-native might be a prohibitive task, some of the large athel tamarisk trees, that consume disproportionately more water than cottonwood or willow and increase salt concentrations in the soil, should be removed and replaced with native plantings; (2) slight alteration to the gradient and elevation of the marsh may distribute effluent further downstream; however, this would also change the species composition in the marsh. Presently only the first measure is being considered. Irrigation of plantings will be needed to encourage and facilitate growth of roots to groundwater.[3]

Water inputs for this alternative will vary temporally and spatially throughout the year to accommodate different vegetation types. For instance, cottonwood and willow are dependent on higher seasonal flows from December through February and groundwater within three meters of the surface, whereas more xeric vegetation found in the upper flood plains will require only periodic irrigation from approximately once per week to once per month, depending on drought conditions. Flows should not be extended beyond the normal

[3] Alternatively, excess water that enters the adjacent sand and gravel pits and fine sediment materials from the cleaning process might be viable sources of water and sediment for extending native riparian vegetation in this area. However, it was not

seasonality of events, because this might encourage establishment of tamarisk. Cottonwood and willow release seeds only through April and June, respectively, whereas tamarisk seeds through October and can therefore, take advantage of delayed releases often associated with reservoirs (Tellman, 2002). A program defining delivery rates, frequency and hydroperiods should be completed in the next phase of the project.

Major structural and other physical elements include: riparian protection, eastern levee riparian strip and western levee fill.

The hydraulic analysis considers the impact of vegetation on flood conditions. A conservative approach was taken presuming there is no vegetation washout; predicting such events are possible, but requires good empirical data to estimate the relationship between discharge and vegetation loss in the modeling. The hydraulic analysis is based on the pre-New Waddell Dam standard project flood (SPF), even though the primary concern is to maintain capacity for the 100-year flood event. The results of this analysis are presented in Appendix I.

A list of plant species, densities and general habitat benefits for plantings under hydric, mesic and xeric environmental conditions is provided in Section 4 of the main text. Accordingly, the species in these tables represent a range of water requirements from the following major vegetation types: upper Sonoran desert scrub, Sonoran riparian woodland and scrubland – hydric/ mesic/xeric, Sonoran riparian wetlands. Hydric species generally depend on both on surface water and groundwater within 3 m of the surface. Mesic species can take advantage of groundwater at greater depths (generally up to 10 m) and can withstand periods of drought. Xeric species are particularly adapted to extended periods of drought. Within each group, the use of plants with a high hydrologic component (generally woody species with low flexibility), medium hydrologic component and low hydrologic component (generally herbaceous species with high flexibility) are determined by flood capacity limitations within the channel. Appendix B provides the complete list of these species (FCDMC, 2001).

Selection of species is based not only on their hydrologic component, but also for their low transpiration rate and ability to serve as ground cover that would reduce soil evaporative losses. In general, this selection might naturally occur when defining a plant palette for more arid versus hydric conditions (i.e., saltbush would not do well in waterlogged soils).

Along the eastern riparian strip vegetation will be dominated mostly by hydric and mesic species with increasing distance from the low flow channel(s). Along the western riparian strip, vegetation will be dominated by species more tolerant of xeric conditions. In the management areas outside the protected strips there will be some replacement planting of native species. Along the eastern riparian strip more xeric species will be planted along the protection barrier with mesic and hydric species towards the low flow channel. The selection of species by water requirements will be based for the most part, on existing groundwater conditions and ephemeral flows, from xeric species in the northern segment to mesic species in the southern segment.

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possible to research this option in this phase of the project.

6.6 FINAL ALTERNATIVES 5, 6 AND 7: ALTERNATIVES 2, 3 AND 4 WITHOUT WESTERN RIPARIAN STRIP

Alternatives 5, 6 and 7 are the same as their counterparts, Alternatives 2, 3 and 4, respectively, but do not include any restoration along the western levee. Water use requirements are 0.8, 1.1 and 4.8 mGPD, respectively.

6.7 FINAL ALTERNATIVE 8: MODERATE WATER USE, WITH REDUCED VEGETATION MANAGEMENT AREAS, WITH REDUCED WESTERN RIPARIAN STRIP

Alternative 8 is also based on the management measures described in Section 4.2 and is an adaptation of Alternatives 2, 4 and 5. Restoration options are focused on two areas: the I-10 site near the Papago Diversion Channel; and the Avondale Wastewater Treatment Plant (AWWTP) site. Water use requirements are 1.9 mGPD, in addition to 1 mGPD of effluent from the AWWTP. Restoration near the Durango Channel (Buckeye Road) site was not considered under Alternative 8 because of limited freeboard for flood conveyance and the Goodyear Airport exclusion zone that imposes restrictions to prevent bird-strikes and other risks (see Figure 4). The boundaries of the two remaining restoration areas are also determined in part, by the limits of this exclusion zone (i.e., the southern limit of the I-10 site and the northern limit of the AWWTP site). Following is a qualitative description of Alternative 8. For an illustration, see Figures 29 and 30.

Restoration at the two sites would involve six primary measures: (1) removal of exotic and invasive species throughout the entire restoration site; (2) construction of a riparian strip along the eastern and western levees; (3) establishment of vegetation management areas between the riparian strips and at the AWWTP site; (4) introduction of water from an external source; (5) non-construction measures to enhance habitat resources [e.g., microtopographic variation, creation of plant regeneration areas, etc.]; and (6) measures to eliminate or reduce impacts from adjacent park and trail users.

I-10 Site. Restoration at this site would be similar to that described for Alternatives 2 and 5. The length of the riparian strips on the eastern and western sides is about half the length as Alternative 2. This site would be bounded on the east and southern limit (downstream terminus of the restoration) by a multi-use trail operated by the City of Avondale, which would connect Friendship Park to Coldwater Park. Starting from Friendship Park, the trail would extend south along the eastern levee and drop into the riverbed along the grade-control structure located south of I-10 and up onto the western levee before continuing south to Coldwater Park (see Figure 21). Management measures to minimize or eliminate potential habitat disturbances from the trail and the adjacent park extension are considered in this alternative.

A riparian strip would be located along the eastern levee of the channel starting from 130 feet north of I-10 to 3000 feet south of I-10 (note location of grade structure and I-10 on Figure 4). The eastern riparian strip, totaling 3130 feet in length will average 310 feet in width, covering 26 acres, and will have two braided side channels. It will be planted with mesic and hydric riparian vegetation and irrigation will come from an existing City of Avondale groundwater well. Bank terrace armor to protect the riparian areas would partially exclude frequent flows (up to 15-year events) from the riparian strip to reduce the chances of significant vegetation losses in the short term; however, the constructed areas and vegetation are sacrificial to larger

flows that would inevitably erode part or all of the protection and vegetation (as might occur under natural conditions).

Restoration along the western levee would involve xeric vegetation and added fill. The western levee would be filled on the inner slope at 4:1 with a mixture of riverbed and imported material. This would extend approximately 75 feet into the main channel and would extend 3885 feet south of I-10.

Bank terrace armor would also protect the filled areas along the western levee from frequent flood events; however, flood protection would not be to the same extent as the eastern protection since most the western levee plantings would be elevated above very-frequent flood events.

A vegetation management area of 63 acres would be established between McDowell Road and the grade-control structure immediately south of the I-10. Within this area a limited amount of native vegetation would be planted. Invasive species would be controlled to encourage establishment of existing and planted native species. No structural changes would occur. Additional input of water and sediment would be planned to coincide with natural flows and create conditions that are favorable for the regeneration and establishment of native species. The proportion of vegetation would be maintained at relatively the same level as existing levels, but with the goal of supporting more native vegetation.

External inputs of water for periodic irrigation of the western riparian strip, seasonal irrigation of vegetation management areas and as a perennial source of water for the eastern riparian strip would come from existing City of Avondale groundwater wells. A delivery system will be constructed from the nearest connector to the restored area. The water needs for this area are estimated at 1.9 mGPD.

AWWTP Site. Similar to Alternative 4, there is a vegetation management area at this site. In contrast, there is no riparian strip extending north of the effluent outfall because it requires an additional source of water that cannot be identified or committed at this time (i.e., commitment to construct new wells or divert water from existing supplies). The area around the AWWTP outflow pipe currently sustains a small marsh and a vegetated strip downstream supported by a perennial source of water from the treatment plant effluent and relatively shallow groundwater. Under Alternative 8, it is assumed that effluent retained at the site would be reduced from the current rate of 3.5 mGPD to 1 mGPD. Since 1 mGPD of effluent would probably not be able to sustain existing habitat, a water recirculation system consisting of filtration galleries, a pump, distribution piping, and a powerline from the existing grid to run the system would be installed. The goal of this system would be to capture infiltrated effluent and shallow groundwater at < 20 feet and make this more available for plant use at the surface.

Restoration in this area would be focused on vegetation management as described above for the I-10 site. This management area will be approximately 18 acres. No structural changes would occur and the volume of vegetation would be maintained at relatively the same as existing levels, but the establishment of native species would benefit habitat.

7. STUDY RESULTS

Table K-3 presents a summary of the HEP analysis detailed in Tables K-4 to K-8. In each table a single alternative is assessed at T0, T1, T15, and T50. Along the left columns, the vegetation or habitat type and

time period of analysis is listed by alternative. The function-based standards are listed for the desert riparian ecosystem as defined in Table K-1. The HSIs are summed for each row, averaged and then multiplied by the acreage for the area directly affected by each alternative to determine the number of HUs. The alternatives differ in the area affected by restoration; however for the purposes of the economic analysis, the acreage for alternatives was normalized to Alternative 4, which restores the greatest amount of acreage (303.9 acres). In the case of each alternative the habitat units for the restored area were calculated and then these were summed with the habitat units for the acreage that was unrestored. In the latter case, habitat units for the unrestored portion were based on the same HSIs derived for the no action Alternative 1. Following this approach, only Alternative 4 would have all of its acreage restored. Conversely, for Alternative 2 from Table K-5, 72.1 acres will be restored and these HUs will reflect the habitat benefits from the project. The remaining 231.8 acres contributes HUs based on the same HSIs calculated for Alternative 1.

Table K-3 Summary of Habitat Outputs

Alternative	Time = 0 Years	Time = 1 Years	Time = 15 Years	Time = 50 Years
	Habitat Units			
Alternative 1 No Action	77.72	77.72	63.21	63.21
Alternative 2 - Low Water Use	77.93	87.55	84.97	88.91
Alternative 3 - Medium Water Use	77.78	89.76	90.31	95.41
Alternative 4 -High Water Use and Vegetation Management Areas	77.72	154.90	189.84	209.96
Alternative 5 - Low Water Use w/o Western Riparian Strip	77.93	82.16	75.69	78.55
Alternative 6 - Medium Water Use w/o Western Riparian Strip	77.85	84.43	81.09	85.11
Alternative 7 - High Water Use and Vegetation Management Areas w/o Western Riparian Strip	77.72	147.35	179.05	197.01
Alternative 8 - Moderate Water Use, w/ Reduced Vegetation Management Areas, w/ Reduced Western Riparian Strip	77.98	101.68	104.84	113.40

For all the alternatives it was generally presumed that development and other changes, as well as the relatively slower rate of vegetation development in desert ecosystems, would affect the restoration project significantly during the first 15 years, either depressing the rate of development of vegetation and other habitat characteristics or outright degradation of restored areas that would require re-implementation of the restoration (Tables K-4 to K-8). It was estimated that the long-term effect on restoration, after urban development has passed its peak, would be a slow rate of ecosystem development towards an equilibrium affected by periodic unpredictable natural and anthropogenic events.

Table K-4 Habitat Evaluation for Alternative 1 (No Action Alternative)

								Alternative 1			
Vegetation Type	Time Period	Indices based on Functional Standdardsfor Riparian/Riverine Habitat (1)						Restoration Acres	Total HIS	Average HIS	Habitat Units
		Structural Diversity	Macro/Microtopographic Complexity	Exotic Species	Contiguous Vegetation	Plant Richness	Surface Water Persistence				
Riparian Scrubland/Woodland (xeric) (2)	T0	0.00	0.00	0.40	0.00	0.20	0.00	95.80	0.60	0.10	9.58
	T1	0.00	0.00	0.40	0.00	0.20	0.00	95.80	0.60	0.10	9.58
	T15	0.00	0.00	0.20	0.00	0.10	0.00	95.80	0.30	0.05	4.79
	T50	0.00	0.00	0.20	0.00	0.10	0.00	95.80	0.30	0.05	4.79
Riparian Scrubland/Woodland (Mesic)	T0	0.25	0.25	0.20	0.00	0.60	0.50	137.90	1.80	0.30	41.37
	T1	0.25	0.25	0.20	0.00	0.60	0.50	137.90	1.80	0.30	41.37
	T15	0.25	0.25	0.20	0.00	0.40	0.50	137.90	1.60	0.27	36.77
	T50	0.25	0.25	0.20	0.00	0.40	0.50	137.90	1.60	0.27	36.77
Riparian Crubland/Woodland (Hydrid)	T0	0.50	0.25	0.40	0.00	0.60	0.50	59.50	2.25	0.38	22.31
	T1	0.50	0.25	0.40	0.00	0.60	0.50	59.50	2.25	0.38	22.31
	T15	0.50	0.25	0.20	0.00	0.40	0.50	59.50	1.85	0.31	18.35
	T50	0.50	0.25	0.20	0.00	0.40	0.50	59.50	1.85	0.31	18.35
Riparian/Herbaceous/Wetland (Hydric and Channel)	T0	0.25	0.25	0.40	0.00	0.60	1.00	10.70	2.50	0.42	4.46
	T1	0.25	0.25	0.40	0.00	0.60	1.00	10.70	2.50	0.42	4.46
	T15	0.25	0.50	0.20	0.00	0.40	0.50	10.70	1.85	0.31	3.30
	T50	0.25	0.50	0.20	0.00	0.40	0.50	10.70	1.85	0.31	3.30
						Total Acreage		303.90			
											Total Alt1
								Total HUS at T=0			77.72
								Total HUS at T=1			77.72
(1) The HSIs presented here do not account for natural flood events that will resutl in partial or complete washout of vegetation.								Total HUS at T=15			63.21
(2) Includes species characteristic of upper sonoran desert species and drought tolerant species common to upper floodplains.								Total HUS at T=50			63.21

Table K-5 Habitat Evaluation for Alternatives 2 and 5 Low Water Use/Low Water Use Without Western Levee Restoration

Vegetation Type	Time Period	Indices based on Functional Standdardsfor Riparian/Riverine Habitat (1)						Alternative 2				Alternative 5			
		Structural Diversity	Macro/Microtopographic Complexity	Exotic Species	Contiguous Vegetation	Plant Richness	Surface Water Persistence	Restoration Acres	Total HIS	Average HIS	Habitat Units	Restoration Acres	Habitat Units		
Riparian Scrubland/Woodland (xeric) (2)	T0	0.00	0.00	0.40	0.00	0.20	0.00	32.90	0.60	0.10	3.29	7.00	0.70		
	T1	0.25	0.25	0.60	0.00	0.25	0.50	32.90	1.85	0.31	10.14	7.00	2.16		
	T15	0.50	0.25	0.80	0.10	0.30	0.50	32.90	2.45	0.41	13.43	7.00	2.86		
	T50	0.50	0.50	0.80	0.10	0.30	0.50	32.90	2.70	0.45	14.81	7.00	3.15		
Riparian Scrubland/Woodland (Mesic)	T0	0.25	0.25	0.20	0.00	0.60	0.50	12.30	1.80	0.30	3.69	12.30	3.69		
	T1	0.50	0.50	0.60	0.10	0.40	0.50	12.30	2.60	0.43	5.33	12.30	5.33		
	T15	0.50	0.50	0.80	0.25	0.50	0.50	12.30	3.05	0.51	6.25	12.30	6.25		
	T50	0.50	0.50	0.80	0.25	0.75	0.50	12.30	3.30	0.55	6.77	12.30	6.77		
Riparian Crubland/Woodland (Hydrid)	T0	0.50	0.25	0.40	0.00	0.60	0.50	22.50	2.25	0.38	8.44	22.50	8.44		
	T1	0.50	0.50	0.60	0.10	0.40	0.50	22.50	2.60	0.43	9.75	22.50	9.75		
	T15	0.75	0.50	0.80	0.25	0.60	0.50	22.50	3.40	0.57	12.75	22.50	12.75		
	T50	0.75	0.50	0.80	0.50	0.80	0.50	22.50	3.85	0.64	14.44	22.50	14.44		
Riparian/Herbaceous/Wetland (Hydric and Channel)	T0	0.25	0.25	0.40	0.00	0.60	1.00	4.40	2.50	0.42	1.83	4.40	1.83		
	T1	0.25	0.25	0.60	0.25	0.40	0.50	4.40	2.25	0.38	1.65	4.40	1.65		
	T15	0.25	0.25	0.80	0.50	0.50	0.50	4.40	2.80	0.47	2.05	4.40	2.05		
	T50	0.25	0.50	0.80	0.50	0.75	0.50	4.40	3.30	0.55	2.42	4.40	2.42		
						Total Restored Acreage		72.10				46.20			
										Unaffected Alt 2	Restored Alt 2	Unaffected Alt 5	Restored Alt 5	Total Alt 2	Total Alt 5
								Total HUS at T=0		60.68	17.25	63.27	14.66	77.93	77.93
								Total HUS at T=1		60.68	26.87	63.27	18.89	87.55	82.16
(1) The HSIs presented here do not account for natural flood events that will resutl in partial or complete washout of vegetation.								Total HUS at T=15		50.48	34.49	51.78	23.91	84.97	75.69
(2) Includes species characteristic of upper sonoran desert species and drought tolerant species common to upper floodplains.								Total HUS at T=50		50.48	38.43	51.78	26.77	88.91	78.55

Table K-6 Habitat Evaluation for Alternatives 3 and 6 Medium Water Use/Medium Water Use without Western Levee Restoration

								Alternative 3				Alternative 6			
Vegetation Type	Time Period	Indices based on Functional Standdardsfor Riparian/Riverine Habitat (1)						Restoration Acres	Total HIS	Average HIS	Habitat Units	Restoration Acres	Habitat Units		
		Structural Diversity	Macro/Microtopographic Complexity	Exotic Species	Contiguous Vegetation	Plant Richness	Surface Water Persistence								
Riparian Scrubland/Woodland (xeric) (2)	T0	0.00	0.00	0.40	0.00	0.20	0.00	36.00	0.60	0.10	3.60	10.10	1.01		
	T1	0.25	0.25	0.60	0.00	0.25	0.50	36.00	1.85	0.31	11.10	10.10	3.11		
	T15	0.50	0.25	0.80	0.10	0.30	0.50	36.00	2.45	0.41	14.70	10.10	4.12		
	T50	0.50	0.50	0.80	0.10	0.30	0.50	36.00	2.70	0.45	16.20	10.10	4.55		
Riparian Scrubland/Woodland (Mesic)	T0	0.25	0.25	0.20	0.00	0.60	0.50	23.60	1.80	0.30	7.08	23.60	7.08		
	T1	0.50	0.50	0.60	0.10	0.40	0.50	23.60	2.60	0.43	10.23	23.60	10.23		
	T15	0.50	0.50	0.80	0.25	0.50	0.50	23.60	3.05	0.51	12.00	23.60	12.00		
	T50	0.50	0.50	0.80	0.25	0.75	0.50	23.60	3.30	0.55	12.98	23.60	12.98		
Riparian Crubland/Woodland (Hydrid)	T0	0.50	0.25	0.40	0.00	0.60	0.50	27.50	2.25	0.38	10.31	27.50	10.31		
	T1	0.50	0.50	0.60	0.10	0.40	0.50	27.50	2.60	0.43	11.92	27.50	11.92		
	T15	0.75	0.50	0.80	0.25	0.60	0.50	27.50	3.40	0.57	15.58	27.50	15.58		
	T50	0.75	0.50	0.80	0.50	0.80	0.50	27.50	3.85	0.64	17.65	27.50	17.65		
Riparian/Herbaceous/Wetland (Hydric and Channel)	T0	0.25	0.25	0.40	0.00	0.60	1.00	6.60	2.50	0.42	2.75	6.60	2.75		
	T1	0.25	0.25	0.60	0.25	0.40	0.50	6.60	2.25	0.38	2.48	6.60	2.48		
	T15	0.25	0.25	0.80	0.50	0.50	0.50	6.60	2.80	0.47	3.08	6.60	3.08		
	T50	0.25	0.50	0.80	0.50	0.75	0.50	6.60	3.30	0.55	3.63	6.60	3.63		
						Total Restored Acreage		93.70				67.80			
										Unaffected Alt 3	Restored Alt 3	Unaffected Alt 6	Restored Alt 6	Total Alt 3	Total Alt 6
								Total HUS at T=0		54.04	23.74	56.70	21.15	77.78	77.85
								Total HUS at T=1		54.04	35.72	56.70	27.73	89.76	84.43
(1) The HSIs presented here do not account for natural flood events that will result in partial or complete washout of vegetation.								Total HUS at T=15		44.95	45.36	46.31	34.78	90.31	81.09
(2) Includes species characteristic of upper sonoran desert species and drought tolerant species common to upper floodplains.								Total HUS at T=50		44.95	50.46	46.31	38.80	95.41	85.11

Table K-7 Habitat Evaluation for Alternatives 4 and 7 Water Use and Vegetation Management Areas/High Water Use and Vegetation Management Areas without Western Levee Restoration

Vegetation Type	Time Period	Indices based on Functional Standdardsfor Riparian/Riverine Habitat (1)						Alternative 4				Alternative 7			
		Structural Diversity	Macro/Microtopographic Complexity	Exotic Species	Contiguous Vegetation	Plant Richness	Surface Water Persistence	Restoration Acres	Total HIS	Average HIS	Habitat Units	Restoration Acres	Habitat Units		
Riparian Scrubland/Woodland (xeric) (2)	T0	0.00	0.00	0.40	0.00	0.20	0.00	95.80	0.60	0.10	9.58	69.90	6.99		
	T1	0.50	0.25	0.60	0.25	0.25	0.50	95.80	2.35	0.39	37.52	69.90	27.38		
	T15	0.50	0.25	1.00	0.25	0.30	0.50	95.80	2.80	0.47	44.71	69.90	32.62		
	T50	0.75	0.50	1.00	0.25	0.30	0.50	95.80	3.30	0.55	52.69	69.90	38.45		
Riparian Scrubland/Woodland (Mesic)	T0	0.25	0.25	0.20	0.00	0.60	0.50	137.90	1.80	0.30	41.37	137.90	41.37		
	T1	0.50	0.50	0.60	0.50	0.60	0.50	137.90	3.20	0.53	73.55	137.90	73.55		
	T15	0.75	0.50	0.80	0.75	0.70	0.50	137.90	4.00	0.67	91.93	137.90	91.93		
	T50	1.00	0.50	0.80	0.75	0.80	0.50	137.90	4.35	0.73	99.98	137.90	99.98		
Riparian Crubland/Woodland (Hydrid)	T0	0.50	0.25	0.40	0.00	0.60	0.50	59.50	2.25	0.38	22.31	59.50	22.31		
	T1	0.50	0.50	0.60	0.50	0.70	1.00	59.50	3.80	0.63	37.68	59.50	37.68		
	T15	0.75	0.50	0.80	0.75	0.80	1.00	59.50	4.60	0.77	45.62	59.50	45.62		
	T50	1.00	0.50	0.80	0.75	0.90	1.00	59.50	4.95	0.83	49.09	59.50	49.09		
Riparian/Herbaceous/Wetland (Hydric and Channel)	T0	0.25	0.25	0.40	0.00	0.60	1.00	10.70	2.50	0.42	4.46	10.70	4.46		
	T1	0.50	0.25	0.60	0.50	0.60	1.00	10.70	3.45	0.58	6.15	10.70	6.15		
	T15	0.50	0.50	0.80	0.75	0.70	1.00	10.70	4.25	0.71	7.58	10.70	7.58		
	T50	0.75	0.50	0.80	0.75	0.80	1.00	10.70	4.60	0.77	8.20	10.70	8.20		
						Total Restored Acreage		303.90				278.00			
										Unaffected Alt 4	Restored Alt 4	Unaffected Alt 7	Restored Alt 7	Total Alt 4	Total Alt 7
								Total HUS at T=0		0.00	77.72	2.59	75.13	77.72	77.72
								Total HUS at T=1		0.00	154.90	2.59	144.76	154.90	147.35
								Total HUS at T=15		0.00	189.84	1.30	177.75	189.84	179.05
								Total HUS at T=50		0.00	209.96	1.30	195.71	209.96	197.01

(1) The HSIs presented here do not account for natural flood events that will resutl in partial or complete washout of vegetation.

(2) Includes species characteristic of upper sonoran desert species and drought tolerant species common to upper floodplains.

Table K-8 Habitat Evaluation for Alternative 8 Moderate Water Use, With Reduced Vegetation Management Areas, With reduced Western Riparian Strip

Vegetation Type	Time Period	Indices based on Functional Standdardsfor Riparian/Riverine Habitat (1)						Alternative 8				
		Structural Diversity	Macro/Microtopographic Complexity	Exotic Species	Contiguous Vegetation	Plant Richness	Surface Water Persistence	Restoration Acres	Total HIS	Average HIS	Habitat Units	
Riparian Scrubland/Woodland (xeric) (2)	T0	0.00	0.00	0.40	0.00	0.20	0.00	53.30	0.60	0.10	5.33	
	T1	0.50	0.25	0.60	0.00	0.25	0.50	53.30	2.10	0.35	18.66	
	T15	0.50	0.25	1.00	0.10	0.30	0.50	53.30	2.65	0.44	23.54	
	T50	0.75	0.50	1.00	0.10	0.30	0.50	53.30	3.15	0.53	27.98	
Riparian Scrubland/Woodland (Mesic)	T0	0.25	0.25	0.20	0.00	0.60	0.50	44.80	1.80	0.30	13.44	
	T1	0.50	0.50	0.60	0.10	0.60	0.50	44.80	2.80	0.47	20.91	
	T15	0.75	0.50	0.80	0.25	0.70	0.50	44.80	3.50	0.58	26.13	
	T50	1.00	0.50	0.80	0.25	0.80	0.50	44.80	3.85	0.64	28.75	
Riparian Crubland/Woodland (Hydrid)	T0	0.50	0.25	0.40	0.00	0.60	0.50	13.00	2.25	0.38	4.88	
	T1	0.50	0.50	0.60	0.10	0.70	1.00	13.00	3.40	0.57	7.37	
	T15	0.75	0.50	0.80	0.25	0.80	1.00	13.00	4.10	0.68	8.88	
	T50	1.00	0.50	0.80	0.50	0.90	1.00	13.00	4.70	0.78	10.18	
Riparian/Herbaceous/Wetland (Hydric and Channel)	T0	0.25	0.25	0.40	0.00	0.60	1.00	3.60	2.50	0.42	1.50	
	T1	0.50	0.25	0.60	0.25	0.60	1.00	3.60	3.20	0.53	1.92	
	T15	0.50	0.50	0.80	0.50	0.70	1.00	3.60	4.00	0.67	2.40	
	T50	0.75	0.50	0.80	0.50	0.80	1.00	3.60	4.35	0.73	2.61	
						Total Restored Acreage		114.70				
										Unaffected Alt 8	Restored Alt 8	Total Alt 8
								Total HUS at T=0		52.83	25.15	77.98
								Total HUS at T=1		52.83	48.85	101.68
(1) The HSIs presented here do not account for natural flood events that will resutl in partial or complete washout of vegetation.								Total HUS at T=15		43.88	60.96	104.84
(2) Includes species characteristic of upper sonoran desert species and drought tolerant species common to upper floodplains.								Total HUS at T=50		43.88	69.52	113.40

Some of the most important differences considered among the alternatives included the absence of vegetation management areas in Alternatives 2, 3, 5 and 6, and the absence of the western riparian strip in Alternatives 5, 6 and 7, which diminish the contiguity of habitat within the project reach and the extent of development of habitat characteristics. Alternatives 4 and 7, followed by Alternative 8, would provide the greatest opportunity for development of vegetation and characteristics affected by the presence of surface water, albeit from pumped groundwater.

Aside from some of these differences among the HSIs, the number of habitat units is dictated by the acreage of each alternative. While the western riparian strip provides additional xeric habitat that is important for reestablishing a complete gradient of conditions for wildlife that use riparian and alluvial ecosystems, this is not reflected well in the analysis because vegetation types are, for the most part, considered independently. Obviously Alternatives 4 and 7 that cover the most area and also support the highest HSIs for some of the standards, result in the greatest habitat output, 209.96 and 197.01 habitat units, respectively at T=50. Alternative 8 provides 113.40 HUs. Of the seven action alternatives, these reestablish the most ecologically natural conditions over the entire project reach.

Habitat outputs for each alternative are converted to average annual habitat units over the 50-year life of the project (Table K-9). The acreage for the without project condition would change, depending on the restoration alternative; therefore, HUs also differ by alternative. The AAHUs decrease over time and all of them converge towards the same number by the 15th year of the period of analysis.

Table K-9 Average Annual Habitat Units (AAHU)
(Based on Average of HUs to the end of the year that is indicated.)

Alternative	HU T=0	HU T=1	HU T=15	HU T=50	AAHU
Alternative 1	77.72	77.72	63.21	63.21	65.63
Alternative 2	79.10	87.55	84.97	86.62	86.62
Alternative 3	78.57	89.80	90.37	95.47	91.85
Alternative 4	114.91	154.90	189.84	209.96	190.33
Alternative 5	76.73	82.15	75.69	78.55	77.67
Alternative 6	76.28	84.48	81.15	85.17	82.96
Alternative 7	111.46	147.35	179.04	197.01	179.40
Alternative 8	86.91	101.68	104.84	113.40	107.04

8. HEP ANALYSIS TEAM

The HEP analysis team consists of representatives from the USACE environmental and engineering branches, USFWS, GFDA and USFWS. The draft HEP analysis presented here has currently been distributed to team members for review and discussion prior to finalization. Based on research of relevant resource documents and site visits, the group will finalize the determinations in the draft analysis. The members of the analysis team are:

- William Butler, U.S. Army Corps of Engineers
- Mike Martinez, Fish and Wildlife Biologist for USFWS

- Bill Werner, Game and Fish Department of Arizona
- Shari Koslowsky, M.S. Ecology, Aspen Environmental Group Inc.

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APPENDIX L.

AIR QUALITY CONFORMITY DETERMINATION

Table 1: FUGITIVE DUST EMISSION ESTIMATES FOR CONSTRUCTION ACTIVITIES FOR ALTERNATIVE 2

Dirt Pushing or Bull Dozing

Pieces of construction equipment	Days a year	Hours a day	Equipment Hours per day	Rule 310 Reduction	Emission Factor (lbs/hour)	PM10 Emissions (lbs/day)	PM10 Emissions (tons/year)
12	60	8	96	70%	1.3	37.44	1.12

General Construction Activity

Emission Factor	Acres a Day	Days	Rule 310 Reduction	PM10 Emissions	
(lbs/day/acre)	(acres)	(days)		(lbs/year)	(tons/year)
24	3	60	70%	1,296	0.65

Note:

Emission Factor = 1.2 tons TSP/acre/month (1/20 month) (2,000 lbs/ton) (.20 TSP is PM10)

Paved Roads

k	sL	W	E	vehicle miles traveled	PM10 Emissions
(lbs/vmt)	(g/m2)	(tons)	(lbs/vmt)	(vmt per year)	(tons/year)
0.016	0.40	23.00	0.119	170,610	10.18

Notes

E=k(sL/2)^0.65 (W/3)^1.5

where: E = particulate emission factor (having units matching the units of k)

k = base emission factor (lb/vehicle miles traveled)

sL = road surface silt loading (grams per square meter) (g/m^2)

W = average weight (tons) of the vehicles traveling the road = 23 tons (95% are assumed to average 24 tons and 5% are assumed to be 2 tons)

SUMMARY OF ANNUAL FUGITIVE DUST (PM10) EMISSIONS (TONS)

Units	Dirt Pushing	General Activity	Paved Roads	**Totals**
tons/year	1.12	0.65	10.18	11.95

Sources:

Table A9-9-F *SCAQMD CEQA Handbook, 1993*

Sections 13.2.1 and 13.2.3 of USEPA Compilation of Air Pollutant Emission Factors (AP-42)

Table 2: Exhaust Emission Estimates For Alternative 2

		On-Site Sources									Off-site Sources					
Parameter	**Units**	**Chipper**	**Grader**	**Dozer**	**Chain Saw**	**Cement Mixer**	**Spray Truck**	**Drill Rig**	**Loader**		**Parameter**	**Units**	**Worker Trips**	**Haul Truck**		
Number of Equipment Units		3	3	3	10	1	1	1	6		Miles per trip		10	10		trips
Operational Hours	hr/day	8	8	8	8	8	8	8	8		Trips per day		15	269.35		16161
Days per Year	day/year	20	60	60	20	3	20	2	60		days per year		60	60		trips/hour/front
Average Rated Horse Power	hp	50	156.6	356	5	11	489	209	147		Conversion Factor	(lb/g)	0.002205	0.002205		11.22291667
Typical Load Factor	%	62.00%	57.50%	59.00%	50.00%	56.00%	41.00%	75.00%	46.50%							total miles
Emission Factor	lb/hp-hr										Emission Factor	(g/mile)				170610
CO		0.02	0.008	0.01	2.15	0.01	0.032	0.02	0.011		CO		27.83	6.42		
ROCs		0.003	0.003	0.002	0.684	0.002	0.005	0.003	0.002		ROCs		3.84	1.34		
NOx		0.024	0.021	0.021	0.0021	0.024	0.026	0.024	0.023		NOx		2.42	9.27		
SOx		0.002	0.002	0.002	0.0008	0.002	0.002	0.002	0.002		SOx		0.05	0.30		
PM10		0.0015	0.001	0.0005	0.00143	0.001	0.002	0.0015	0.0015		PM10		0.11	0.43		
Total Daily Emissions	(lb/year)									**Total (tons)**					**Total (tons)**	
CO		297.600	1037.318	3024.576	8600.000	1.478	1026.509	50.160	2165.486	7.953	CO		552.286	2287.767	1.420	
ROCs		44.640	388.994	604.915	2736.000	0.296	160.392	7.524	393.725	2.146	ROCs		76.205	477.509	0.277	
NOx		357.120	2722.961	6351.610	8.400	3.548	834.038	60.192	4527.835	7.254	NOx		48.025	3303.365	1.676	
SOx		29.760	259.330	604.915	3.200	0.296	64.157	5.016	393.725	0.665	SOx		0.992	106.905	0.054	
PM10		22.320	129.665	151.229	5.720	0.148	64.157	3.762	295.294	0.325	PM10		2.183	153.231	0.078	

TOTAL ON-SITE AND OFF-SITE COMBINED EXHAUST EMISSIONS (TONS)

CO	9.373
ROCs	2.423
NOx	8.930
SOx	0.719
PM10	0.403

Assumptions:

It is assumed that construction with heavy equipment would last for approximatley 3 months on three different fronts.Vegetation clearing would take approximately one month

It is assumed that well drilling would take one day for each of the two wells.

Haul trips (assume 20 cubic yard capacity per trip) = 16,160 trips over a 60 day period (16,100 trips for imported fill; 30 trips for vegetation debris; and 30 trips for other supplies)

Approximatley 15 construction workers would commute to and from the project for 3 months, 5 days a week.

Sources:

Tables A9-8-B and -C, A9-5-K-6 and A9-5-L *SCAQMD CEQA Air Quality Handbook, 1993*

Chipper emission factors are "Other Construction Equipment" with hp obtained from manufacturer specifications.

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Table 3: FUGITIVE DUST EMISSION ESTIMATES FOR CONSTRUCTION ACTIVITIES FOR ALTERNATIVE 3

Dirt Pushing or Bull Dozing

Pieces of construction equipment	Days a year	Hours a day	Equipment Hours per day	Rule 310 Reduction	Emission Factor (lbs/hour)	PM10 Emissions (lbs/day)	PM10 Emissions (tons/year)
12	80	8	96	70%	1.3	37.44	1.50

General Construction Activity

Emission Factor	Acres a Day	Days	Rule 310 Reduction	PM10 Emissions	
(lbs/day/acre)	(acres)	(days)		(lbs/year)	(tons/year)
24	3	80	70%	1,728	0.86

Note:

Emission Factor = 1.2 tons TSP/acre/month (1/20 month) (2,000 lbs/ton) (.20 TSP is PM10)

Paved Roads

k	sL	W	E	vehicle miles traveled	PM10 Emissions
(lbs/vmt)	(g/m2)	(tons)	(lbs/vmt)	(vmt per year)	(tons/year)
0.016	0.40	22.00	0.112	148,600	8.29

Notes

E=k(sL/2)^0.65 (W/3)^1.5

where: E = particulate emission factor (having units matching the units of k)

k = base emission factor (lb/vehicle miles traveled)

sL = road surface silt loading (grams per square meter) (g/m^2)

W = average weight (tons) of the vehicles traveling the road = 22 tons (92% are assumed to average 24 tons and 5% are assumed to be 2 tons)

SUMMARY OF ANNUAL FUGITIVE DUST (PM10) EMISSIONS (TONS)

Units	Dirt Pushing	General Activity	Paved Roads	**Totals**
tons/year	1.50	0.86	8.29	10.65

Sources:

Table A9-9-F *SCAQMD CEQA Handbook, 1993*

Sections 13.2.1 and 13.2.3 of USEPA Compilation of Air Pollutant Emission Factors (AP-42)

Table 4: Exhaust Emission Estimates For Alternative 3

Parameter	Units	On-Site Sources: Chipper	Grader	Dozer	Chain Saw	Cement Mixer	Spray Truck	Drill Rig	Loader		Off-site Sources: Parameter	Units	Worker Trips	Haul Truck	
Number of Equipment Units		3	3	3	10	1	1	1	6		Miles per trip		10	10	
Operational Hours	hr/day	8	8	8	8	8	8	8	8		Trips per day		15	170.75	
Days per Year	day/year	30	80	80	30	3	30	2	80		days per year		80	80	
Average Rated Horse Power	hp	50	156.6	356	5	11	489	209	147		Conversion Factor	(lb/g)	0.002205	0.002205	
Typical Load Factor	%	62.00%	57.50%	59.00%	50.00%	56.00%	41.00%	75.00%	46.50%						
Emission Factor	lb/hp-hr										Emission Factor	(g/mile)			
CO		0.02	0.008	0.01	2.15	0.01	0.032	0.02	0.011		CO		27.83	6.42	
ROCs		0.003	0.003	0.002	0.684	0.002	0.005	0.003	0.002		ROCs		3.84	1.34	
NOx		0.024	0.021	0.021	0.0021	0.024	0.026	0.024	0.023		NOx		2.42	9.27	
SOx		0.002	0.002	0.002	0.0008	0.002	0.002	0.002	0.002		SOx		0.05	0.30	
PM10		0.0015	0.001	0.0005	0.00143	0.001	0.002	0.0015	0.0015		PM10		0.11	0.43	
Total Daily Emissions	(lb/year)									**Total (tons)**					**Total (tons)**
CO		446.40	1383.09	4032.77	12900.00	1.48	1539.76	50.16	2887.32	11.397	CO		736.38	1933.72	1.34
ROCs		66.96	518.66	806.55	4104.00	0.30	240.59	7.52	524.97	3.101	ROCs		101.61	403.61	0.25
NOx		535.68	3630.61	8468.81	12.60	3.55	1251.06	60.19	6037.11	9.732	NOx		64.03	2792.15	1.43
SOx		44.64	345.77	806.55	4.80	0.30	96.24	5.02	524.97	0.892	SOx		1.32	90.36	0.05
PM10		33.48	172.89	201.64	8.58	0.15	96.24	3.76	393.72	0.438	PM10		2.91	129.52	0.07

trips
13660
trips/hour/front
7.114583333
total miles
148600

TOTAL ON-SITE AND OFF-SITE COMBINED EXHAUST EMISSIONS (TONS)

CO	12.73
ROCs	3.35
NOx	11.16
SOx	0.94
PM10	0.50

Assumptions:

It is assumed that construction with heavy equipment would last for approximatley 4 months on three different fronts.Vegetation clearing would take approximately six weeks

It is assumed that well drilling would take one day for each of the two wells.

Haul trips (assume 20 cubic yard capacity per trip) = 13,660 trips over a 80 day period (13,600 trips for imported fill; 30 trips for vegetation debris; and 30 trips for other supplies)

Approximatley 15 construction workers would commute to and from the project for 4 months, 5 days a week.

Sources:

Tables A9-8-B and -C, A9-5-K-6 and A9-5-L *SCAQMD CEQA Air Quality Handbook, 1993*

Chipper emission factors are "Other Construction Equipment" with hp obtained from manufacturer specifications.

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Table 5: FUGITIVE DUST EMISSION ESTIMATES FOR CONSTRUCTION ACTIVITIES FOR ALTERNATIVE 4

Dirt Pushing or Bull Dozing

Pieces of construction equipment	Days a year	Hours a day	Equipment Hours per day	Rule 310 Reduction	Emission Factor (lbs/hour)	PM10 Emissions (lbs/day)	PM10 Emissions (tons/year)
12	120	8	96	70%	1.3	37.44	2.25

General Construction Activity

Emission Factor	Acres a Day	Days	Rule 310 Reduction	PM10 Emissions	
(lbs/day/acre)	(acres)	(days)		(lbs/year)	(tons/year)
24	3	120	70%	2,592	1.30

Note:

Emission Factor = 1.2 tons TSP/acre/month (1/20 month) (2,000 lbs/ton) (.20 TSP is PM10)

Paved Roads

k (lbs/vmt)	sL (g/m2)	W (tons)	E (lbs/vmt)	vehicle miles traveled (vmt per year)	PM10 Emissions (tons/year)
0.016	0.40	23.00	0.119	280,000	16.70

Notes

E=k(sL/2)^0.65 (W/3)^1.5

where: E = particulate emission factor (having units matching the units of k)

k = base emission factor (lb/vehicle miles traveled)

sL = road surface silt loading (grams per square meter) (g/m^2)

W = average weight (tons) of the vehicles traveling the road = 23 tons (94% are assumed to average 24 tons and 6% are assumed to be 2 tons)

SUMMARY OF ANNUAL FUGITIVE DUST (PM10) EMISSIONS (TONS)

Units	Dirt Pushing	General Activity	Paved Roads	**Totals**
tons/year	2.25	1.30	16.70	20.25

Sources:

Table A9-9-F *SCAQMD CEQA Handbook, 1993*

Sections 13.2.1 and 13.2.3 of USEPA Compilation of Air Pollutant Emission Factors (AP-42)

Table 6: Exhaust Emission Estimates For Alternative 4

Parameter	Units	On-Site Sources: Chipper	Grader	Dozer	Chain Saw	Cement Mixer	Spray Truck	Drill Rig	Loader	
Number of Equipment Units		3	3	3	10	1	1	1	6	
Operational Hours	hr/day	8	8	8	8	8	8	8	8	
Days per Year	day/year	60	120	120	60	3	60	5	120	
Average Rated Horse Power	hp	50	156.6	356	5	11	489	209	147	
Typical Load Factor	%	62.00%	57.50%	59.00%	50.00%	56.00%	41.00%	75.00%	46.50%	
Emission Factor	lb/hp-hr									
CO		0.02	0.008	0.01	2.15	0.01	0.032	0.02	0.011	
ROCs		0.003	0.003	0.002	0.684	0.002	0.005	0.003	0.002	
NOx		0.024	0.021	0.021	0.0021	0.024	0.026	0.024	0.023	
SOx		0.002	0.002	0.002	0.0008	0.002	0.002	0.002	0.002	
PM10		0.0015	0.001	0.0005	0.00143	0.001	0.002	0.0015	0.0015	
Total Daily Emissions	(lb/year)									**Total (tons)**
CO		892.80	2074.64	6049.15	25800.00	1.48	3079.53	125.40	4330.97	20.731
ROCs		133.92	777.99	1209.83	8208.00	0.30	481.18	18.81	787.45	5.742
NOx		1071.36	5445.92	12703.22	25.20	3.55	2502.12	150.48	9055.67	14.943
SOx		89.28	518.66	1209.83	9.60	0.30	192.47	12.54	787.45	1.365
PM10		66.96	259.33	302.46	17.16	0.15	192.47	9.41	590.59	0.686

Off-site Sources: Parameter	Units	Worker Trips	Haul Truck	
Miles per trip		10	10	
Trips per day		15	218.33	
days per year		120	120	
Conversion Factor	(lb/g)	0.002205	0.002205	
Emission Factor	(g/mile)			
CO		27.83	6.42	
ROCs		3.84	1.34	
NOx		2.42	9.27	
SOx		0.05	0.30	
PM10		0.11	0.43	
				Total (tons)
CO		1104.57	3708.90	2.41
ROCs		152.41	774.13	0.46
NOx		96.05	5355.37	2.73
SOx		1.98	173.31	0.09
PM10		4.37	248.42	0.13

trips
26200
trips/hour/front
9.097222222
total miles
280000

TOTAL ON-SITE AND OFF-SITE COMBINED EXHAUST EMISSIONS (TONS)

CO	23.14
ROCs	6.21
NOx	17.67
SOx	1.45
PM10	0.81

Assumptions:

It is assumed that construction with heavy equipment would last for approximatley 6 months on three different fronts.Vegetation clearing would take approximately 3 months.

It is assumed that well drilling would take one day for each of the five wells.

Haul trips (assume 20 cubic yard capacity per trip) = 26,200 trips over a 120 day period (26,000 trips for imported fill; 150 trips for vegetation debris; and 50 trips for other supplies)

Approximatley 15 construction workers would commute to and from the project for 6 months, 5 days a week.

Sources:

Tables A9-8-B and -C, A9-5-K-6 and A9-5-L *SCAQMD CEQA Air Quality Handbook, 1993*

Chipper emission factors are "Other Construction Equipment" with hp obtained from manufacturer specifications.

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Table 7: FUGITIVE DUST EMISSION ESTIMATES FOR CONSTRUCTION ACTIVITIES FOR ALTERNATIVE 5

Dirt Pushing or Bull Dozing

Pieces of construction equipment	Days a year	Hours a day	Equipment Hours per day	Rule 310 Reduction	Emission Factor (lbs/hour)	PM10 Emissions (lbs/day)	PM10 Emissions (tons/year)
8	60	8	64	70%	1.3	24.96	0.75

General Construction Activity

Emission Factor	Acres a Day	Days	Rule 310 Reduction	PM10 Emissions	
(lbs/day/acre)	(acres)	(days)		(lbs/year)	(tons/year)
24	2	60	70%	864	0.43

Note:

Emission Factor = 1.2 tons TSP/acre/month (1/20 month) (2,000 lbs/ton) (.20 TSP is PM10)

Paved Roads

k	sL	W	E	vehicle miles traveled	PM10 Emissions
(lbs/vmt)	(g/m2)	(tons)	(lbs/vmt)	(vmt per year)	(tons/year)
0.016	0.40	22.00	0.112	95,600	5.34

Notes

E=k(sL/2)^0.65 (W/3)^1.5

where: E = particulate emission factor (having units matching the units of k)

k = base emission factor (lb/vehicle miles traveled)

sL = road surface silt loading (grams per square meter) (g/m^2)

W = average weight (tons) of the vehicles traveling the road = 22 tons (91% are assumed to average 24 tons and 9% are assumed to be 2 tons)

SUMMARY OF ANNUAL FUGITIVE DUST (PM10) EMISSIONS (TONS)

Units	Dirt Pushing	General Activity	Paved Roads	**Totals**
tons/year	0.75	0.43	5.34	6.52

Sources:

Table A9-9-F *SCAQMD CEQA Handbook, 1993*

Sections 13.2.1 and 13.2.3 of USEPA Compilation of Air Pollutant Emission Factors (AP-42)

Table 8: Exhaust Emission Estimates For Alternative 5

Parameter	Units	On-Site Sources: Chipper	Grader	Dozer	Chain Saw	Cement Mixer	Spray Truck	Drill Rig	Loader		Off-site Sources: Parameter	Units	Worker Trips	Haul Truck	
Number of Equipment Units		2	2	2	10	1	1	1	4		Miles per trip		10	10	
Operational Hours	hr/day	8	8	8	8	8	8	8	8		Trips per day		15	144.33	
Days per Year	day/year	20	60	60	20	3	20	2	60		days per year		60	60	
Average Rated Horse Power	hp	50	156.6	356	5	11	489	209	147		Conversion Factor	(lb/g)	0.002205	0.002205	
Typical Load Factor	%	62.00%	57.50%	59.00%	50.00%	56.00%	41.00%	75.00%	46.50%						
Emission Factor	lb/hp-hr										Emission Factor	(g/mile)			
CO		0.02	0.008	0.01	2.15	0.01	0.032	0.02	0.011		CO		27.83	6.42	
ROCs		0.003	0.003	0.002	0.684	0.002	0.005	0.003	0.002		ROCs		3.84	1.34	
NOx		0.024	0.021	0.021	0.0021	0.024	0.026	0.024	0.023		NOx		2.42	9.27	
SOx		0.002	0.002	0.002	0.0008	0.002	0.002	0.002	0.002		SOx		0.05	0.30	
PM10		0.0015	0.001	0.0005	0.00143	0.001	0.002	0.0015	0.0015		PM10		0.11	0.43	
Total Daily Emissions	(lb/year)									**Total (tons)**					**Total (tons)**
CO		198.400	691.546	2016.384	8600.000	1.478	1026.509	50.160	1443.658	6.915	CO		552.286	1225.918	0.889
ROCs		29.760	259.330	403.277	2736.000	0.296	160.392	7.524	262.483	1.915	ROCs		76.205	255.877	0.166
NOx		238.080	1815.307	4234.406	8.400	3.548	834.038	60.192	3018.557	4.987	NOx		48.025	1770.134	0.909
SOx		19.840	172.886	403.277	3.200	0.296	64.157	5.016	262.483	0.456	SOx		0.992	57.286	0.029
PM10		14.880	86.443	100.819	5.720	0.148	64.157	3.762	196.862	0.229	PM10		2.183	82.110	0.042

haul trips
8660
trips/hour/front
9.020833333
total miles
95600

TOTAL ON-SITE AND OFF-SITE COMBINED EXHAUST EMISSIONS (TONS)

CO	7.804
ROCs	2.081
NOx	5.896
SOx	0.485
PM10	0.271

Assumptions:

It is assumed that construction with heavy equipment would last for approximatley 3 months on two different fronts.Vegetation clearing would take approximately one month

It is assumed that well drilling would take one day for each of the two wells.

Haul trips (assume 20 cubic yard capacity per trip) = 8660 trips over a 60 day period (8,600 trips for imported fill; 30 trips for vegetation debris; and 30 trips for other supplies)

Approximatley 15 construction workers would commute to and from the project for 3 months, 5 days a week.

Sources:

Tables A9-8-B and -C, A9-5-K-6 and A9-5-L *SCAQMD CEQA Air Quality Handbook, 1993*

Chipper emission factors are "Other Construction Equipment" with hp obtained from manufacturer specifications.

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Table 9: FUGITIVE DUST EMISSION ESTIMATES FOR CONSTRUCTION ACTIVITIES FOR ALTERNATIVE 6

Dirt Pushing or Bull Dozing

Pieces of construction equipment	Days a year	Hours a day	Equipment Hours per day	Rule 310 Reduction	Emission Factor (lbs/hour)	PM10 Emissions (lbs/day)	PM10 Emissions (tons/year)
8	80	8	64	70%	1.3	24.96	1.00

General Construction Activity

Emission Factor	Acres a Day	Days	Rule 310 Reduction	PM10 Emissions	
(lbs/day/acre)	(acres)	(days)		(lbs/year)	(tons/year)
24	2	80	70%	1,152	0.58

Note:

Emission Factor = 1.2 tons TSP/acre/month (1/20 month) (2,000 lbs/ton) (.20 TSP is PM10)

Paved Roads

k	sL	W	E	vehicle miles traveled	PM10 Emissions
(lbs/vmt)	(g/m2)	(tons)	(lbs/vmt)	(vmt per year)	(tons/year)
0.016	0.40	20.00	0.097	73,600	3.56

Notes

E=k(sL/2)^0.65 (W/3)^1.5

where: E = particulate emission factor (having units matching the units of k)

k = base emission factor (lb/vehicle miles traveled)

sL = road surface silt loading (grams per square meter) (g/m^2)

W = average weight (tons) of the vehicles traveling the road = 20 tons (84% are assumed to average 24 tons and 16% are assumed to be 2 tons)

SUMMARY OF ANNUAL FUGITIVE DUST (PM10) EMISSIONS (TONS)

Units	Dirt Pushing	General Activity	Paved Roads	**Totals**
tons/year	1.00	0.58	3.56	5.13

Sources:

Table A9-9-F *SCAQMD CEQA Handbook, 1993*

Sections 13.2.1 and 13.2.3 of USEPA Compilation of Air Pollutant Emission Factors (AP-42)

Table 10: Exhaust Emission Estimates For Alternative 6

Parameter	Units	On-Site Sources: Chipper	Grader	Dozer	Chain Saw	Cement Mixer	Spray Truck	Drill Rig	Loader	
Number of Equipment Units		2	2	2	10	1	1	1	4	
Operational Hours	hr/day	8	8	8	8	8	8	8	8	
Days per Year	day/year	30	80	80	30	3	30	2	80	
Average Rated Horse Power	hp	50	156.6	356	5	11	489	209	147	
Typical Load Factor	%	62.00%	57.50%	59.00%	50.00%	56.00%	41.00%	75.00%	46.50%	
Emission Factor	lb/hp-hr									
CO		0.02	0.008	0.01	2.15	0.01	0.032	0.02	0.011	
ROCs		0.003	0.003	0.002	0.684	0.002	0.005	0.003	0.002	
NOx		0.024	0.021	0.021	0.0021	0.024	0.026	0.024	0.023	
SOx		0.002	0.002	0.002	0.0008	0.002	0.002	0.002	0.002	
PM10		0.0015	0.001	0.0005	0.00143	0.001	0.002	0.0015	0.0015	
Total Daily Emissions	(lb/year)									**Total (tons)**
CO		297.60	922.06	2688.51	12900.00	1.48	1539.76	50.16	1924.88	10.013
ROCs		44.64	345.77	537.70	4104.00	0.30	240.59	7.52	349.98	2.793
NOx		357.12	2420.41	5645.88	12.60	3.55	1251.06	60.19	4024.74	6.709
SOx		29.76	230.52	537.70	4.80	0.30	96.24	5.02	349.98	0.612
PM10		22.32	115.26	134.43	8.58	0.15	96.24	3.76	262.48	0.310

Off-site Sources: Parameter	Units	Worker Trips	Haul Truck	
Miles per trip		10	10	
Trips per day		15	77.00	
days per year		80	80	
Conversion Factor	(lb/g)	0.002205	0.002205	
Emission Factor	(g/mile)			
CO		27.83	6.42	
ROCs		3.84	1.34	
NOx		2.42	9.27	
SOx		0.05	0.30	
PM10		0.11	0.43	
				Total (tons)
CO		736.38	872.02	0.80
ROCs		101.61	182.01	0.14
NOx		64.03	1259.13	0.66
SOx		1.32	40.75	0.02
PM10		2.91	58.41	0.03

trips
6160
trips/hour/front
4.8125
total miles
73600

TOTAL ON-SITE AND OFF-SITE COMBINED EXHAUST EMISSIONS (TONS)

CO	10.82
ROCs	2.93
NOx	7.37
SOx	0.63
PM10	0.34

Assumptions:

It is assumed that construction with heavy equipment would last for approximatley 4 months on two different fronts.Vegetation clearing would take approximately six weeks

It is assumed that well drilling would take one day for each of the two wells.

Haul trips (assume 20 cubic yard capacity per trip) = 6,160 trips over a 80 day period (6,100 trips for imported fill; 30 trips for vegetation debris; and 30 trips for other supplies)

Approximatley 15 construction workers would commute to and from the project for 4 months, 5 days a week.

Sources:

Tables A9-8-B and -C, A9-5-K-6 and A9-5-L *SCAQMD CEQA Air Quality Handbook, 1993*

Chipper emission factors are "Other Construction Equipment" with hp obtained from manufacturer specifications.

Appendix J of AP-42, USEPA AP-42

Table 11: FUGITIVE DUST EMISSION ESTIMATES FOR CONSTRUCTION ACTIVITIES FOR ALTERNATIVE 7

Dirt Pushing or Bull Dozing

Pieces of construction equipment	Days a year	Hours a day	Equipment Hours per day	Rule 310 Reduction	Emission Factor (lbs/hour)	PM10 Emissions (lbs/day)	PM10 Emissions (tons/year)
8	120	8	64	70%	1.3	24.96	1.50

General Construction Activity

Emission Factor	Acres a Day	Days	Rule 310 Reduction	PM10 Emissions	
(lbs/day/acre)	(acres)	(days)		(lbs/year)	(tons/year)
24	2	120	70%	1,728	0.86

Note:

Emission Factor = 1.2 tons TSP/acre/month (1/20 month) (2,000 lbs/ton) (.20 TSP is PM10)

Paved Roads

k	sL	W	E	vehicle miles traveled	PM10 Emissions
(lbs/vmt)	(g/m2)	(tons)	(lbs/vmt)	(vmt per year)	(tons/year)
0.016	0.40	22.00	0.112	204,500	11.41

Notes

E=k(sL/2)^0.65 (W/3)^1.5

where: E = particulate emission factor (having units matching the units of k)

k = base emission factor (lb/vehicle miles traveled)

sL = road surface silt loading (grams per square meter) (g/m^2)

W = average weight (tons) of the vehicles traveling the road = 22 tons (91% are assumed to average 24 tons and 9% are assumed to be 2 tons)

SUMMARY OF ANNUAL FUGITIVE DUST (PM10) EMISSIONS (TONS)

Units	Dirt Pushing	General Activity	Paved Roads	**Totals**
tons/year	1.50	0.86	11.41	13.77

Sources:

Table A9-9-F *SCAQMD CEQA Handbook, 1993*

Sections 13.2.1 and 13.2.3 of USEPA Compilation of Air Pollutant Emission Factors (AP-42)

Table 12: Exhaust Emission Estimates For Alternative 7

On-Site Sources											Off-site Sources				
Parameter	**Units**	**Chipper**	**Grader**	**Dozer**	**Chain Saw**	**Cement Mixer**	**Spray Truck**	**Drill Rig**	**Loader**		**Parameter**	**Units**	**Worker Trips**	**Haul Truck**	
Number of Equipment Units		2	2	2	10	1	1	1	4		Miles per trip		10	10	trips
Operational Hours	hr/day	8	8	8	8	8	8	8	8		Trips per day		15	155.42	18650
Days per Year	day/year	60	120	120	60	3	60	5	120		days per year		120	120	trips/hour/front
Average Rated Horse Power	hp	50	156.6	356	5	11	489	209	147		Conversion Factor	(lb/g)	0.002205	0.002205	9.713541667
Typical Load Factor	%	62.00%	57.50%	59.00%	50.00%	56.00%	41.00%	75.00%	46.50%						total miles
Emission Factor	lb/hp-hr														204500
CO		0.02	0.008	0.01	2.15	0.01	0.032	0.02	0.011		Emission Factor	(g/mile)			
ROCs		0.003	0.003	0.002	0.684	0.002	0.005	0.003	0.002		CO		27.83	6.42	
NOx		0.024	0.021	0.021	0.0021	0.024	0.026	0.024	0.023		ROCs		3.84	1.34	
SOx		0.002	0.002	0.002	0.0008	0.002	0.002	0.002	0.002		NOx		2.42	9.27	
PM10		0.0015	0.001	0.0005	0.00143	0.001	0.002	0.0015	0.0015		SOx		0.05	0.30	
Total Daily Emissions	(lb/year)									**Total (tons)**	PM10		0.11	0.43	
CO		595.20	1383.09	4032.77	25800.00	1.48	3079.53	125.40	2887.32	18.655					**Total (tons)**
ROCs		89.28	518.66	806.55	8208.00	0.30	481.18	18.81	524.97	5.279	CO		1104.57	2640.11	1.87
NOx		714.24	3630.61	8468.81	25.20	3.55	2502.12	150.48	6037.11	10.409	ROCs		152.41	551.05	0.35
SOx		59.52	345.77	806.55	9.60	0.30	192.47	12.54	524.97	0.946	NOx		96.05	3812.13	1.95
PM10		44.64	172.89	201.64	17.16	0.15	192.47	9.41	393.72	0.494	SOx		1.98	123.37	0.06
											PM10		4.37	176.83	0.09

TOTAL ON-SITE AND OFF-SITE COMBINED EXHAUST EMISSIONS (TONS)

CO	20.53
ROCs	5.63
NOx	12.36
SOx	1.01
PM10	0.58

Assumptions:

It is assumed that construction with heavy equipment would last for approximatley 6 months on two different fronts.Vegetation clearing would take approximately 3 months.

It is assumed that well drilling would take one day for each of the five wells.

Haul trips (assume 20 cubic yard capacity per trip) = 18,650 trips over a 120 day period (18,500 trips for imported fill; 100 trips for vegetation debris; and 50 trips for other supplies)

Approximatley 15 construction workers would commute to and from the project for 6 months, 5 days a week.

Sources:

Tables A9-8-B and -C, A9-5-K-6 and A9-5-L *SCAQMD CEQA Air Quality Handbook, 1993*

Chipper emission factors are "Other Construction Equipment" with hp obtained from manufacturer specifications.

Appendix J of AP-42, USEPA AP-42

Table 13: FUGITIVE DUST EMISSION ESTIMATES FOR CONSTRUCTION ACTIVITIES FOR ALTERNATIVE 8

Dirt Pushing or Bull Dozing

Pieces of construction equipment	Days a year	Hours a day	Equipment Hours per day	Rule 310 Reduction	Emission Factor (lbs/hour)	PM10 Emissions (lbs/day)	PM10 Emissions (tons/year)
12	80	8	96	70%	1.3	37.44	1.50

General Construction Activity

Emission Factor	Acres a Day	Days	Rule 310 Reduction	PM10 Emissions	
(lbs/day/acre)	(acres)	(days)		(lbs/year)	(tons/year)
24	3	80	70%	1,728	0.86

Note:

Emission Factor = 1.2 tons TSP/acre/month (1/20 month) (2,000 lbs/ton) (.20 TSP is PM10)

Paved Roads

k	sL	W	E	vehicle miles traveled	PM10 Emissions
(lbs/vmt)	(g/m2)	(tons)	(lbs/vmt)	(vmt per year)	(tons/year)
0.016	0.40	22.00	0.112	132,000	7.37

Notes

E=k(sL/2)^0.65 (W/3)^1.5

where: E = particulate emission factor (having units matching the units of k)

k = base emission factor (lb/vehicle miles traveled)

sL = road surface silt loading (grams per square meter) (g/m^2)

W = average weight (tons) of the vehicles traveling the road = 22 tons (90% are assumed to average 24 tons and 10% are assumed to be 2 tons)

SUMMARY OF ANNUAL FUGITIVE DUST (PM10) EMISSIONS (TONS)

Units	Dirt Pushing	General Activity	Paved Roads	**Totals**
tons/year	1.50	0.86	7.37	9.73

Sources:

Table A9-9-F *SCAQMD CEQA Handbook, 1993*

Sections 13.2.1 and 13.2.3 of USEPA Compilation of Air Pollutant Emission Factors (AP-42)

Table 14: Exhaust Emission Estimates For Alternative 8

		On-Site Sources									Off-site Sources				
Parameter	**Units**	**Chipper**	**Grader**	**Dozer**	**Chain Saw**	**Cement Mixer**	**Spray Truck**	**Drill Rig**	**Loader**		**Parameter**	**Units**	**Worker Trips**	**Haul Truck**	
Number of Equipment Units		3	3	3	10	1	1	1	6		Miles per trip		10	10	
Operational Hours	hr/day	8	8	8	8	8	8	8	8		Trips per day		15	150.00	
Days per Year	day/year	30	80	80	30	3	30	5	80		days per year		80	80	
Average Rated Horse Power	hp	50	156.6	356	5	11	489	209	147		Conversion Factor	(lb/g)	0.002205	0.002205	
Typical Load Factor	%	62.00%	57.50%	59.00%	50.00%	56.00%	41.00%	75.00%	46.50%						
Emission Factor	lb/hp-hr										Emission Factor	(g/mile)			
CO		0.02	0.008	0.01	2.15	0.01	0.032	0.02	0.011		CO		27.83	6.42	
ROCs		0.003	0.003	0.002	0.684	0.002	0.005	0.003	0.002		ROCs		3.84	1.34	
NOx		0.024	0.021	0.021	0.0021	0.024	0.026	0.024	0.023		NOx		2.42	9.27	
SOx		0.002	0.002	0.002	0.0008	0.002	0.002	0.002	0.002		SOx		0.05	0.30	
PM10		0.0015	0.001	0.0005	0.00143	0.001	0.002	0.0015	0.0015		PM10		0.11	0.43	
Total Daily Emissions	(lb/year)									**Total (tons)**					**Total (tons)**
CO		446.400	1383.091	4032.768	12900.000	1.478	1539.763	125.400	2887.315	11.435	CO		736.382	1698.732	1.218
ROCs		66.960	518.659	806.554	4104.000	0.296	240.588	18.810	524.966	3.107	ROCs		101.606	354.564	0.228
NOx		535.680	3630.614	8468.813	12.600	3.548	1251.058	150.480	6037.114	9.777	NOx		64.033	2452.842	1.258
SOx		44.640	345.773	806.554	4.800	0.296	96.235	12.540	524.966	0.896	SOx		1.323	79.380	0.040
PM10		33.480	172.886	201.638	8.580	0.148	96.235	9.405	393.725	0.441	PM10		2.911	113.778	0.058

trips
12000
trips/hour/front
6.25
total miles
132000

TOTAL ON-SITE AND OFF-SITE COMBINED EXHAUST EMISSIONS (TONS)

CO	12.652
ROCs	3.335
NOx	11.036
SOx	0.936
PM10	0.500

Assumptions:

It is assumed that construction with heavy equipment would last for approximatley 4 months on three different fronts.Vegetation clearing would take approximately six weeks.

It is assumed that no well drilling would occur. However, a drill would be needed for approximately one day to dig power pole foundation holes.

Haul trips (assume 20 cubic yard capacity per trip) = 11,910 trips over a 80 day period (11,850 trips for imported fill; 30 trips for vegetation debris; and 30 trips for other supplies)

Approximatley 15 construction workers would commute to and from the project for 4 months, 5 days a week.

Sources:

Tables A9-8-B and -C, A9-5-K-6 and A9-5-L *SCAQMD CEQA Air Quality Handbook, 1993*

Chipper emission factors are "Other Construction Equipment" with hp obtained from manufacturer specifications.

Appendix J of AP-42, USEPA AP-42

I. INTRODUCTION

Appendix K, "Habitat Evaluation Procedure," presents the results of the ecosystem output analysis for the proposed alternatives based on differences between the without- and with-project conditions. In total, eight plans including the No Action plan were analyzed. The eight action plans are briefly described as follows.

Alternative 1 - No Action

Alternative 2 - Low Water Use: This alternative consists of a riparian strip along the western levee from McDowell Road to Coldwater Park and along the eastern levee from the I-10 outfall (Papago Diversion Channel) to the second grade control structure. The vegetation type along the western levee would be entirely xeric riparian vegetation and/or vegetation typical of the upper Sonoran desert; vegetation along the eastern levee would consist of a gradient of hydric, mesic and xeric vegetation with increasing distance from the low flow channel.

Alternative 3 - Medium Water Use: Alternative 3 would extend over a slightly greater area than Alternative 2: approximately 74 acres through establishment of riparian strips; and 61 acres through establishment of native cover in areas affected by construction that are currently sparsely vegetated and dominated by invasive exotic species. The configuration would consist of a riparian strip along the western levee from McDowell Road to Coldwater Park and along the eastern levee from the I-10 outfall (Papago Diversion Channel) to the second grade control structure. Relative to Alternative 2, there would be an additional area of restoration south of Lower Buckeye in an unleveed portion of the river.

Alternative 4 - High Water Use and Vegetation Management Areas: Alternative 4 would extend along the greatest length of the 5.5-mile project reach and would occupy the greatest total area: approximately 172 acres of riparian strips; 106 acres managed to facilitate growth of native vegetation; and 70 acres of native cover established in areas affected by construction that are currently sparsely vegetated and dominated by invasive exotic species. Alternative 4 would require the greatest amount of water (7.9 mgpd [million gallons per day]), which would come from up to five new wells located throughout the project reach and some irrigation from existing City supplies. The eastern riparian strip would extend below the Durango Channel at Buckeye Road. Within the riparian strip, there would be one to two meandering low-flow side channels. A constructed berm would partially exclude frequent flows (up to 15-year events) from the riparian strip to reduce the chances of significant losses; however, the terrace bank armor may not exclude less frequent flows (greater than 15 years). Alternative 4 would not adversely affect the existing SPF condition.

Along the west side of the channel from approximately McDowell Road to the second grade control structure between Van Buren and Buckeye Roads, the interior slope of the levee would be filled to a slope of approximately 3:1 and vegetated with more xeric vegetation. Terrace bank armor would protect the riparian strip from frequent flood events.

Some areas in the interior of the channel, outside of the protected strips, have been designated as Vegetation Management Areas to indicate that while no structural changes would occur in these areas, restoration actions would be taken. In Vegetation Management Areas, exotic species would be replaced with natives so that the total biomass would remain approximately the same. The existing flood control capacity of the channel is maintained. The Vegetation Management Areas identified near the I-10 outfall, the Durango Channel at Buckeye Road and the AWWTP cover approximately 107 acres. The same external source of water used for the eastern riparian strip would be directed to these areas on a seasonal basis to mimic historical, natural discharges.

In the area around the AWWTP effluent outflow pipe, the combination of the perennial source of surface water and relatively shallow groundwater currently sustains a small marsh and a vegetated strip. Under Alternative 4, it is assumed that there would be no change in the current 3.5 mgpd of effluent from the AWWTP and that this effluent would continue to sustain existing vegetation within that area. For that reason, the protected riparian strip along the east side is not extended to this area. Although complete removal of non-natives might be a prohibitive task, large athel tamarisk trees, which consume disproportionately more water than cottonwood or willow and increase salt concentrations in the soil, would be removed and replaced with native plantings. Irrigation of plantings would be needed to encourage and facilitate growth of roots to groundwater.

Alternative 5 - Low Water Use without Western Riparian Strip: This alternative consists of that of Alternative 2 without restoration along the western levee.

Alternative 6 - Medium Water Use without Western Riparian Strip: This alternative consists of that of Alternative 3 without restoration along the western levee.

Alternative 7 - High Water Use and Vegetation Management Areas without Western Riparian Strip: This alternative consists of that of Alternative 4 without restoration along the western levee.

Alternative 8 - Low Water Use, With Reduced Vegetation Management Areas and Reduced Western Riparian Strip: Alternative 8 is an adaptation of Alternatives 2, 4 and 5, based on management measures and considerations. Alternative 8 would occupy approximately: 26 acres of riparian strips; 81 acres managed to facilitate growth of native vegetation (i.e., vegetation management areas); and 41 acres of native cover established

in areas affected by construction that are currently sparsely vegetated and dominated by invasive exotic species. Alternative 8 requires a relatively low water use (1.8 mGPD) and focuses restoration at two locations: (1) the I-10 site near the Papago Diversion Channel and (2) the Avondale Wastewater Treatment Plant (AWWTP) site. Restoration options near the Durango Channel (Buckeye Road) site were not considered under Alternative 8 to avoid any potential impacts associated with the 10,000-foot Goodyear Airport exclusion zone that imposes restrictions to prevent bird-strikes and other risks. The airport exclusion zone also partly determined the southern limit of the I-10 site and the northern limit of the AWWTP site.

Restoration at the two sites for Alternative 8 would primarily involve six measures:

(1) removal of exotic and invasive species throughout the entire restoration site;
(2) construction of a riparian strip along the eastern and western levees;
(3) establishment of Vegetation Management Areas between the riparian strips and at the AWWTP site;
(4) introduction of water from an external source;
(5) non-construction measures to enhance habitat resources (e.g., microtopographic variation, creation of plant regeneration areas, etc.); and
(6) measures to eliminate or reduce impacts from adjacent park and trail users.

A summary of the results of the habitat evaluation analysis is shown below in **Table 1**.

Table 1 - Summary of Habitat Outputs

	Habitat Units					
Alternative:	T=0	T=1	T=15	T=50	Average Annual	Net Average Annual Gain
Alternative 1 - No Action	77.72	77.72	63.21	63.21	65.63	-
Alternative 2 - Low Water Use	79.10	87.55	84.97	88.91	86.62	20.99
Alternative 3 - Medium Water Use	78.57	89.80	90.37	95.47	91.85	26.22
Alternative 4 -High Water Use and Vegetation Management Areas	114.91	154.90	189.84	209.96	190.85	125.22
Alternative 5 - Low Water Use without Western Riparian Strip	76.73	82.15	75.69	78.55	77.67	12.04
Alternative 6 - Medium Water Use without Western Riparian Strip	76.28	84.48	81.15	85.17	82.96	17.33
Alternative 7 - High Water Use and Vegetation Management Areas without Western Riparian Strip	111.46	147.35	179.04	197.01	179.40	113.77
Alternative 8 – Low Water Use, With Reduced Vegetation Management Areas and Western Riparian Strip	86.91	101.68	104.84	113.40	107.04	41.41

The following analyses employ the quantified ecosystem output information of **Table 1** and the cost data, as detailed in Appendix J and displayed in **Table 2**, to investigate the incremental justification of the alternatives using the computer model, IWR-PLAN, as described below.

For ecosystem restoration projects, economic analysis consists of comparing the cost of alternatives to their relative output of habitat units. Each alternative and each component within an alternative increases the overall output of habitat values compared to the No Action Plan. The analysis uses the increase in habitat values in which relative Habitat Indices (HIs) were identified for each restoration action. The increased habitat output, by alternative, is then incrementally compared to the incremental cost of its implementation.

Table 2 - Alternatives Cost Data				
Alternative	Total Construction Cost	Annual Cost[1]	Annual OMRR&R	Total Annual Cost
Alternative 1	$0	$0	$0	$0
Alternative 2	$11,390,160	$685,100	$120,822	$805,922
Alternative 3	$16,144,264	$971,052	$144,857	$1,115,909
Alternative 4	$24,577,690	$1,478,309	$673,597	$2,151,906
Alternative 5	$5,244,570	$315,453	$78,932	$394,385
Alternative 6	$7,897,511	$475,023	$128,607	$603,630
Alternative 7	$17,740,386	$1,067,056	$318,992	$1,386,048
Alternative 8	$6,325,200	$380,451	$129,166	$509,617

[1]50-yr amortization with the FY04 discount rate of 5⅞

II. IWR-PLAN

The Corps' IWR-PLAN software was used to conduct the analyses. IWR-PLAN, developed by the Institute of Water Resources of the U.S. Army Corps of Engineers, is a Decision Support System that performs incremental analysis. It was used to identify the most cost-effective combinations of components and the best buys for the whole possible range of outputs of habitat units and associated costs. ***Cost-effective combinations*** incur the least cost for the same output of habitat units. ***Best buy combinations*** give the least incremental increase in cost per incremental increase in output of habitat units.

III. PROCEDURES FOR DECISION MAKING

Incremental analysis is a powerful tool for decision making for ecosystem restoration projects. Once the appropriate input categories and values are modeled, decision making for selecting the best appropriate plan is simply a matter of understanding the cost effectiveness of the various components of the analyzed plans. Selection of a plan may fall into the following four categories which show the constraints on the degree of restoration and the corresponding selection criteria **(Table 3)**.

Table 3 - Selection Criteria

Restoration Constraint		Selection Criteria	Discussion
1	Specified available budget	Cost effectiveness at the target budget	A cost-effective plan which satisfies the specified available budget may be identified from IWR-PLAN output. The corresponding increase in habitat units may then be identified.
2	Specified target increases in habitat units	Habitat output; No budget constraint	A cost-effective plan which satisfies the target increase in habitat units may be identified from IWR-PLAN output. The corresponding budget may then be identified.
3	Range in available budget	Best buy plans within the target range	A best buy plan which satisfies the given range of available budget may be identified from IWR-PLAN output. The corresponding increase in habitat units may then be identified.
4	Range of target increase in habitat units	Range of desired habitat output; No budget constraint	A best buy plan which satisfies the given range of increase in habitat units may be identified from IWR-PLAN output. The corresponding budget range may then be identified.

The selection criteria and decision-making categories in the table above would become useful when considering the Agua Fria River Habitat Restoration project in relation to other competing projects on a Federal, State, and municipal level. Plan selection could depend upon the availability of funds and/or desire for a high output restoration project. The selection criteria above, along with IWR-PLAN decision tools could help identify appropriate measures in response to the priorities of the approving administration.

IV. ANALYSIS AND RESULTS

In addition to the construction cost, the following costs were included in the incremental analysis: OMRR&R costs over the project life (50 years), costs associated with LERRDs, and monitoring after construction. All of the alternative plans analyzed were determined to be cost effective through the use of the software package of IWR-PLAN. This analysis is displayed in **Table 4**, below.

Table 4 - Average Cost per Habitat Unit Created

Plan	Total Annual Cost	Average Annual Habitat Units (HUs)	Annual Cost/HU ($/HU)
No Action (Alt 1)	$0	0.00	$0
Alternative 2	$805,922	20.99	$38,396
Alternative 3	$1,115,909	26.22	$42,559
Alternative 4	$2,151,906	125.22	$17,185
Alternative 5	$394,385	12.04	$32,756
Alternative 6	$603,630	17.33	$34,832
Alternative 7	$1,386,048	113.77	$12,183
Alternative 8	$521,831	41.41	$12,602

Through the IWR-PLAN software four alternatives, excluding the no action alternative, were identified as cost effective. These alternatives are 4, 5, 7, and 8. On an unconstrained basis, Alternatives 4 and 7 are identified as "best buys", whereas Alternative 8 does not receive this rating. Alternative 8 fails to receive this rating, on an unconstrained basis, because the marginal cost on a per habitat unit created basis of going from the no action alternative to the Alternative 7 level is lower. When the budgetary constraint is considered into the incremental analysis formulation only one alternative is identified as both cost effective and a best buy, Alternative 8.

The result of the IWR-PLAN's constrained best buy analysis is shown in **Table 5**, below.

Table 5 - Incremental Cost of Constrained Best Buy Plans

Most Efficient Plans (Best Buys) as identified in IWR-PLAN Analysis					
Plan	Annual Cost	Net Output	Incremental Cost	Incremental Output	Incremental Cost per Unit
Alt 1	$0	0.00	$0	0.00	$0
Alt 8	$521,831	41.41	$521,831	41.41	$12,602

V. PLAN SELECTION

The habitat evaluation procedure in combination with the cost estimates and IWR-PLAN indicate only one alternative (Alternative 8) meets the constrained "Best Buy" criteria. Accordingly, **Alternative 8 - Low Water Use, With Reduced Vegetation Management Areas and Reduced Western Riparian Strip** at a construction cost of $6,528,265 and yielding an annual increase in habitat units of 41.41 is recommended for plan implementation.

APPENDIX N.

DRAFT PROJECT COOPERATION AGREEMENT

December 1995
(Revised February 1998)

MODEL PROJECT COOPERATION AGREEMENT FOR
SECTION 1135, PROJECT MODIFICATIONS
FOR THE IMPROVEMENT OF THE ENVIRONMENT

****

PROJECT COOPERATION AGREEMENT
BETWEEN
THE DEPARTMENT OF THE ARMY
AND
[FULL NAME OF NON-FEDERAL SPONSOR]
FOR MODIFICATION OF THE
[FULL NAME OF PROJECT]

THIS AGREEMENT is entered into this _____ day of _____, 19 __, by and between the DEPARTMENT OF THE ARMY (hereinafter the "Government"), represented by the U.S. Army Engineer for the **[LOCATION OF DISTRICT/DIVISION]** District (hereinafter the "District Engineer") and the **[NON-FEDERAL SPONSOR]** (hereinafter the "Non-Federal Sponsor"), represented by the **[TITLE OF THE PERSON SIGNING THE AGREEMENT]**.

WITNESSETH, THAT:

WHEREAS, the Secretary of the Army completed construction of the **[NAME OF THE PROJECT TO BE MODIFIED]** (hereinafter the "Existing Project", as defined in Article I.A. of this Agreement) in **[YEAR CONSTRUCTION WAS COMPLETED]**;

WHEREAS, modification of the Existing Project is authorized by Section 1135 of the Water Resources Development Act of 1986, Public Law 99-662, as amended;

WHEREAS, the Government and the Non-Federal Sponsor desire to enter into a Project Cooperation Agreement for implementation of the **[NAME OF THE PROJECT MODIFICATION OR A SEPARABLE ELEMENT OF THE PROJECT MODIFICATION]** (hereinafter the "Project Modification", as defined in Article I.B. of this Agreement);

WHEREAS, Section 1135 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, specifies the cost-sharing requirements applicable to this Project Modification;

[INCLUDE THE FOLLOWING "WHEREAS" CLAUSE IF THE NON-FEDERAL SPONSOR WILL PERFORM WORK-IN-KIND]

WHEREAS, the Non-Federal Sponsor desires to perform certain work (hereinafter the "work-in-kind", as defined in Article I.M. of this Agreement) which is a part of the Project Modification;

WHEREAS, the Government and Non-Federal Sponsor have the full authority and capability to perform as hereinafter set forth and intend to cooperate in cost-sharing and financing of the implementation of the Project Modification in accordance with the terms of this Agreement.

NOW, THEREFORE, the Government and the Non-Federal Sponsor agree as follows:

ARTICLE I - DEFINITIONS AND GENERAL PROVISIONS

For purposes of this Agreement:

A. The term "Existing Project" shall mean **[BRIEFLY DESCRIBE THE PROJECT TO BE MODIFIED IN TERMS OF ITS BASIC AUTHORIZATION AND APPLICABLE MODIFICATIONS, AUTHORIZED PURPOSES, AND MAJOR FEATURES]**.

B. The term "Project Modification" shall mean **[DESCRIBE THE WORK TO BE UNDERTAKEN PURSUANT TO THIS AGREEMENT IN SUFFICIENT DETAIL TO AVOID ANY CONFUSION OVER WHAT WORK IS OR IS NOT INCLUDED]** as generally described in **[SPECIFY THE APPROVED ECOSYSTEM RESTORATION REPORT OR OTHER APPROVED DOCUMENTATION]**, dated _____,19___ and approved by the **[TITLE OF THE APPROVING OFFICIAL]**, on _____, 19___. **[INCLUDE THE FOLLOWING PHRASE FOR WORK-IN-KIND:** The Project Modification includes the work-in-kind described in Article I.M. of this Agreement.]

C. The term "total project modification costs" shall mean all costs incurred by the Non-Federal Sponsor and the Government in accordance with the terms of this Agreement directly related to implementation of the Project Modification. Subject to the provisions of this Agreement, the term shall include, but is not necessarily limited to, feasibility phase planning costs; all engineering and design costs, including those incurred in the feasibility phase; the costs of investigations to identify the existence and extent of hazardous substances in accordance with Article XV.A. of this Agreement; the costs incurred by the Government for clean-up and response in accordance with Article XV.C. of this Agreement; costs of historic preservation activities in accordance with Article XVIII.A. of this Agreement;

actual implementation costs; **[INCLUDE THE FOLLOWING PHRASE FOR WORK-IN-KIND:** the credit amount for the work-in-kind performed by the Non-Federal Sponsor in accordance with Article II.D.4. of this Agreement;] supervision and administration costs; costs of participation in the Project Coordination Team in accordance with Article V of this Agreement; costs of contract dispute settlements or awards; the value of lands, easements, rights-of-way, relocations, and suitable borrow and dredged or excavated material disposal areas for which the Government affords credit in accordance with Article IV of this Agreement; and costs of audit in accordance with Article X of this Agreement. The term does not include any costs for operation, maintenance, repair, replacement, or rehabilitation; any costs due to betterments; or any costs of dispute resolution under Article VII of this Agreement.

D. The term "financial obligation for implementation" shall mean a financial obligation of the Government **[INCLUDE THE FOLLOWING PHRASE FOR WORK-IN-KIND:** or a financial obligation of the Non-Federal Sponsor for work-in-kind], other than an obligation pertaining to the provision of lands, easements, rights-of-way, relocations, and borrow and dredged or excavated material disposal areas, that results or would result in a cost that is or would be included in total project modification costs.

E. The term "implementation" shall mean all actions required to carry out the Project Modification including all actions required for modification in operations of the Existing Project.

F. The term "non-Federal proportionate share" shall mean the ratio of the Non-Federal Sponsor's total cash contribution required in accordance with Article II.D.2. of this Agreement to total financial obligations for implementation as projected by the Government.

G. The term "period of implementation" shall mean the time from the effective date of this Agreement to the date that the District Engineer notifies the Non-Federal Sponsor in writing of the Government's determination that implementation of the Project Modification is complete.

H. The term "highway" shall mean any public highway, roadway, street, or way, including any bridge thereof.

I. The term "relocation" shall mean providing a functionally equivalent facility to the owner of an existing utility, cemetery, highway or other public facility, or railroad

when such action is authorized in accordance with applicable legal principles of just compensation. Providing a functionally equivalent facility may take the form of alteration, lowering, raising, or replacement and attendant removal of the affected facility or part thereof.

J. The term "fiscal year" shall mean one fiscal year of the Government. The Government fiscal year begins on October 1 and ends on September 30.

K. The term "functional portion of the Project Modification" shall mean a portion of the Project Modification that is suitable for tender to the Non-Federal Sponsor to operate and maintain **[DELETE "to operate and maintain" IF OPERATION AND MAINTENANCE OF THE PROJECT MODIFICATION IS NOT REQUIRED]** in advance of completion of the entire Project Modification. For a portion of the Project Modification to be suitable for tender, the District Engineer must notify the Non-Federal Sponsor in writing of the Government's determination that the portion of the Project Modification is complete and can function independently and for a useful purpose, although the balance of the Project Modification is not complete.

L. The term "betterment" shall mean a change in the design and construction of an element of the Project Modification resulting from the application of standards that the Government determines exceed those that the Government would otherwise apply for accomplishing the design and construction of that element.

[INCLUDE PARAGRAPH I.M. FOR WORK-IN-KIND]

M. The term "work-in-kind" shall mean **[WORK-IN-KIND MAY INCLUDE A FACILITY, SUPPLY, OR SERVICE THAT IS NECESSARY TO CARRY OUT THE MODIFICATION OR MEASURE. DESCRIBE THE WORK TO BE PERFORMED BY THE NON-FEDERAL SPONSOR IN DETAIL SUFFICIENT TO AVOID ANY CONFUSION OVER WHAT IS OR IS NOT INCLUDED]**, as approved by **[CITE THE APPROPRIATE APPROVAL AUTHORITY]** in a **[CITE APPROVAL DOCUMENT OR MEMORANDUM]** dated _____, 19_____. The work-in-kind includes implementation of the authorized improvements as well as planning, engineering, design, supervision and administration, and other activities associated with implementation, but does not include the implementation of betterments or the provision of lands, easements, rights-of-way, relocations, or suitable borrow and dredged or excavated material disposal areas associated with the work-in-kind.

ARTICLE II - OBLIGATIONS OF THE GOVERNMENT AND THE

NON-FEDERAL SPONSOR

A. The Government, subject to the availability of funds and using those funds and funds provided by the Non-Federal Sponsor, shall expeditiously implement the Project Modification, applying those procedures usually applied to Federal projects, pursuant to Federal laws, regulations, and policies.

1. The Government shall afford the Non-Federal Sponsor the opportunity to review and comment on the solicitations for all contracts, including relevant plans and specifications, prior to the Government's issuance of such solicitations. The Government shall not issue the solicitation for the first contract for implementation until the Non-Federal Sponsor has confirmed in writing its willingness to proceed with the Project Modification. To the extent possible, the Government shall afford the Non-Federal Sponsor the opportunity to review and comment on all contract modifications, including change orders, prior to the issuance to the contractor of a Notice to Proceed. In any instance where providing the Non-Federal Sponsor with notification of a contract modification or change order is not possible prior to issuance of the Notice to Proceed, the Government shall provide such notification in writing at the earliest date possible. To the extent possible, the Government also shall afford the Non-Federal Sponsor the opportunity to review and comment on all contract claims prior to resolution thereof. The Government shall consider in good faith the comments of the Non-Federal Sponsor, but the contents of solicitations, award of contracts, execution of contract modifications, issuance of change orders, resolution of contract claims, and performance of all work on the Project Modification (whether the work is performed under contract or by Government personnel), shall be exclusively within the control of the Government.

2. Throughout the period of implementation, the District Engineer shall furnish the Non-Federal Sponsor with a copy of the Government's Written Notice of Acceptance of Completed Work for each contract for the Project Modification.

[INCLUDE PARAGRAPH II.A.3. IF THE NON-FEDERAL SPONSOR DESIRES A "VOLUNTARY COST CAP."]

3. Notwithstanding paragraph A.1. of this Article, if, upon the award of any contract for implementation of the Project Modification, cumulative financial obligations for implementation would exceed $_____, the Government and the Non-Federal Sponsor agree to defer award of that contract and

all subsequent contracts for implementation of the Project Modification until such time as the Government and the Non-Federal Sponsor agree to proceed with further contract awards for the Project Modification, but in no event shall the award of contracts be deferred for more than three years. Notwithstanding this general provision for deferral of contract awards, the Government, after consultation with the Non-Federal Sponsor, may award a contract or contracts after the Assistant Secretary of the Army (Civil Works) makes a written determination that the award of such contract or contracts must proceed in order to comply with law or to protect life or property from imminent and substantial harm.

B. The Non-Federal Sponsor may request the Government to accomplish betterments. Such requests shall be in writing and shall describe the betterments requested to be accomplished. If the Government in its sole discretion elects to accomplish the requested betterments or any portion thereof, it shall so notify the Non-Federal Sponsor in a writing that sets forth any applicable terms and conditions, which must be consistent with this Agreement. In the event of conflict between such a writing and this Agreement, this Agreement shall control. The Non-Federal Sponsor shall be solely responsible for all costs due to the requested betterments and shall pay all such costs in accordance with Article VI.C. of this Agreement.

C. When the District Engineer determines that the entire Project Modification is complete or that a portion of the Project Modification has become a functional portion of the Project Modification, the District Engineer shall so notify the Non-Federal Sponsor in writing and furnish the Non-Federal Sponsor with an Operation, Maintenance, Repair, Replacement, and Rehabilitation Manual (hereinafter the "OMRR&R Manual") and **[DELETE "with an Operation, Maintenance, Repair, Replacement, and Rehabilitation Manual (hereinafter the "OMRR&R Manual") and" IF OPERATION AND MAINTENANCE OF THE PROJECT MODIFICATION IS NOT REQUIRED]** with copies of all of the Government's Written Notices of Acceptance of Completed Work for all contracts for the Project Modification or the functional portion of the Project Modification that have not been provided previously. Upon such notification, the Non-Federal Sponsor shall operate, maintain, repair, replace, and rehabilitate the entire Project Modification or the functional portion of the Project Modification in accordance with Article VIII of this Agreement. **[DELETE LAST SENTENCE IF OPERATION AND MAINTENANCE OF THE PROJECT MODIFICATION IS NOT REQUIRED]**

D. The Non-Federal Sponsor shall contribute 25 percent of total project modification costs in accordance with the provisions of this paragraph.

1. In accordance with Article III of this Agreement, the Non-Federal Sponsor shall provide all lands, easements, rights-of-way, and suitable borrow and dredged or excavated material disposal areas that the Government determines the Non-Federal Sponsor must provide for the implementation, operation, and maintenance **[DELETE ", operation, and maintenance" IF OPERATION AND MAINTENANCE OF THE PROJECT MODIFICATION IS NOT REQUIRED]** of the Project Modification, and shall perform or ensure performance of all relocations that the Government determines to be necessary for the implementation, operation, and maintenance **[DELETE ", operation, and maintenance" IF OPERATION AND MAINTENANCE OF THE PROJECT MODIFICATION IS NOT REQUIRED]** of the Project Modification.

2. If the Government projects that the value of the Non-Federal Sponsor's contributions under paragraph D.1. of this Article and Articles V, X, and XV.A. of this Agreement will be less than 25 percent of total project modification costs, the Non-Federal Sponsor shall provide an additional cash contribution, in accordance with Article VI.B. of this Agreement, in the amount necessary to make the Non-Federal Sponsor's total contribution equal to 25 percent of total project modification costs.

3. If the Government determines that the value of the Non-Federal Sponsor's contributions provided under paragraphs D.1. and D.2. of this Article and Articles V, X, and XV.A. of this Agreement has exceeded 25 percent of total project modification costs, the Government, subject to the availability of funds, shall reimburse the Non-Federal Sponsor for any such value in excess of 25 percent of total project modification costs. After such a determination, the Government, in its sole discretion, may provide any remaining Project Modification lands, easements, rights-of-way, and suitable borrow and dredged or excavated material disposal areas and perform any remaining Project Modification relocations on behalf of the Non-Federal Sponsor. Notwithstanding the provision of lands, easements, rights-of-way, and suitable borrow and dredged or excavated material disposal areas or performance of relocations by the Government under this paragraph, the Non-Federal Sponsor shall be responsible, as between the Government and the Non-Federal Sponsor, for the costs of cleanup and response in accordance with Article XV.C. of this Agreement.

[INCLUDE PARAGRAPH II.D.4. FOR CREDITABLE WORK-IN-KIND.]

4. The Government has determined that the work-in-kind is compatible with the Project Modification and has approved a credit in the estimated amount of $_____ **[NOTE: NOT MORE THAN 80 PERCENT OF THE 25-PERCENT NON-FEDERAL SHARE OF THE TOTAL PROJECT MODIFICATION COSTS]** for implementation of such work by the Non-Federal Sponsor. The affording of such credit shall be subject to an on-site inspection by the Government to verify that the work was accomplished in a satisfactory manner and is suitable for inclusion in the Project Modification. The actual amount of credit shall be subject to an audit in accordance with Article X.C. of this Agreement to determine reasonableness, allocability, and allowability of costs. To afford such credit, the Government shall apply the credit amount toward any additional cash contribution required under paragraph D.2. of this Article. The Non-Federal Sponsor shall not receive credit for any amount in excess of such additional cash contribution, nor shall the Non-Federal Sponsor be entitled to any reimbursement for any excess credit amount. In no event shall the Non-Federal Sponsor perform work-in-kind that would result in either the credit afforded under this paragraph exceeding 80 percent of the Non-Federal Sponsor□s share of total project modification costs or the credit afforded under this paragraph, plus the value of lands, easements, rights-of-way, relocations, and suitable borrow and dredged or excavated material disposal areas for which the Government affords credit in accordance with Article IV of this Agreement, exceeding 25 percent of total project modification costs.

E. The Non-Federal Sponsor may request the Government to provide lands, easements, rights-of-way, and suitable borrow and dredged or excavated material disposal areas or perform relocations on behalf of the Non-Federal Sponsor. Such requests shall be in writing and shall describe the services requested to be performed. If in its sole discretion the Government elects to perform the requested services or any portion thereof, it shall so notify the Non-Federal Sponsor in a writing that sets forth any applicable terms and conditions, which must be consistent with this Agreement. In the event of conflict between such a writing and this Agreement, this Agreement shall control. The Non-Federal Sponsor shall be solely responsible for all costs of the requested services and shall pay all such costs in accordance with Article VI.C. of this Agreement. Notwithstanding the provision of lands, easements, rights-of-way, and suitable borrow and dredged or excavated material disposal areas or performance of relocations by the Government under this paragraph, the Non-Federal Sponsor shall be responsible, as between the Government

and the Non-Federal Sponsor, for the costs of cleanup and response in accordance with Article XV.C. of this Agreement.

F. The Government shall perform a final accounting in accordance with Article VI.D. of this Agreement to determine the contributions provided by the Non-Federal Sponsor in accordance with paragraphs B., D., and E. of this Article and Articles V, X, and XV.A. of this Agreement and to determine whether the Non-Federal Sponsor has met its obligations under paragraphs B., D., and E. of this Article.

G. The Non-Federal Sponsor shall not use Federal funds to meet its share of total project modification costs under this Agreement unless the Federal granting agency verifies in writing that the expenditure of such funds is expressly authorized by statute.

ARTICLE III - LANDS, RELOCATIONS, DISPOSAL AREAS, AND PUBLIC LAW 91-646 COMPLIANCE

A. The Government, after consultation with the Non-Federal Sponsor, shall determine the lands, easements, and rights-of-way required for the implementation, operation, and maintenance **[DELETE ", operation, and maintenance" IF OPERATION AND MAINTENANCE OF THE PROJECT MODIFICATION IS NOT REQUIRED]** of the Project Modification, including those required for relocations, borrow materials, and dredged or excavated material disposal. The Government in a timely manner shall provide the Non-Federal Sponsor with general written descriptions, including maps as appropriate, of the lands, easements, and rights-of-way that the Government determines the Non-Federal Sponsor must provide, in detail sufficient to enable the Non-Federal Sponsor to fulfill its obligations under this paragraph, and shall provide the Non-Federal Sponsor with a written notice to proceed with acquisition of such lands, easements, and rights-of-way. Prior to the end of the period of implementation, the Non-Federal Sponsor shall acquire all lands, easements, and rights-of-way set forth in such descriptions. Furthermore, prior to issuance of the solicitation for each construction contract, the Non-Federal Sponsor shall provide the Government with authorization for entry to all lands, easements, and rights-of-way the Government determines the Non-Federal Sponsor must provide for that contract. The Non-Federal Sponsor shall ensure that lands, easements, and rights-of-way that the Government determines to be required for the operation and maintenance **[REPLACE "operation and maintenance" WITH "functioning" IF OPERATION AND MAINTENANCE OF THE PROJECT IS NOT REQUIRED]** of the Project Modification and that were provided by the Non-Federal Sponsor are retained in public ownership for uses

compatible with the authorized purposes of the Project Modification.

B. The Government, after consultation with the Non-Federal Sponsor, shall determine the improvements required on lands, easements, and rights-of-way to enable the proper disposal of dredged or excavated material associated with the implementation, operation, and maintenance **[DELETE ", operation, and maintenance" IF OPERATION AND MAINTENANCE OF THE PROJECT MODIFICATION IS NOT REQUIRED]** of the Project Modification. Such improvements may include, but are not necessarily limited to, retaining dikes, wasteweirs, bulkheads, embankments, monitoring features, stilling basins, and de-watering pumps and pipes. The Government in a timely manner shall provide the Non-Federal Sponsor with general written descriptions of such improvements in detail sufficient to enable the Non-Federal Sponsor to fulfill its obligations under this paragraph, and shall provide the Non-Federal Sponsor with a written notice to proceed with construction of such improvements. Prior to the end of the period of implementation, the Non-Federal Sponsor shall provide all improvements set forth in such descriptions. Furthermore, prior to issuance of the solicitation for each Government construction contract, the Non-Federal Sponsor shall prepare plans and specifications for all improvements the Government determines to be required for the proper disposal of dredged or excavated material under that contract, submit such plans and specifications to the Government for approval, and provide such improvements in accordance with the approved plans and specifications.

C. The Government, after consultation with the Non-Federal Sponsor, shall determine the relocations necessary for the implementation, operation, and maintenance **[DELETE ", operation, and maintenance" IF OPERATION AND MAINTENANCE OF THE PROJECT MODIFICATION IS NOT REQUIRED]** of the Project Modification, including those necessary to enable the removal of borrow materials and the proper disposal of dredged or excavated material. The Government in a timely manner shall provide the Non-Federal Sponsor with general written descriptions, including maps as appropriate, of such relocations in detail sufficient to enable the Non-Federal Sponsor to fulfill its obligations under this paragraph, and shall provide the Non-Federal Sponsor with a written notice to proceed with such relocations. Prior to the end of the period of implementation, the Non-Federal Sponsor shall perform or ensure the performance of all relocations as set forth in such descriptions. Furthermore, prior to issuance of the solicitation for each Government construction contract, the Non-Federal Sponsor shall prepare or ensure the preparation of plans and specifications for, and perform or ensure the

performance of, all relocations the Government determines to be necessary for that contract.

D. The Non-Federal Sponsor in a timely manner shall provide the Government with such documents as are sufficient to enable the Government to determine the value of any contribution provided pursuant to paragraphs A., B., or C. of this Article. Upon receipt of such documents the Government, in accordance with Article IV of this Agreement and in a timely manner, shall determine the value of such contribution, include such value in total project modification costs, and afford credit for such value toward the Non-Federal Sponsor's share of total project modification costs.

E. The Non-Federal Sponsor shall comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 C.F.R. Part 24, in acquiring lands, easements, and rights-of-way required for the implementation, operation, and maintenance **[DELETE ", operation and maintenance" IF OPERATION AND MAINTENANCE OF THE PROJECT MODIFICATION IS NOT REQUIRED]** of the Project Modification, including those necessary for relocations, borrow materials, and dredged or excavated material disposal, and shall inform all affected persons of applicable benefits, policies, and procedures in connection with said Act.

[INCLUDE THE FOLLOWING PARAGRAPH IF THERE IS A NON-FEDERAL SPONSOR OPERATION AND MAINTENANCE REQUIREMENT AND IF LAND OWNED BY THE UNITED STATES AND ADMINISTERED BY THE GOVERNMENT IS REQUIRED FOR THE PROJECT MODIFICATION]

F. The Government shall make available to the Non-Federal Sponsor by lease, substantially in accordance with Exhibit A, those lands administered by the Government which the Government determines to be required for the implementation, operation and maintenance of the Project Modification. If there is an existing lease or license covering the property required for the Project Modification, such lease will be modified to delete this area prior to the issuance of the lease or license to the Non-Federal Sponsor of the Project Modification. No provision of this Agreement shall merge into any lease executed pursuant to this paragraph.

ARTICLE IV - CREDIT FOR LANDS, RELOCATIONS, AND DISPOSAL AREAS

A. The Non-Federal Sponsor shall receive credit toward its share of total project modification costs for the value of the lands, easements, rights-of-way, and suitable borrow and dredged or excavated material disposal areas that the Non-Federal Sponsor must provide pursuant to Article III of this Agreement, and for the value of the relocations that the Non-Federal Sponsor must perform or for which it must ensure performance pursuant to Article III of this Agreement. However, the Non-Federal Sponsor shall not receive credit for the value of any lands, easements, rights-of-way, relocations, or borrow and dredged or excavated material disposal areas that have been provided previously as an item of cooperation for another Federal project, including the Existing Project. The Non-Federal Sponsor also shall not receive credit for the value of lands, easements, rights-of-way, relocations, or borrow and dredged or excavated material disposal areas to the extent that such items are provided using Federal funds unless the Federal granting agency verifies in writing that such credit is expressly authorized by statute.

B. For the sole purpose of affording credit in accordance with this Agreement, the value of lands, easements, and rights-of-way, including those necessary for relocations, borrow materials, and dredged or excavated material disposal, shall be the fair market value of the real property interests, plus certain incidental costs of acquiring those interests, as determined in accordance with the provisions of this paragraph.

1. Date of Valuation. The fair market value of lands, easements, or rights-of-way owned by the Non-Federal Sponsor on the effective date of this Agreement shall be the fair market value of such real property interests as of the date the Non-Federal Sponsor provides the Government with authorization for entry thereto. **[USE THE FOLLOWING SENTENCE FOR WORK-IN-KIND:** However, for lands, easements, or rights-of-way owned by the Non-Federal Sponsor on the effective date of this Agreement that are required for the construction of the work-in-kind, fair market value shall be the value of such real property interests as of the date the Non-Federal Sponsor awards the first construction contract for the work-in-kind, or, if the Non-Federal Sponsor performs the implementation with its own labor, the date that the Non-Federal Sponsor begins implementation of the work-in-kind.] The fair market value of lands, easements, or rights-of-way acquired by the Non-Federal Sponsor after the effective date of this Agreement shall be the fair market value of such real property interests at the time the interests are acquired.

2. General Valuation Procedure. Except as provided in paragraph B.3. of this Article, the fair market value of lands, easements, or rights-of-way shall be determined in accordance with paragraph B.2.a. of this Article, unless thereafter a different amount is determined to represent fair market value in accordance with paragraph B.2.b. of this Article.

a. The Non-Federal Sponsor shall obtain, for each real property interest, an appraisal that is prepared by a qualified appraiser who is acceptable to the Non-Federal Sponsor and the Government. The appraisal must be prepared in accordance with the applicable rules of just compensation, as specified by the Government. **[NOTE: SEE DRAFT CHAPTER 12 OF ER 405-1-12 FOR GUIDANCE ON THE USE OF FEDERAL VERSUS STATE RULES IN PREPARING AN APPRAISAL.]** The fair market value shall be the amount set forth in the Non-Federal Sponsor's appraisal, if such appraisal is approved by the Government. In the event the Government does not approve the Non-Federal Sponsor's appraisal, the Non-Federal Sponsor may obtain a second appraisal, and the fair market value shall be the amount set forth in the Non-Federal Sponsor's second appraisal, if such appraisal is approved by the Government. In the event the Government does not approve the Non-Federal Sponsor's second appraisal, or the Non-Federal Sponsor chooses not to obtain a second appraisal, the Government shall obtain an appraisal, and the fair market value shall be the amount set forth in the Government's appraisal, if such appraisal is approved by the Non-Federal Sponsor. In the event the Non-Federal Sponsor does not approve the Government's appraisal, the Government, after consultation with the Non-Federal Sponsor, shall consider the Government's and the Non-Federal Sponsor's appraisals and determine an amount based thereon, which shall be deemed to be the fair market value.

b. Where the amount paid or proposed to be paid by the Non-Federal Sponsor for the real property interest exceeds the amount determined pursuant to paragraph B.2.a. of this Article, the Government, at the request of the Non-Federal Sponsor, shall consider all factors relevant to determining fair market value and, in its sole discretion, after consultation with the Non-Federal Sponsor, may approve in writing an amount greater than the amount determined pursuant to paragraph B.2.a. of this Article, but not to exceed the amount actually paid or proposed to be paid. If the Government approves such an amount, the fair market value shall be the lesser of the approved amount or the amount paid by the Non-Federal Sponsor, but no less than the amount determined pursuant to paragraph B.2.a. of this Article.

3. Eminent Domain Valuation Procedure. For lands, easements, or rights-of-way acquired by eminent domain proceedings instituted after the effective date of this Agreement, the Non-Federal Sponsor shall, prior to instituting such proceedings, submit to the Government notification in writing of its intent to institute such proceedings and an appraisal of the specific real property interests to be acquired in such proceedings. The Government shall have 60 days after receipt of such a notice and appraisal within which to review the appraisal, if not previously approved by the Government in writing.

a. If the Government previously has approved the appraisal in writing, or if the Government provides written approval of, or takes no action on, the appraisal within such 60-day period, the Non-Federal Sponsor shall use the amount set forth in such appraisal as the estimate of just compensation for the purpose of instituting the eminent domain proceeding.

b. If the Government provides written disapproval of the appraisal, including the reasons for disapproval, within such 60-day period, the Government and the Non-Federal Sponsor shall consult in good faith to promptly resolve the issues or areas of disagreement that are identified in the Government's written disapproval. If, after such good faith consultation, the Government and the Non-Federal Sponsor agree as to an appropriate amount, then the Non-Federal Sponsor shall use that amount as the estimate of just compensation for the purpose of instituting the eminent domain proceeding. If, after such good faith consultation, the Government and the Non-Federal Sponsor cannot agree as to an appropriate amount, then the Non-Federal Sponsor may use the amount set forth in its appraisal as the estimate of just compensation for the purpose of instituting the eminent domain proceeding.

c. For lands, easements, or rights-of-way acquired by eminent domain proceedings instituted in accordance with sub-paragraph B.3. of this Article, fair market value shall be either the amount of the court award for the real property interests taken, to the extent the Government determined such interests are required for the implementation, operation, and maintenance **[DELETE ", operation, and maintenance" IF OPERATION AND MAINTENANCE OF THE PROJECT MODIFICATION IS NOT REQUIRED]** of the Project Modification, or the amount of any stipulated settlement or portion thereof that the Government approves in writing.

4. Incidental Costs. For lands, easements, or rights-of-way acquired by the Non-Federal Sponsor within a five-year period preceding the effective date of this Agreement, or at any time after the effective date of this Agreement, the value of the interest shall include the documented incidental costs of acquiring the interest, as determined by the Government, subject to an audit in accordance with Article X.C. of this Agreement to determine reasonableness, allocability, and allowability of costs. Such incidental costs shall include, but not necessarily be limited to, closing and title costs, appraisal costs, survey costs, attorney's fees, plat maps, and mapping costs, as well as the actual amounts expended for payment of any Public Law 91-646 relocation assistance benefits provided in accordance with Article III.E. of this Agreement.

C. After consultation with the Non-Federal Sponsor, the Government shall determine the value of relocations in accordance with the provisions of this paragraph.

1. For a relocation other than a highway, the value shall be only that portion of relocation costs that the Government determines is necessary to provide a functionally equivalent facility, reduced by depreciation, as applicable, and by the salvage value of any removed items.

2. For a relocation of a highway, the value shall be only that portion of relocation costs that would be necessary to accomplish the relocation in accordance with the design standard that the State of **[IDENTIFY APPROPRIATE STATE]** would apply under similar conditions of geography and traffic load, reduced by the salvage value of any removed items.

3. Relocation costs shall include, but not necessarily be limited to, actual costs of performing the relocation; planning, engineering and design costs; supervision and administration costs; and documented incidental costs associated with performance of the relocation, but shall not include any costs due to betterments, as determined by the Government, nor any additional cost of using new material when suitable used material is available. Relocation costs shall be subject to an audit in accordance with Article X.C. of this Agreement to determine reasonableness, allocability, and allowability of costs.

D. The value of the improvements made to lands, easements, and rights-of-way for the proper disposal of dredged or excavated material shall be the costs of the improvements, as determined by the Government, subject to an audit in accordance with Article

X.C. of this Agreement to determine reasonableness, allocability, and allowability of costs. Such costs shall include, but not necessarily be limited to, actual costs of providing the improvements; planning, engineering and design costs; supervision and administration costs; and documented incidental costs associated with providing the improvements, but shall not include any costs due to betterments, as determined by the Government.

ARTICLE V - PROJECT MODIFICATION COORDINATION TEAM

A. To provide for consistent and effective communication, the Non-Federal Sponsor and the Government, not later than 30 days after the effective date of this Agreement, shall appoint named senior representatives to a Project Modification Coordination Team. Thereafter, the Project Modification Coordination Team shall meet regularly until the end of the period of implementation. The Government's Project Manager and a counterpart named by the Non-Federal Sponsor shall co-chair the Project Modification Coordination Team.

B. The Government's Project Manager and the Non-Federal Sponsor's counterpart shall keep the Project Modification Coordination Team informed of the progress of implementation and of significant pending issues and actions, and shall seek the views of the Project Modification Coordination Team on matters that the Project Modification Coordination Team generally oversees.

C. Until the end of the period of implementation, the Project Modification Coordination Team shall generally oversee the Project Modification, including issues related to design; plans and specifications; scheduling; real property and relocation requirements; real property acquisition; contract awards and modifications; contract costs; the Government's cost projections; final inspection of the entire Project Modification or functional portions of the Project Modification; preparation of the proposed OMRR&R Manual; anticipated requirements and needed capabilities for performance of operation, maintenance, repair, replacement, and rehabilitation of the Project Modification; **[DELETE "preparation of the proposed OMRR&R Manual; anticipated requirements and needed capabilities for performance of operation, maintenance, repair, replacement, and rehabilitation of the Project Modification;" IF OPERATION AND MAINTENANCE OF THE PROJECT MODIFICATION IS NOT REQUIRED]** and other related matters.

D. The Project Modification Coordination Team may make recommendations that it deems warranted to the District Engineer

on matters that the Project Modification Coordination Team generally oversees, including suggestions to avoid potential sources of dispute. The Government in good faith shall consider the recommendations of the Project Modification Coordination Team. The Government, having the legal authority and responsibility for implementation of the Project Modification, has the discretion to accept, reject, or modify the Project Modification Coordination Team's recommendations.

E. The costs of participation in the Project Modification Coordination Team shall be included in total project modification costs and cost shared in accordance with the provisions of this Agreement.

ARTICLE VI - METHOD OF PAYMENT

OPTION-I [USE OPTION I IF IMPLEMENTATION OF THE PROJECT MODIFICATION WILL BE COMPLETED WITHIN ONE FISCAL YEAR, OR IF NON-FEDERAL SPONSOR ELECTS TO PROVIDE ITS SHARE IN ONE LUMP SUM. DELETE THE ENTIRE OPTION IF IT DOES NOT APPLY.]

A. The Government shall maintain current records of contributions provided by the parties and current projections of total project modification costs and costs due to betterments. At least quarterly, the Government shall provide the Non-Federal Sponsor with a report setting forth all contributions provided to date and the current projections of total project modification costs, of total costs due to betterments, of the components of total project modification costs, of each party's share of total project modification costs, of the Non-Federal Sponsor's total cash contributions required in accordance with Articles II.B., II.D., and II.E. of this Agreement, and of the non-Federal proportionate share. On the effective date of this Agreement, total project modification costs are projected to be $_____, and the Non-Federal Sponsor's cash contribution required under Article II.D. of this Agreement is projected to be $_____. **[NOTE: PROJECTIONS SHOULD BE INFLATED THROUGH THE PERIOD OF CONSTRUCTION.]** Such amounts are estimates subject to adjustment by the Government and are not to be construed as the total financial responsibilities of the Government and the Non-Federal Sponsor.

B. The Non-Federal Sponsor shall provide the cash contribution required under Article II.D.2. of this Agreement in accordance with the following provisions: Not less than **[NUMBER OF DAYS, 30 OR MORE]** calendar days prior to the scheduled date for issuance of the solicitation for the first construction contract, the Government shall notify the Non-Federal Sponsor in writing of such scheduled date and the funds the Government

[INCLUDE THE FOLLOWING PHRASE FOR WORK-IN-KIND: , after consideration of any credit afforded pursuant to Article II.D.4. of this Agreement,] determines to be required from the Non-Federal Sponsor to meet its projected cash contribution under Article II.D.2. of this Agreement. Not later than such scheduled date, the Non-Federal Sponsor shall provide the Government with the full amount of the required funds by delivering a check payable to "FAO, USAED, [APPROPRIATE USACE DISTRICT]" to the District Engineer. The Government shall draw from the funds provided by the Non-Federal Sponsor such sums as the Government [INCLUDE THE FOLLOWING PHRASE FOR WORK-IN-KIND: , after consideration of any credit afforded pursuant to Article II.D.4. of this Agreement,] deems necessary to cover: (a) the non-Federal proportionate share of financial obligations for implementation incurred prior to commencement of the period of implementation; and (b) the non-Federal proportionate share of financial obligations for implementation as they are incurred during the period of implementation. In the event the Government determines that the Non-Federal Sponsor must provide additional funds to meet the Non-Federal Sponsor's cash contribution, the Government shall notify the Non-Federal Sponsor in writing of the additional funds required. Within [NORMALLY 60] calendar days thereafter, the Non-Federal Sponsor shall provide the Government with a check for the full amount of the additional required funds. [EXPLANATORY NOTES: 1) IF DURING NEGOTIATION OF THE PCA THE NON-FEDERAL SPONSOR, IN A REQUEST PROCESSED THROUGH PROPER CHANNELS, CAN DEMONSTRATE TO THE SATISFACTION OF THE ASSISTANT SECRETARY OF THE ARMY (CIVIL WORKS) THAT A LONGER TIME PERIOD FOR PAYMENT OF THE ADDITIONAL REQUIRED FUNDS IS APPROPRIATE, THE PCA SUBMITTED TO HQUSACE FOR REVIEW MUST STATE THE DIFFERENT TIME PERIOD. 2) IF ADDITIONAL FUNDS ARE REQUIRED FROM THE NON-FEDERAL SPONSOR, THEY SHOULD BE REQUESTED IMMEDIATELY SO THAT THE NON-FEDERAL SPONSOR WILL MAINTAIN ITS PROPORTIONATE SHARE OF FINANCIAL OBLIGATIONS. FEDERAL FUNDS SHOULD NOT BE USED TO MEET ANY SHORTFALL IN SPONSOR FUNDS.]

OPTION II [USE OPTION II IF IMPLEMENTATION OF THE PROJECT MODIFICATION WILL EXTEND TO MORE THAN ONE FISCAL YEAR, UNLESS THE NON-FEDERAL SPONSOR WISHES TO MAKE ITS CONTRIBUTION IN FULL AT THE OUTSET. DELETE THE ENTIRE OPTION IF IT DOES NOT APPLY.]

A. The Government shall maintain current records of contributions provided by the parties and current projections of total project modification costs and costs due to betterments. By [SPECIFIC DATE, BASED ON THE TIMING OF THE NON-FEDERAL SPONSOR'S FISCAL CYCLE] of each year and at least quarterly thereafter, the Government shall provide the Non-Federal Sponsor

with a report setting forth all contributions provided to date and the current projections of total project modification costs, of total costs due to betterments, of the components of total project modification costs, of each party's share of total project modification costs, of the Non-Federal Sponsor's total cash contributions required in accordance with Articles II.B., II.D., and II.E. of this Agreement, of the non-Federal proportionate share, and of the funds the Government projects to be required from the Non-Federal Sponsor for the upcoming fiscal year. On the effective date of this Agreement, total project modification costs are projected to be $_____, and the Non-Federal Sponsor's cash contribution required under Article II.D. of this Agreement is projected to be $_____. **[NOTE: PROJECTIONS SHOULD BE INFLATED THROUGH THE PERIOD OF CONSTRUCTION.]** Such amounts are estimates subject to adjustment by the Government and are not to be construed as the total financial responsibilities of the Government and the Non-Federal Sponsor.

B. The Non-Federal Sponsor shall provide the cash contribution required under Article II.D.2. of this Agreement in accordance with the provisions of this paragraph. **[ARTICLE VI.B.1. OFFERS THE NON-FEDERAL SPONSOR THREE MECHANISMS FROM WHICH TO CHOOSE IN DECIDING HOW TO PROVIDE ITS CASH CONTRIBUTION TO THE FEDERAL GOVERNMENT. THE NON-FEDERAL SPONSOR SHOULD INDICATE ITS CHOICE DURING THE COURSE OF NEGOTIATING THE AGREEMENT. THE PCA SHOULD REFLECT ONLY ONE MECHANISM.]**

1. Not less than **[NUMBER OF DAYS, 30 OR MORE]** calendar days prior to the scheduled date for issuance of the solicitation for the first construction contract, the Government shall notify the Non-Federal Sponsor in writing of such scheduled date and the funds the Government **[INCLUDE THE FOLLOWING PHRASE FOR WORK-IN-KIND:** , after consideration of any credit afforded pursuant to Article II.D.4. of this Agreement,**]** determines to be required from the Non-Federal Sponsor to meet the non-Federal proportionate share of projected financial obligations for implementation through the first fiscal year of implementation, including the non-Federal proportionate share of financial obligations for implementation incurred prior to the period of implementation. Not later than such scheduled date, the Non-Federal Sponsor shall **[INDICATE MECHANISM: [1]** provide the Government with the full amount of the required funds by delivering a check payable to "FAO, USAED, **[APPROPRIATE USACE DISTRICT]**" to the District Engineer. **[2]** verify to the satisfaction of the Government that the Non-Federal Sponsor has deposited the required funds in an escrow or other account

acceptable to the Government, with interest accruing to the Non-Federal Sponsor. [3] present the Government with an irrevocable letter of credit acceptable to the Government for the required funds.]

2. For the second and subsequent fiscal years of implementation, the Government shall notify the Non-Federal Sponsor in writing, no later than 60 calendar days prior to the beginning of that fiscal year, of the funds the Government **[INCLUDE THE FOLLOWING PHRASE FOR WORK-IN-KIND:** , after consideration of any credit afforded pursuant to Article II.D.4. of this Agreement,] determines to be required from the Non-Federal Sponsor to meet the non-Federal proportionate share of projected financial obligations for implementation for that fiscal year. No later than 30 calendar days prior to the beginning of the fiscal year, the Non-Federal Sponsor shall make the full amount of the required funds for that fiscal year available to the Government through the funding mechanism specified in Article VI.B.1. of this Agreement.

3. The Government shall draw from the funds provided by the Non-Federal Sponsor such sums as the Government **[INCLUDE THE FOLLOWING PHRASE FOR WORK-IN-KIND:** , after consideration of any credit afforded pursuant to Article II.D.4. of this Agreement,] deems necessary to cover: (a) the non-Federal proportionate share of financial obligations for implementation incurred prior to the period of implementation; and (b) the non-Federal proportionate share of financial obligations for implementation as they are incurred during the period of implementation.

4. If at any time during the period of implementation the Government determines that additional funds will be needed from the Non-Federal Sponsor to cover the non-Federal proportionate share of projected financial obligations for implementation for the current fiscal year, the Government shall notify the Non-Federal Sponsor in writing of the additional funds required, and the Non-Federal Sponsor, no later than **[NORMALLY 60]** calendar days from receipt of such notice, shall make the additional required funds available through the payment mechanism specified in Article VI.B.1. of this Agreement. **[EXPLANATORY NOTES: 1) IF DURING NEGOTIATION OF THE PCA THE NON-FEDERAL SPONSOR, IN A REQUEST PROCESSED THROUGH PROPER CHANNELS, CAN DEMONSTRATE TO THE SATISFACTION OF THE ASSISTANT SECRETARY OF THE ARMY (CIVIL WORKS) THAT A LONGER TIME PERIOD FOR PAYMENT OF THE ADDITIONAL REQUIRED FUNDS IS APPROPRIATE, THE PCA SUBMITTED TO HQUSACE FOR REVIEW MUST STATE THE DIFFERENT TIME PERIOD. 2) IF**

ADDITIONAL FUNDS ARE REQUIRED FROM THE NON-FEDERAL SPONSOR, THEY SHOULD BE REQUESTED IMMEDIATELY SO THAT THE NON-FEDERAL SPONSOR WILL MAINTAIN ITS PROPORTIONATE SHARE OF FINANCIAL OBLIGATIONS. FEDERAL FUNDS SHOULD NOT BE USED TO MEET ANY SHORTFALL IN SPONSOR FUNDS.]

[INCLUDE PARAGRAPHS C. AND D. FOR BOTH OPTIONS I AND II IN ARTICLE VI.]

C. In advance of the Government incurring any financial obligation associated with additional work under Article II.B. or II.E. of this Agreement, the Non-Federal Sponsor shall **[INDICATE MECHANISM: [1]** provide the Government with the full amount of the funds required to pay for such additional work by delivering a check payable to "FAO, USAED, **[APPROPRIATE USACE DISTRICT]**" to the District Engineer. **[2]** verify to the satisfaction of the Government that the Non-Federal Sponsor has deposited the full amount of the funds required to pay for such additional work in an escrow or other account acceptable to the Government, with interest accruing to the Non-Federal Sponsor.] The Government shall draw from the funds provided by the Non-Federal Sponsor such sums as the Government deems necessary to cover the Government's financial obligations for such additional work as they are incurred. In the event the Government determines that the Non-Federal Sponsor must provide additional funds to meet its cash contribution, the Government shall notify the Non-Federal Sponsor in writing of the additional funds required. Within **[NORMALLY 30]** calendar days thereafter, the Non-Federal Sponsor shall provide the Government with a check for the full amount of the additional required funds.

D. Upon completion of the Project Modification or termination of this Agreement, and upon resolution of all relevant claims and appeals, the Government shall conduct a final accounting and furnish the Non-Federal Sponsor with the results of the final accounting. The final accounting shall determine total project modification costs, each party's contribution provided thereto, and each party's required share thereof. The final accounting also shall determine costs due to betterments and the Non-Federal Sponsor's cash contribution provided pursuant to Article II.B. of this Agreement.

1. In the event the final accounting shows that the total contribution provided by the Non-Federal Sponsor is less than its required share of total project modification costs plus costs due to any betterments provided in accordance with Article II.B. of this Agreement, the Non-Federal Sponsor shall, no later

than 90 calendar days after receipt of written notice, make a cash payment to the Government of whatever sum is required to meet the Non-Federal Sponsor's required share of total project modification costs plus costs due to any betterments provided in accordance with Article II.B. of this Agreement. **[EXPLANATORY NOTE: IF DURING NEGOTIATION OF THE PCA THE NON-FEDERAL SPONSOR CAN DEMONSTRATE TO THE SATISFACTION OF THE ASSISTANT SECRETARY OF THE ARMY (CIVIL WORKS) THAT A LONGER TIME PERIOD FOR PAYMENT OF THE ADDITIONAL REQUIRED FUNDS IS APPROPRIATE, THE PCA SUBMITTED TO HQUSACE FOR REVIEW MUST STATE THE DIFFERENT TIME PERIOD.]**

2. In the event the final accounting shows that the total contribution provided by the Non-Federal Sponsor exceeds its required share of total project modification costs plus costs due to any betterments provided in accordance with Article II.B. of this Agreement, the Government shall, subject to the availability of funds, refund the excess to the Non-Federal Sponsor no later than 90 calendar days after the final accounting is complete. In the event existing funds are not available to refund the excess to the Non-Federal Sponsor, the Government shall seek such appropriations as are necessary to make the refund.

ARTICLE VII - DISPUTE RESOLUTION

As a condition precedent to a party bringing any suit for breach of this Agreement, that party must first notify the other party in writing of the nature of the purported breach and seek in good faith to resolve the dispute through negotiation. If the parties cannot resolve the dispute through negotiation, they may agree to a mutually acceptable method of non-binding alternative dispute resolution with a qualified third party acceptable to both parties. The parties shall each pay 50 percent of any costs for the services provided by such a third party as such costs are incurred. The existence of a dispute shall not excuse the parties from performance pursuant to this Agreement.

ARTICLE VIII - OPERATION, MAINTENANCE, REPAIR, REPLACEMENT, AND REHABILITATION (OMRR&R)

[OPTION I - USE THIS OPTION IF OPERATION AND MAINTENANCE OF THE PROJECT MODIFICATION <u>IS</u> REQUIRED AND WILL BE PERFORMED BY THE NON-FEDERAL SPONSOR]

A. Upon notification in accordance with Article II.C. of this Agreement and for so long as the Project Modification remains authorized, the Non-Federal Sponsor shall operate, maintain, repair, replace, and rehabilitate the entire Project

Modification or the functional portion of the Project Modification, at no cost to the Government, in a manner compatible with the Project Modification's authorized purposes and in accordance with applicable Federal and State laws as provided in Article XI of this Agreement and specific directions prescribed by the Government in the OMRR&R Manual and any subsequent amendments thereto.

B. The Non-Federal Sponsor hereby gives the Government a right to enter, at reasonable times and in a reasonable manner, upon property that the Non-Federal Sponsor owns or controls for access to the Project Modification for the purpose of inspection and, if necessary, for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the Project Modification. If an inspection shows that the Non-Federal Sponsor for any reason is failing to perform its obligations under this Agreement, the Government shall send a written notice describing the non-performance to the Non-Federal Sponsor. If, after 30 calendar days from receipt of the notice, the Non-Federal Sponsor continues to fail to perform, then the Government shall have the right to enter, at reasonable times and in a reasonable manner, upon property the Non-Federal Sponsor owns or controls for access to the Project Modification for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the Project Modification. No completion, operation, maintenance, repair, replacement, or rehabilitation by the Government shall operate to relieve the Non-Federal Sponsor's obligations as set forth in this Agreement, or to preclude the Government from pursuing any other remedy at law or equity to ensure faithful performance pursuant to this Agreement.

[OPTION II - USE THIS OPTION IF OPERATION AND MAINTENANCE OF THE PROJECT MODIFICATION <u>IS NOT</u> REQUIRED]

A. Upon completion of the Project Modification, or functional portion of the Project Modification, the Government will turn over the Project Modification, or functional portion thereof, to the Non-Federal Sponsor and all further Federal responsibility for the Project Modification or functional portion thereof, will cease. The Non-Federal Sponsor shall have no obligation under this Agreement to operate, maintain, repair, replace, or rehabilitate the Project Modification, or functional portion thereof, and shall perform these functions only as it deems warranted in its sole discretion. The Non-Federal Sponsor shall not itself, nor permit anyone else to, take any action inconsistent with the Project Modification, or functional portion thereof.

B. The Non-Federal Sponsor hereby gives the Government a right to enter, at reasonable times and in a reasonable manner, upon property that the Non-Federal Sponsor owns or controls for access to the Project Modification for the purpose of inspection. If an inspection shows that the Non-Federal Sponsor for any reason is failing to perform its obligations under this Agreement, the Government shall send a written notice describing the non-performance to the Non-Federal Sponsor. If, after 30 calendar days from receipt of the notice, the Non-Federal Sponsor continues to fail to perform, then the Government shall have the right to enter, at reasonable times and in a reasonable manner, upon property the Non-Federal Sponsor owns or controls for access to the Project Modification. No action by the Government shall operate to relieve the Non-Federal Sponsor's obligations as set forth in this Agreement, or to preclude the Government from pursuing any other remedy at law or equity to ensure faithful performance pursuant to this Agreement.

ARTICLE IX - INDEMNIFICATION

The Non-Federal Sponsor shall hold and save the Government free from all damages arising from the implementation, operation, maintenance, repair, replacement and rehabilitation **[DELETE ", operation, maintenance, repair, replacement and rehabilitation" IF OPERATION AND MAINTENANCE OF THE PROJECT MODIFICATION IS NOT REQUIRED]** of the Project Modification, and any Project Modification-related betterments, except for damages due to the fault or negligence of the Government or its contractors.

ARTICLE X - MAINTENANCE OF RECORDS AND AUDIT

A. Not later than 60 calendar days after the effective date of this Agreement, the Government and the Non-Federal Sponsor shall develop procedures for keeping books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to this Agreement. These procedures shall incorporate, and apply as appropriate, the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 C.F.R. Section 33.20. The Government and the Non-Federal Sponsor shall maintain such books, records, documents, and other evidence in accordance with these procedures and for a minimum of three years after the period of implementation and resolution of all relevant claims arising therefrom. To the extent permitted under applicable Federal laws and regulations, the Government and the Non-Federal Sponsor shall each allow the other to inspect such books, documents, records, and other evidence.

B. Pursuant to 32 C.F.R. Section 33.26, the Non-Federal Sponsor is responsible for complying with the Single Audit Act of 1984, 31 U.S.C. Sections 7501-7507, as implemented by Office of Management and Budget (OMB) Circular No. A-133 and Department of Defense Directive 7600.10. Upon request of the Non-Federal Sponsor and to the extent permitted under applicable Federal laws and regulations, the Government shall provide to the Non-Federal Sponsor and independent auditors any information necessary to enable an audit of the Non-Federal Sponsor's activities under this Agreement. The costs of any non-Federal audits performed in accordance with this paragraph shall be allocated in accordance with the provisions of OMB Circulars A-87 and A-133, and such costs as are allocated to the Project Modification shall be included in total project modification costs and cost shared in accordance with the provisions of this Agreement.

C. In accordance with 31 U.S.C. Section 7503, the Government may conduct audits in addition to any audit that the Non-Federal Sponsor is required to conduct under the Single Audit Act. Any such Government audits shall be conducted in accordance with Government Auditing Standards and the cost principles in OMB Circular No. A-87 and other applicable cost principles and regulations. The costs of Government audits performed in accordance with this paragraph shall be included in total project modification costs and cost shared in accordance with the provisions of this Agreement.

ARTICLE XI - FEDERAL AND STATE LAWS

In the exercise of their respective rights and obligations under this Agreement, the Non-Federal Sponsor and the Government agree to 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, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army".

ARTICLE XII - RELATIONSHIP OF PARTIES

A. In the exercise of their respective rights and obligations under this Agreement the Government and the Non-Federal Sponsor each act in an independent capacity, and neither is to be considered the officer, agent, or employee of the other.

B. In the exercise of its rights and obligations under this Agreement, neither party shall provide, without the consent of the other party, any contractor with a release that waives or purports to waive any rights such other party may have to seek relief or redress against such contractor either pursuant to any cause of action that such other party may have or for violation of any law.

ARTICLE XIII - OFFICIALS NOT TO BENEFIT

No member of or delegate to the Congress, nor any resident commissioner, shall be admitted to any share or part of this Agreement, or to any benefit that may arise therefrom.

ARTICLE XIV - TERMINATION OR SUSPENSION

A. If at any time the Non-Federal Sponsor fails to fulfill its obligations under Article II.B., II.D., II.E., VI, or XVIII.C. of this Agreement, the Assistant Secretary of the Army (Civil Works) shall terminate this Agreement or suspend future performance under this Agreement unless he determines that continuation of work on the Project Modification is in the interest of the United States or is necessary in order to satisfy agreements with any other non-Federal interests in connection with the Project Modification.

B. If appropriations are not available in amounts sufficient to meet the Government's share of Project Modification expenditures for the then-current or upcoming fiscal year, the Government shall so notify the Non-Federal Sponsor in writing, and 60 calendar days thereafter either party may elect without penalty to terminate this Agreement or to suspend future performance under this Agreement. In the event that either party elects to suspend future performance under this Agreement pursuant to this paragraph, such suspension shall remain in effect until such time as the Government receives sufficient appropriations or until either the Government or the Non-Federal Sponsor elects to terminate this Agreement.

C. In the event that either party elects to terminate this Agreement pursuant to this Article or Article XV of this Agreement, both parties shall conclude their activities relating to the Project Modification and proceed to a final accounting in accordance with Article VI.D. of this Agreement.

D. Any termination of this Agreement or suspension of future performance under this Agreement in accordance with this Article or Article XV of this Agreement shall not relieve the

parties of any obligation previously incurred. Any delinquent payment shall be charged interest at a rate, to be determined by the Secretary of the Treasury, equal to 150 per centum of the average bond equivalent rate of the 13-week Treasury bills auctioned immediately prior to the date on which such payment became delinquent, or auctioned immediately prior to the beginning of each additional 3-month period if the period of delinquency exceeds 3 months.

ARTICLE XV - HAZARDOUS SUBSTANCES

A. After execution of this Agreement and upon direction by the District Engineer, the Non-Federal Sponsor shall perform, or cause to be performed, any investigations for hazardous substances that the Government or the Non-Federal Sponsor determines to be necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (hereinafter "CERCLA"), 42 U.S.C. Sections 9601-9675, that may exist in, on, or under lands, easements, and rights-of-way that the Government determines, pursuant to Article III of this Agreement, to be required for the implementation, operation, and maintenance **[DELETE ", operation, and maintenance" IF OPERATION AND MAINTENANCE OF THE PROJECT MODIFICATION IS NOT REQUIRED]** of the Project Modification, except for any such lands, easements, or rights-of-way that are owned by the United States and administered by the Government, and except for any such lands that the Government determines to be subject to the navigation servitude. The Government shall perform, or cause to be performed, all investigations on lands, easements, or rights-of-way that are owned by the United States and administered by the Government. For lands that the Government determines to be subject to the navigation servitude, only the Government shall perform such investigations unless the District Engineer provides the Non-Federal Sponsor with prior specific written direction, in which case the Non-Federal Sponsor shall perform such investigations in accordance with such written direction. All actual costs incurred by the Non-Federal Sponsor or the Government for such investigations for hazardous substances shall be included in total project modification costs and cost shared in accordance with the provisions of this Agreement, subject to an audit in accordance with Article X.C. of this Agreement to determine reasonableness, allocability, and allowability of costs.

B. In the event it is discovered through any investigation for hazardous substances or other means that hazardous substances regulated under CERCLA exist in, on, or under any lands,

easements, or rights-of-way, that the Government determines, pursuant to Article III of this Agreement, the Non-Federal Sponsor must provide for the implementation, operation, and maintenance **[DELETE ", operation, and maintenance" IF OPERATION AND MAINTENANCE OF THE PROJECT MODIFICATION IS NOT REQUIRED]** of the Project Modification, the Non-Federal Sponsor and the Government shall provide prompt written notice to each other, and the Non-Federal Sponsor shall not proceed with the acquisition of the real property interests until both parties agree that the Non-Federal Sponsor should proceed.

C. The Government and the Non-Federal Sponsor shall determine whether to initiate implementation of the Project Modification, or, if already in implementation, whether to continue with work on the Project Modification, suspend future performance under this Agreement, or terminate this Agreement for the convenience of the Government, in any case where hazardous substances regulated under CERCLA are found to exist in, on, or under any lands, easements, or rights-of-way that the Government determines, pursuant to Article III of this Agreement, to be required for the implementation, operation, and maintenance **[DELETE ", operation, and maintenance" IF OPERATION AND MAINTENANCE OF THE PROJECT MODIFICATION IS NOT REQUIRED]** of the Project Modification. Should the Government and the Non-Federal Sponsor determine to initiate or continue with implementation after considering any liability that may arise under CERCLA, the Non-Federal Sponsor shall be responsible, as between the Government and the Non-Federal Sponsor, for the costs of clean-up and response, to include the costs of any studies and investigations necessary to determine an appropriate response to the contamination on lands, easements or rights of way that the Government determines, pursuant to Article III of this Agreement, to be required for the implementation, operation, and maintenance **[DELETE ", operation, and maintenance" IF OPERATION AND MAINTENANCE OF THE PROJECT MODIFICATION IS NOT REQUIRED]** of the Project Modification, except for any such lands, easements, or rights-of-way owned by the United States and administered by the Government. Such costs shall not be considered a part of total project modification costs. In the event the Non-Federal Sponsor fails to provide any funds necessary to pay for clean up and response costs or to otherwise discharge the Non-Federal Sponsor's responsibilities under this paragraph upon direction by the Government, the Government may, in its sole discretion, either terminate this Agreement for the convenience of the Government, suspend future performance under this Agreement, or continue work on the Project Modification. The Government shall be responsible, as between the Government and the Non-Federal Sponsor, for the costs of clean-up and response, to include the

costs of any studies and investigations necessary to determine an appropriate response to the contamination on lands, easements, or rights of way owned by the United States and administered by the Government. All costs incurred by the Government shall be included in total project modification costs and cost shared in accordance with the terms of this Agreement.

D. The Non-Federal Sponsor and the Government shall consult with each other in accordance with Article V of this Agreement in an effort to ensure that responsible parties bear any necessary cleanup and response costs as defined in CERCLA. Any decision made pursuant to paragraph C. of this Article shall not relieve any third party from any liability that may arise under CERCLA.

E. As between the Government and the Non-Federal Sponsor, the Non-Federal Sponsor shall be considered the operator of the Project Modification for purposes of CERCLA liability. **[DELETE THE FOLLOWING SENTENCE IF OPERATION AND MAINTENANCE OF THE PROJECT MODIFICATION IS NOT REQUIRED]** To the maximum extent practicable, the Non-Federal Sponsor shall operate, maintain, repair, replace, and rehabilitate the Project Modification in a manner that will not cause liability to arise under CERCLA.

ARTICLE XVI - NOTICES

A. Any notice, request, demand, or other communication required or permitted to be given under this Agreement shall be deemed to have been duly given if in writing and either delivered personally, or by telegram, or mailed by first-class, registered, or certified mail, as follows:

If to the Non-Federal Sponsor:

[FULL ADDRESS]

If to the Government:

[FULL ADDRESS]

B. A party may change the address to which such communications are to be directed by giving written notice to the other party in the manner provided in this Article.

C. Any notice, request, demand, or other communication made pursuant to this Article shall be deemed to have been received by the addressee at the earlier of such time as it is actually received or seven calendar days after it is mailed.

ARTICLE XVII - CONFIDENTIALITY

To the extent permitted by the laws governing each party, the parties agree to maintain the confidentiality of exchanged information when requested to do so by the providing party.

ARTICLE XVIII - HISTORIC PRESERVATION

A. The costs of identification, survey and evaluation of historic properties shall be included in total project modification costs and cost shared in accordance with the provisions of this Agreement.

B. Pursuant to Section 7(a) of Public Law 93-291 (16 U.S.C. Section 469c(a)), the costs of mitigation and data recovery activities associated with historic preservation shall be borne entirely by the Government and shall not be included in total project modification costs, up to the statutory limit of one percent of the total amount the Government is authorized to expend for the Project Modification.

C. The Government shall not incur costs for mitigation and data recovery that exceed the statutory one percent limit

specified in paragraph B. of this Article unless and until the Assistant Secretary of the Army (Civil Works) has waived that limit in accordance with Section 208(3) of Public Law 96-515 (16 U.S.C. Section 469c-2(3)). Any costs of mitigation and data recovery that exceed the one percent limit shall be included in total project modification costs and shall be cost shared in accordance with the provisions of this Agreement.

ARTICLE XIX - LIMITATION ON GOVERNMENT EXPENDITURES

Notwithstanding any other provisions of this Agreement, the Government□s financial obligations are limited to $5,000,000. The Non-Federal Sponsor shall be responsible for all total project modification costs that exceed this amount.

[INCLUDE ARTICLE XX ONLY IF THE NON-FEDERAL SPONSOR IS A STATE AGENCY OR DERIVES ITS FUNDS DIRECTLY FROM STATE LEGISLATIVE APPROPRIATIONS AND THE STATE IS LIMITED BY ITS CONSTITUTION OR BY STATE STATUTES FROM COMMITTING FUTURE STATE LEGISLATIVE APPROPRIATIONS.]

ARTICLE XX - OBLIGATIONS OF FUTURE APPROPRIATIONS

Nothing herein shall constitute, nor be deemed to constitute, an obligation of future appropriations by the legislature of the State of _____.

[INCLUDE THE FOLLOWING ARTICLE IF THE NON-FEDERAL SPONSOR IS AN INDIAN TRIBE]

ARTICLE XXI - SPECIAL PROVISIONS FOR AN INDIAN TRIBE

A. The Non-Federal Sponsor agrees to waive its sovereign immunity solely for the purposes of suit in an appropriate Federal court by the Government for any breach by the Non-Federal Sponsor of this Agreement, including suit to hold and save the Government free from damages arising on or after the date of this Agreement due to the implementation and subsequent operation and maintenance **[DELETE "and subsequent operation and maintenance" IF OPERATION AND MAINTENANCE OF THE PROJECT MODIFICATION IS NOT REQUIRED]** of the Project Modification, except for damages due to the fault or negligence of the Government or its contractors.

B. The Non-Federal Sponsor agrees to maintain liability insurance in an amount not less than $_____ to insure against bodily injury and property damage arising from the

implementation, operation, maintenance, repair, replacement, or rehabilitation **[DELETE ", operation, maintenance, repair, replacement, or rehabilitation" IF OPERATION AND MAINTENANCE OF THE PROJECT MODIFICATION IS NOT REQUIRED]** of the Project Modification and to assure that the Government will be held free from damages due to implementation, operation, maintenance, repair, replacement, and rehabilitation **[DELETE ", operation, maintenance, repair, replacement, and rehabilitation" IF OPERATION AND MAINTENANCE OF THE PROJECT MODIFICATION IS NOT REQUIRED]** of the Project Modification except for damage due to the fault or negligence of the Government or its contractors. The insurance policy shall specify that the defense of sovereign immunity of the Non-Federal Sponsor, its individual tribal members, or the Government will not be raised by the insurer as a defense against payment under the policy.

[DELETE THE FOLLOWING PARAGRAPH IF OPERATION AND MAINTENANCE OF THE PROJECT MODIFICATION IS NOT REQUIRED]

C. The Non-Federal Sponsor agrees to provide the Government security acceptable to the Government to secure performance of the non-Federal maintenance responsibility set forth in Article VIII of this Agreement. The maintenance is estimated to cost $_____annually. The type of security, which must be a non-trust tribal asset, will be determined and secured prior to the construction contract being awarded.

IN WITNESS WHEREOF, the parties hereto have executed this Agreement, which shall become effective upon the date it is signed by the Department of the Army.

THE DEPARTMENT OF THE ARMY

BY: **[SIGNATURE]**
[TYPED NAME]
[TITLE IN FULL]

DATE:_____

THE **[FULL NAME OF NON-FEDERAL SPONSOR]**

BY:_____**[SIGNATURE]**
[TYPED NAME]
[TITLE IN FULL]

DATE:

CERTIFICATE OF AUTHORITY

I, _____, do hereby certify that I am the principal legal officer of the **[FULL NAME OF NON-FEDERAL SPONSOR]**, that the **[FULL NAME OF NON-FEDERAL SPONSOR]** is a legally constituted public body with full authority and legal capability to perform the terms of the Agreement between the Department of the Army and the **[FULL NAME OF NON-FEDERAL SPONSOR]** in connection with the **[FULL NAME OF "PROJECT MODIFICATION"]**, and to pay damages in accordance with the terms of this Agreement, if necessary, in the event of the failure to perform, and that the persons who have executed this Agreement on behalf of the **[FULL NAME OF NON-FEDERAL SPONSOR]** have acted within their statutory authority.

IN WITNESS WHEREOF, I have made and executed this certification this _____ day of _____ 19___.

_____
[SIGNATURE]
[TYPED NAME]
[TITLE IN FULL]

CERTIFICATION REGARDING LOBBYING

The undersigned certifies, to the best of his or her knowledge and belief that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by Section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

[SIGNATURE OF PCA SIGNATORY]

[TYPED NAME]

[TITLE IN FULL]

DATE: _____

APPENDIX O.

PRELIMINARY RESTORATION PLAN

January 2002

South Pacific Division
Los Angeles District

AGUA FRIA RIVER RIPARIAN RESTORATION SECTION 1135 PRELIMINARY RESTORATION PLAN

1. **Project:** Agua Fria River, Maricopa County, Arizona.

   a. **Name of Modification.** Aqua Fria River Riparian Restoration.

   b. **PWI Number:** 172042

   c. **Project Being Modified.**

The project being modified is the Skunk Creek and the New and Agua Fria Rivers (Arizona Canal Diversion Channel to the Gila River). The project modification is located within the channel of the Agua Fria River, in Avondale, Arizona, approximately 15 miles west of central Phoenix. The Agua Fria River is one of the primary river corridors in the Phoenix Metropolitan area. The channelization of this river has significantly altered the natural and biological functions causing degradation to the ecological system that once existed. The project modification boundaries are along the banks of the Agua Fria River, bounded on the north by McDowell Road, and on the south by the Gila River. The Agua Fria River is bounded on the east and west by soil cement levees constructed in 1987 (Figure 1).

   d. **Date Constructed.**

The bank protection project was completed in 1987 and was a cost-shared between the U.S. Army Corps of Engineers and the Flood Control District of Maricopa County, Arizona.

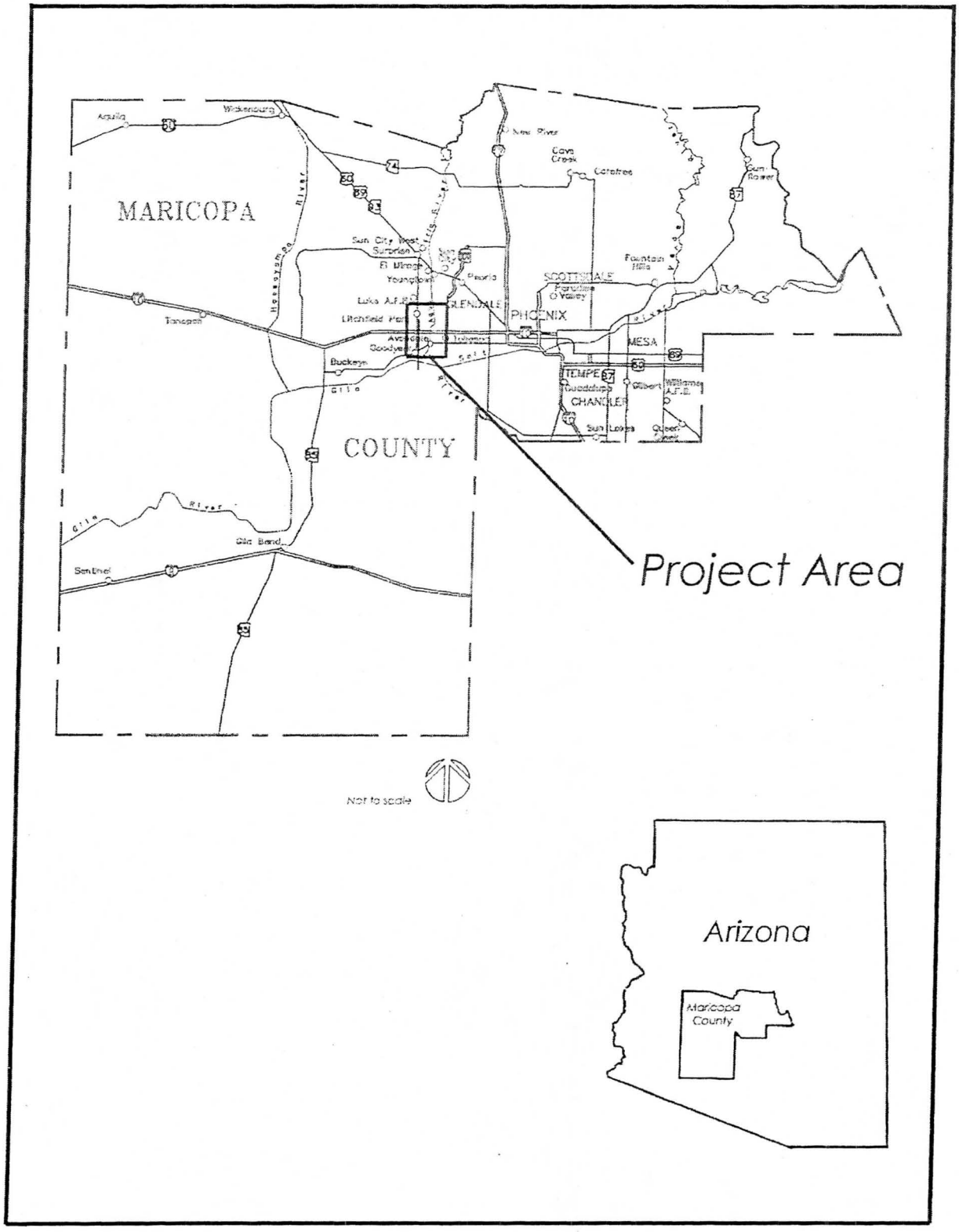
   e. **Authorized Purpose.**

The project modification (hereafter referred to as the project) is authorized under the Flood Control Act of 1965.

   f. **U.S. Congressional District.** The proposed project lies within Congressional Districts 2 and 3 (Arizona).

2. **Location.**

The project is located in the southwestern region of the Phoenix metropolitan area, within Maricopa County, Arizona. The project site is a portion of the Agua Fria River located within the city limits of Avondale (Figures 1). The project area is approximately a five-mile segment of the Agua Fria River beginning at McDowell Road on the north end, extending southward to the confluence of the Gila River. Within this reach of the River, the width varies from approximately 1200' at its narrowest areas at the northern end of the project site, to roughly 2500' at its widest reaches at the southern portion.



Location Map
Figure 1

3. Description of Proposed Ecosystem Restoration.

a. Summary of Proposed Benefits.

The proposed project is to restore approximately 125 acres of riparian habitat to the degraded ecosystem along portions of a six-mile reach of the south-end of the Agua Fria River. The restoration would provide the following benefits:

(1.) increased riparian vegetation acreage;
(2.) increased riparian habitat values and function, such as forage, nesting, cover and resting opportunities for native and migrating animal and aviary species;
(3.) increased bird and wildlife populations;
(4.) improved ecological diversity;
(5.) wildlife movement/migration corridor;
(6.) restored aesthetic value to a visually degraded site;
(7.) environmental educational/interpretive opportunities.

Creation of the proposed project elements (a meandering low-flow channel, contoured riverine terraces, islands of riparian plantings and earthen embankments along the soil-cement levees) would result in benefits to the natural environment. The plan would include the removal of exotic plant species (palm trees, salt cedar, etc.), along with the re-establishment of native vegetation, as appropriate, to provide an ecologically sound environment that more closely mimics the historical riparian features of the Agua Fria River.

Wildlife viewing platforms with environmental interpretive signage could also be included in the overall design. Such features, if developed, are considered recreational and would be formulated separately from the restoration proposal.

b. Federal Causes of Degradation and Consequential Results.

The implementation of bank protection along the Agua Fria River has impacted this region by structurally channelizing the river with steep soil cement levees, preventing the formation of natural banks and meanders which could sustain riparian habitat. This application of bank protection created a physical barrier that removed areas of riparian habitat and prohibits its reestablishment. This condition has resulted in the loss of contiguous riparian habitat. Increased population growth and urban development along the Agua Fria River will continue to increase the cycle of degradation and destruction of valuable natural habitat and ecosystem functions.

c. Proposed Project Features.

The primary objective is to restore riparian habitat and ecological function of an ecologically degraded desert riparian system along a six-mile reach of the Aqua Fria River. The entire project area includes about 1,000 acres, of which approximately 125 acres will be restored. A desert river is unique in the sense that, typically for the majority of the year the river is dry. However, the downpour of a heavy monsoon thunderstorm on the dense, tightly packed clay soil, causes the water to flow across the surface and collect in washes. The desert washes rapidly become torrential river flows. The New Waddell Dam is upstream from the project site on the Agua Fria River and has reduced the Standard Project Flood (SPF) rate of discharge. However, the New Waddell Dam has less impact on the SPF than it does on the 100-year flood. The discharge of the river during a 100-year flood event in the project area is 50,900 cubic feet per

second. The effective drainage area (excluding the drainage area above New Waddell Dam) for the segment of the Agua Fria River in the project area is approximately 485 square miles. The ecological health of this significant watercourse is a vital component to a much larger biological and ecological system.

Goals and objectives are listed below to guide the formulation and future implementation of a restoration plan:

- Restore riparian habitat in a manner promoting ecological resiliency and self-sustaining qualities
- Establish sub-habitats in a manner that supports the greatest diversity of target and beneficial wildlife species including desert cottontail (*Sylvilagus auduboni)*, Gambel's quail *(Lophortyx gambelii)*, mourning and white-winged doves *(Zenaida macroura and asiatica)*, crissal thrasher *(Toxostoma dorsale)*, Abert's towhee *(Pipilo aberti)*, brown towhee *(Pipilo fuscus)*, Say's phoebe *(Sayorinis saya)* and black-tailed gnatcatcher *(Polioptila melanura)* (Brown 1994).
- Establish riparian vegetative communities that represent historic and optimal conditions in the subject regions, to include species such as Goodding willow *(Salix gooddingii)*, desert broom *(Baccharis sarothroides)*, mule fat *(Baccharis viminea)*, desert hackberry *(Celtis pallida)*, desert willow (*Chilopsis linearis*), burrobush *(Hymenoclea monogyra)*, and arrow-weed *(Tessaria sericea)*(Brown, 1994).

The proposed project elements would include a meandering low-flow channel, riverine terraces, islands of riparian plantings and earthen embankments along the soil-cement levees. The earth excavated to create an approximately 300-foot wide low-flow channel would be used to create sections of terracing and embankments along the levees. The function and structural integrity of the armored bank protection itself would not be altered. Although terracing would occur, the degree of flood control projection would not be significantly reduced, as the material for the terraces will be taken from the existing channel. New material for the terraces will not be brought into the channel from outside sources.

Soil cement levees along the Agua Fria River provide flood control protection. Within the PRP project area, there is a levee on the west side of the river from McDowell Road to south to Lower Buckeye Road and ¼-mile beyond. The west-side levee is approximately 3-1/2-miles long within the project area. On the east side of the river, there is a soil cement levee from McDowell Road to Buckeye Road, for a total distance of approximately 2-miles. On the east side, there is no levee south of Buckeye Road, but there is a levee for approximately 1/8- to ¼-mile around a residential neighborhood on the east side of the river at Lower Buckeye Road. This is a total distance of approximately 2-miles on the east side within the project area.

The levees are constructed of soil cement armoring earth fill. The soil cement armor is approximately eight (8') feet thick. The levees typically have 1:1 sideslopes on the front (river) side backside (away from the river). Levee height ranges from 11- to 21-feet, depending on location and quantity of floodwaters to be contained. At the top of each levee there is a maintenance road, with a running surface width of approximately 14-feet.

The constructed, steep impenetrable surface of the soil-cement levee prevents plant growth. The development of earthen embankments covering the soil cement levees would provide opportunity for plants to root, establish and grow.

Alternatives involving the construction of a low flow channel will need to be analyzed in the ERR phase to determine the potential effects of lateral migration of the low flow channel on the existing banks of soil cement.

There are four existing riparian areas located in the Agua Fria River project area between McDowell Road and its convergence with the Gila River. One such area is located just north of Interstate 10 at the River, draining in from the east. There are two drainage channels coming into the Agua Fria from Interstate 10. Another riparian area has formed at the outflow of the ditch just north (uphill) of the Southern Pacific Railway and Buckeye Road, also draining in from the east. A third riparian area with perpetual standing water is located at the outflow pipe from the Avondale Waste Water Treatment Plant, draining in from the east. The treatment plant is located on Dysart Road between Southern and Broadway. The underground outflow pipe runs from this plant along an unpaved farm road.

The fourth area is at the Gila River, just beyond the Agua Fria PRP project area. There is a standing pool of water, surrounded by a dense forest of predominantly mesquite, palo verde and salt cedar. For information about this pool, the Gila River and its forest types, please refer to the Tres Rio Project Description. This pool of water is contained by the inlet structure for the Buckeye Canal. The pool and surrounding area are fenced and public access is not possible.

There are three primary locations (see Figure 1b) with water inflow sources along the six-mile reach of the river. The existing riparian vegetation along these water inflow sources is limited, providing only poor quality habitat for avian and mammal species. As a result of this project, native vegetation would re-establish naturally in/near the created low-flow channel. The plan recommendation would be to locate the best planting sites along the reach to promote long-term sustainability of the riparian vegetation communities once the temporary irrigation for establishment is terminated.

Existing vegetation would be evaluated to determine which groupings of plant material would remain and be used to enhance the restored riparian habitat. A survey of exotic or otherwise undesirable plant species would be required to determine the need and process of their removal. The plan includes the removal of invasive/exotic plant species, such as palm tree seedlings which occur under the McDowell and Van Buren bridges, plus salt cedar *(Tamarix chinenesis)* which occurs in thickets along the Gila River adjacent to the project area, along with the re-establishment of native vegetation, to provide an ecologically sound environment that mimics the historical riparian features of the Agua Fria River. The plant species targeted for removal would require a habitat value assessment. If the invasive/exotic plant species demonstrate significant habitat value, mitigation measures to prevent loss of habitat for animal and avian species will be established.

Plant species would be chosen to provide for the food, shelter, roosting and other requirements of the wildlife, as well as for inundation tolerance. The shallow edges of the low flow channel areas would be planted with emergent vegetation that will tolerate high levels of water inundation, primarily reeds and cattails. Plant species such as desert broom *(Baccharis sarothroides)*, desert willow *(Chilopsis linearis)* and hackberry *(Celtis pallida)* would be planted on the higher terrace level, which tolerates a drier environment with occasional flooding.

Native plant communities would be established in the habitat areas by a variety of methods, including container stock planting, cutting planting, seeding, pole planting, and wattle planting. Plant materials would be acquired through nurseries, contract growers, site salvage operations, and harvesting from existing riparian areas in the vicinity. A combination of the above planting methods will provide a cost-effective method of establishing a process of natural succession in the habitat areas. The plant communities would be irrigated until the plants become established. Harvested rainwater would help sustain and regenerate plant communities along the low-flow channel. The water table underneath the channel is shallow (estimated at less than 15-feet), and would be a sufficient water source to sustain woody plantings once the root systems are established. There are a few consistent sources of water flowing into the Agua Fria River, which can help sustain plant communities. These sources of inflow include the outlet channel from Interstate-10, the surface runoff from Buckeye Road, which is in part due to the ditch along the elevated railroad road tracks, the outflow from the Avondale Waste Water Treatment Plant and the area at the Gila River confluence (See Figure 2).

Figure 2

d. Project Purpose.

This project would modify a portion of the Agua Fria River to rehabilitate a degraded ecosystem. Historic accounts of what the conditions were like approximately 100 years ago describe a tree-lined river with other dense vegetation winding throughout the riverbed and vicinity. During the early 1900's, this once densely vegetated area experienced significant changes due to urban growth. As a result of an increase in population, urbanization, depletion of groundwater and the need for flood control measures along the Agua Fria River, the once low bank terraces and meanders that held significant riparian and wetland areas have been channelized with high, steep, stabilized levees of soil-cement, allowing no plant growth (See Figure 3).

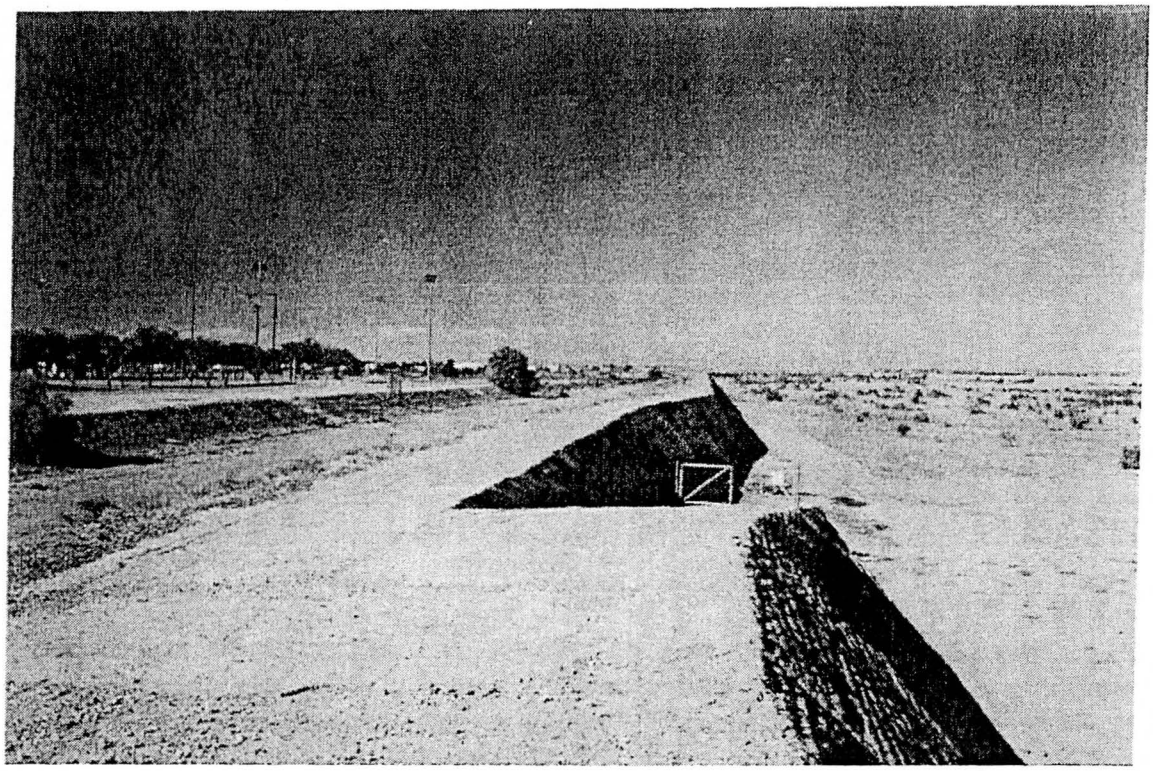


Figure 3

This change in site condition significantly reduced river vegetation in this area. Today the river contains sparse vegetation consisting mostly of grass and herbaceous plants and scattered palo verde and mesquite, providing minimal habitat for wildlife (See Figure 4).

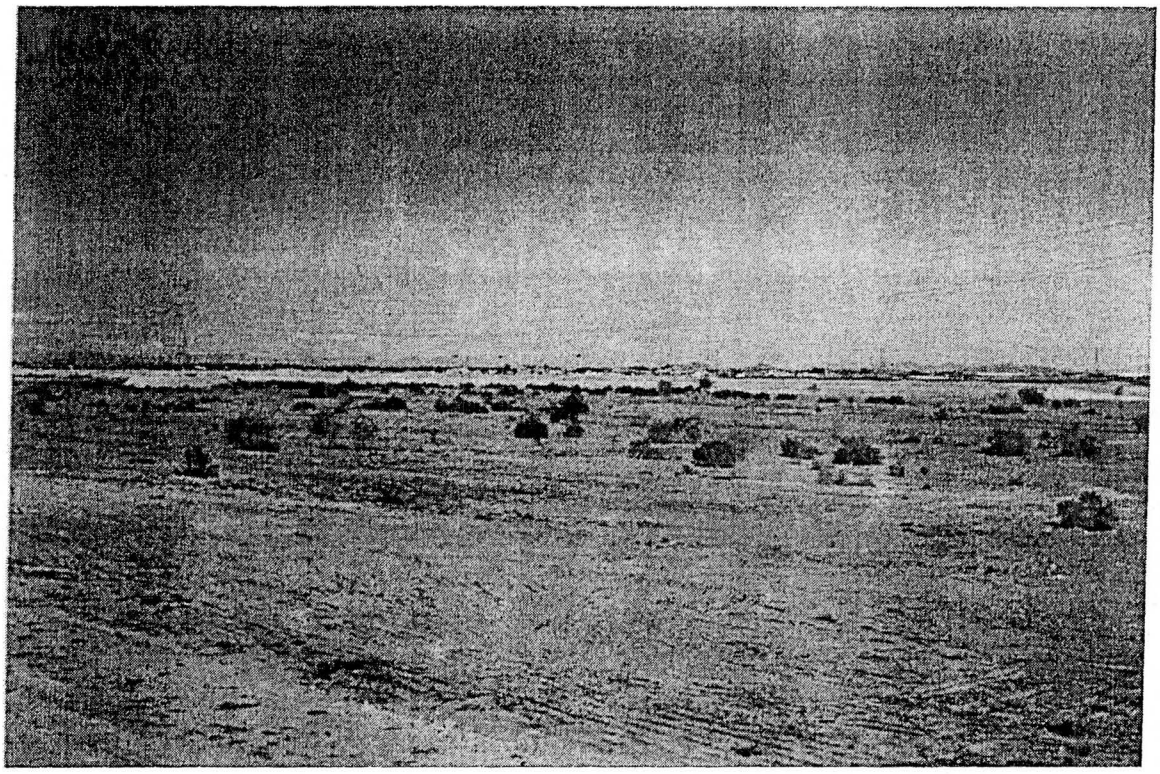


Figure 4

Due to the fact that the Agua Fria River and vicinity lies along the Pacific Flyway migratory route, this project could potentially provide suitable habitat conditions for migrating birds. This type of habitat is essential in desert regions for waterfowl that rely on open water. Waterfowl species most likely to use open water habitats in the project vicinity are the mallard, pintail, and bufflehead, to name a few. The lack of such habitat in the Phoenix metropolitan area has made migrations more difficult and may ultimately result in an alteration of migration patterns.

During the Ecosystem Restoration Report phase the project area will be evaluated for potential habitat for the following species, which are not expected to currently occupy the project area. Existing suitable habitat for these species is not currently found in the project area, although the area near the confluence with the Gila River will be evaluated for potential suitability as southwestern willow flycatcher habitat.

- Southwestern Willow Flycatcher
- Cactus Ferruginous Pygmy Owl
- Yuma Clapper Rail

The state of Arizona, as a whole, is continuing to experience a significant loss of riparian habitat. The Agua Fria River is one of three primary river corridors in the Phoenix area. Within the channel of the Agua Fria River, existing riparian habitat is limited to a few isolated areas. The overall habitats are of low value and are declining. The projected future without-project condition will continue to follow this trend of declination. Without mitigation, this sparse condition of plant life is inadequate in supporting quality habitat and will continue to decline and be threatened.

The restored habitat conditions would support an increased diversity of wildlife and provide linkages with existing riparian habitat downstream of the project site. Riparian areas are important to all wildlife, even if that wildlife does not rely on a riparian system as its home habitat. Riparian systems are especially important in an arid climate because they provide places for animals to eat, drink, and cool off. Migratory songbirds and bats benefit from the native vegetation and insect life available in riparian habitats (England and Laudenslayer, 1995). Riparian corridors provide wildlife a convenient and often more secure means of traveling between areas.

The restored habitats proposed in this project would provide a wide range of environmental and other benefits. The design of the riparian systems would include a stream flow (natural) process to filter out sediments and/or heavy particles, thus improving water quality. The removal of pollution and/or the amelioration of its effects are additional benefits to both humans and wildlife. Vegetation in a riparian system removes and stores nutrients such as nitrogen and phosphorous from water which may otherwise pollute groundwater and surface water. Sediment filtration is another benefit of riparian systems. Removal of these pollutants from river systems, such as the Agua Fria, benefits the entire watershed, and therefore the Gila River downstream may also benefit from this restoration project.

e. Project Outputs.

The proposed project presents an opportunity to rehabilitate a degraded desert riparian corridor to a more natural condition more similar to that which historically existed at the project site. The primary objective is restoration of wildlife habitat through eliminating invasive plant species and reestablishing a viable riparian ecosystem to support target wildlife species. Target species supported by Sonoran riparian scrubland vegetative communities includes high densities of desert cottontail and Gambel's quail, as well as nesting for mourning and white-winged doves if thickets are of sufficient height. Other bird species include the crissel thrasher, Abert's towhee, brown towhee, Say's phoebe and black-tailed gnatcatcher (Brown 1994). Other migratory avian species may also benefit from this project.

The proposed design includes the development of cattail/reed marshes and willow riparian habitats. The marsh areas along the low-flow channel would provide foraging areas and opportunities for both resident and migratory waterfowl as well as a water source for small mammals. This design approach also allows the opportunity for vegetation to remove sediments and excessive nutrients from introduced reclaimed water. Created riparian habitat, particularly willow riparian, would provide cover and nesting habitat for sensitive bird species. Use of the variety of plant communities is expected to increase and add to the overall biological diversity of the study area and surrounding areas.

The proposed project would expand and link to the existing riparian habitats downstream on the Gila River. Linking of these habitats would create a synergy that would make them more diverse and valuable. The restoration would also benefit the surrounding communities and citizens of the Phoenix metropolitan area. The project features of increased vegetation and modifying the bank slope gradient would provide visual enhancements and offer wildlife and environmental interpretive opportunities.

f. Importance of Project Benefits.

Due to the natural scarcity of water in this desert climate, wetland and riparian habitats are particularly valuable to wildlife, playing a critical role in the life cycles of numerous resident and migratory species. Most available natural water sources in the region have been diverted for human use, causing a dramatic decline in natural riparian areas and perennial streams.

The project helps re-establish historic habitat values associated with river corridors in the Avondale area, providing particular benefits for migratory waterfowl, shorebirds, songbirds and small mammals. The proposed project will be to construct groupings of riparian habitats along a portion of the Agua River. As a result of this restoration, the project site would offer increased foraging habitat and nesting opportunities for migrating and resident avian species, as well as small mammals, provide wildlife movement corridors and a linkage at the south end to the Gila River. In addition, restored habitat provides for wildlife and environmental interpretation along the river.

g. Status of Lands, Easements, Right-of-way, Relocations and Disposal Areas (LERRD).

The Flood Control District of Maricopa County, the local sponsor, owns all the properties within the project site. No additional land acquisition will be required for the proposed project.

h. Other Ongoing or Proposed Actions.

The river restoration and habitat enhancements proposed along this segment of the Agua Fria River will complement other local agencies' design visions. The Maricopa Association of Governments' (MAG), is a coalition of the Phoenix metropolitan area governments. MAG has established a Desert Spaces Plan to preserve, protect and enhance the natural resources and open space in Maricopa County (Maricopa Association of Governments, 1995). MAG has identified the Agua Fria River as a conservation area in their Desert Spaces Plan. The project's habitat restoration will also complement the Flood Control District of Maricopa County's West Valley Recreation Corridor concept plan, as well as the City of Avondale's Tres Rios Greenway Specific Plan. Additionally, the Tres Rios Arizona Recreation Component Study prepared in December 1997 supports this restoration plan.

i. Alternatives.

The alternatives developed for this project include variable degrees of meandering of the low-flow channel and variations of terracing and group plantings within the six-mile project area. Design alternatives for terracing along the existing levees may vary with terracing on both sides of the levee to variations of terracing on the channel side (Figure 5).

j. Study Methodology.

An on-site preliminary evaluation determined habitat values to be relatively low due to sparse vegetation and lack of plant diversity in and along the river corridor and the presence of the soil cement levees. Opportunity exists to increase this value. A modified Habitat Evaluation Procedure (HEP) analysis will be completed during the Ecosystem Restoration Report (ERR) phase, in coordination with a team including the Corps, U.S.Fish and Wildlife Service and Arizona Game and Fish.

The HEP will provide information for two general types of wildlife comparisons: 1) the relative value of different areas at the same point in time; and 2) the relative value of the same area at future points in time. By combining the two types of comparisons, the impact of proposed or anticipated land and water use changes on wildlife habitat can be quantified and future conditions and potential values for selected wildlife species can be projected and quantified. The Omart and Anderson Modified HEP model was developed for the Southwest and may be used during this analysis.

4. Consistency Statement.

The proposed project modification is consistent with the flood control purposes of the Agua Fria River, Skunk and Cave Creek Projects, and would not affect the degree of protection provided by these projects. New material for the terraces will not be brought into the channel from outside sources, but will be formed from existing materials inside the channel. The proposed project modification will provide habitat types similar to those that existed prior to straightening of the channel and construction of the levees and urbanization of the area. This will provide restoration of the ecosystem habitat.

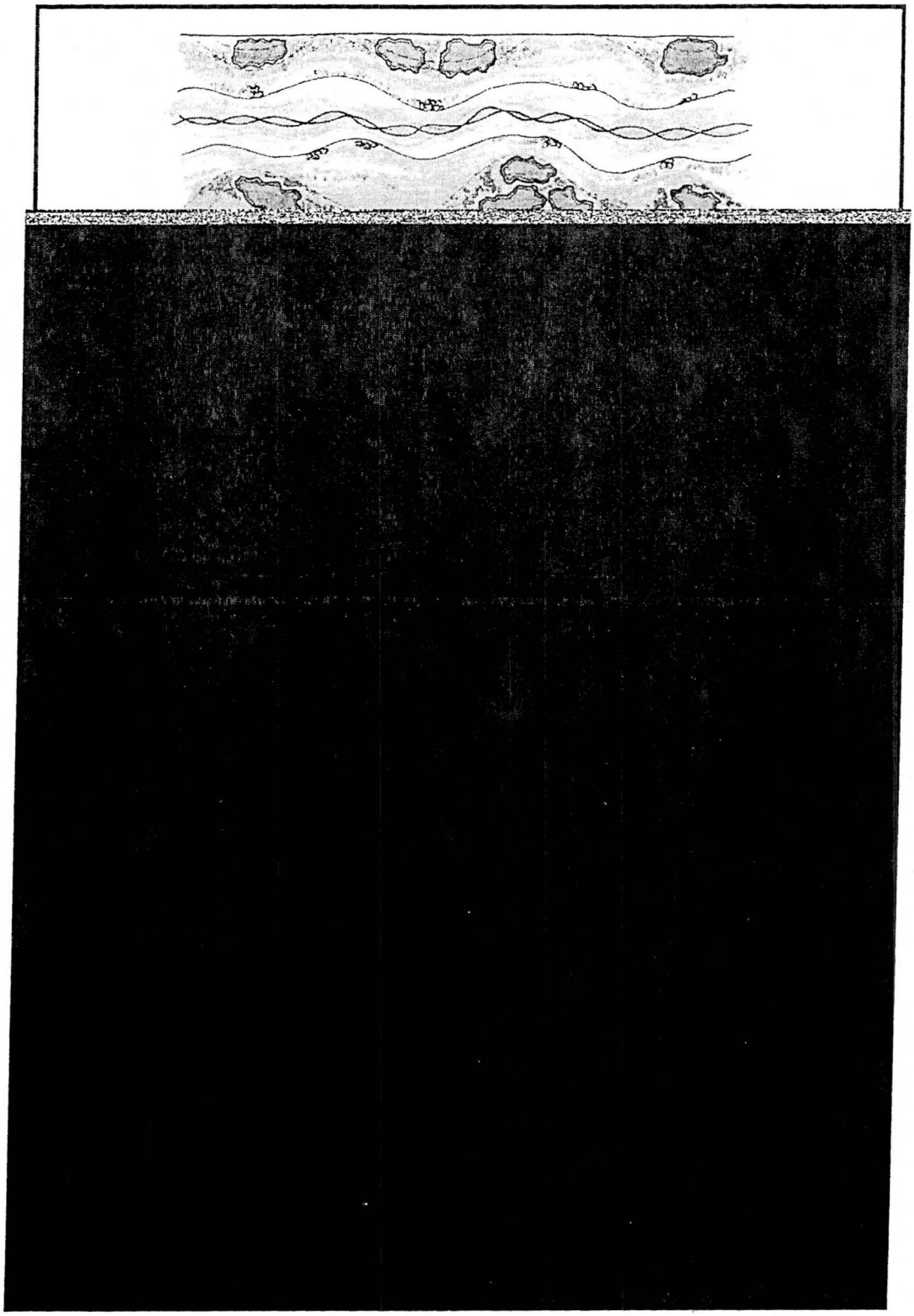


Figure 5

5. Views of Sponsor.

The Flood Control District of Maricopa County and the City of Avondale have expressed interest in providing local sponsor funds for the habitat restoration and channel modifications for this segment of the Agua Fria River. Coordination and field meetings have taken place with the Flood Control District and the City of Avondale.

6. Views of Federal, State and Regional Agencies.

The U.S. Fish and Wildlife Service and the Arizona Department of Game and Fish have been contacted regarding the Agua Fria Restoration Project. The U.S. Fish and Wildlife Service and the Arizona Department of Game and Fish generally support projects that restore and enhance habitat values for native species and/or that remove invasive undesirable non-native species. Coordination with these agencies would continue throughout the development of the project.

7. Status of Environmental Compliance.

An Environmental Assessment (EA) will be prepared in accordance with the National Environmental Policy Act of 1969 (NEPA), as amended and in conjunction with the development of the Ecosystem Restoration Report (ERR). As required by NEPA, all appropriate Federal and State statutes will be complied with, including but not limited to the following: Endangered Species Act (ESA), Fish and Wildlife Coordination Act (FWCA), Clean Water Act (CWA), Clean Air Act (CAA), and National Historic Preservation Act (NHPA). The U.S. Fish and Wildlife Service will be coordinated with pursuant to ESA, to ensure project implementation results in either "no-adverse" or beneficial effects on Federally listed species (potentially) occurring in the project area.

8. Costs and Benefits.

a. Cost / Benefits Analysis.

The project limits of the Agua Fria River considered for restoration is approximately five air miles in length (six river-miles), with a channel width ranging from 1,200 to 2,000 feet. The entire project area includes about 1,000 acres, of which approximately 125 acres will be restored. The implementation cost for the Agua Fria River Riparian Ecosystem Restoration Project is estimated at $6,250,000 dependent upon the availability of water, access to utilities and the extent of grading. Other considerations are the incorporation of environmental interpretive nodes and habitat viewing platforms. These will provide the opportunity for the public to gain an awareness and understanding of the natural systems and processes. However, as previously stated, such elements are considered recreational and, if developed, are formulated separately from the proposed restoration elements.

The primary benefits expected as a result of this project are increased riparian habitat for resident and migratory birds and small mammals. The regrading of the channel will transform the channel from a wide, flat expanse of land which creates a sheet flow of water with rapid evaporation and minimal riparian habitat, to a defined, terraced, desert riverbed which replicates a natural desert wash with lush and frequent riparian habitat.

This alteration in terrain will provide increased opportunity for water to collect and channel in a more concentrated area, promoting a condition more conducive to the proliferation of native vegetation. Riparian vegetation will then be planted and temporarily irrigated to establish and initiate a revegetation process. Once the native desert plantings are established, their nature is to survive and proliferate with the typical annual rainfall and desert riverbed.

b. Institutional and Public Recognition.

The value of riparian habitat is recognized in a variety of documents and plans adopted by the City of Avondale, Maricopa County and the Maricopa Associations of Governments. In many of these agencies plans (as referenced in section, 3 h. Other Ongoing or Proposed Actions), the Agua Fria River is a prime candidate for riparian restoration. The inherent value of riparian ecosystems and biological functions they provide are acknowledged in the following Federal statutes and Executives Orders:

- EC1105-2-214, Project Modifications for Improvement of the Environment and Aquatic Ecosystem Restoration
- Clean Water Act of 1977 (33 U.S.C 1251 et seq., Public Law 92-500)
- Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.)
- Executive Order 11988 Floodplain Management
- Fish and Wildlife Conservation Act of 1980 (16 U.S.C. 2901-2911)
- National Environmental Policy Act of 1969 (42 U.S.C 432- 4347)
- Water Resources Development Act (various Public Laws)

c. Operations and Maintenance, Repair, Replacement Requirement (OMRRR).

The project would need to be monitored at various intervals to evaluate the success of the area as suitable habitat for bird and wildlife species. It is anticipated that operation and management activities associated with the habitat would be primarily related to maintenance of the habitat areas. The success and integrity of the native plant communities will also need to be monitored. It is expected that adjustments in design and operation may be needed in response to changing conditions in the area. Monitoring would also provide information useful for the design and implementation of other ecosystem restoration projects. The following types of monitoring are anticipated to be useful: water quality, bird and bat species surveys and vegetation success.

A major flood event could pose a risk of damage to the project features. Repair of the damage caused as a result of this type of occurrence would not be the responsibility of the Federal Government or the U.S. Army Corps of Engineers. The local sponsor would be responsible for the losses incurred.

The OMRRR requirements for this project may include:

- acquisition of permanent water sources
- removal of non-native invasive plant species, as necessary
- planting of native plant species
- temporary drip irrigation for plant establishment
- cooperation with Arizona Game and Fish for introduction of wildlife species
- maintenance of service roads, interpretive signage and wildlife viewing areas, guard rails and hand rails
- maintenance of terrace and low flow channel
- litter and trash removal

It is estimated that normal routine maintenance would be required at an annual cost of $25,000 for OMRRR. OMRRR costs could vary significantly depending on flood damage, which is difficult to predict.

9. Schedule.

Task	Date
Complete Draft PRP	December 2000
SPL Review & Comments	February 2001
Final PRP to SPD	March 2001
SPD Review	April 2001
Initiate ERR	September 2001
Complete ERR, EA, Draft PCA	September 2002
SPD ERR/PCA Approval	October2002
Initiate Plans and Specs	November 2002
Complete Plans and Specs	May 2003
Execute PCA	June 2003
Advertise for Bids	July 2003
Open Bids	August 2003
Award Construction Contract	September 2003
Initiate Construction	October 2003
Complete Construction	June 2004

10. Financial Data.

a. All costs reflected below, Table 1 is in thousands of dollars (March 2001). Reference Table 2 (ERR Cost Estimate) and Table 3 (Preliminary Construction Cost Estimate) for specific estimated costs to implement the restoration project, in total dollars.

TABLE 1. PROJECT COSTS

(In Thousands of Dollars)	**Total**	**Non-Federal**	**Federal**	**Federal Funding Needs**			
Item				FY	FY+1	FY+2	Balance
ERR	397	0	397	54	343		
Plans & Specs	300	0	300			300	
Construction	5296.6	1498.4	3798.2			100	3698.2
Total	5993.6	1498.4	4495.2	54	343	400	3698.2

Note: Report and Plans and Specifications are initially Federally financed, and costs distributed as part of the non-Federal share of project costs during implementation (construction).

TABLE 2. ECOSYSTEM RESTORATION REPORT (ERR) COST ESTIMATE

Work Element			Estimated Cost	
Planning Management				
	Program Management		$	10,000
	Study Management		$	30,000
	Plan Formulation		$	14,000
	Report Preparation		$	14,000
	Economics		$	10,000
	Real Estate		$	20,000
	PCA Development		$	8,000
	Technical Review (QA/QC)		$	10,000
		Subtotal	$	116,000
Environmental Resources				
	NEPA Analysis & Coordination		$	30,000
	Biological Inventory/Habitat Analysis		$	30,000
	Public Involvement		$	15,000
	Cultural Resources Assessment		$	18,000
	Documentation		$	5,000
	FWS Coordination Act		$	20,000
		Subtotal	$	118,000
Engineering Management				
	Hydrology & Hydraulics		$	85,000
	Engineering & Design		$	30,000
	Surveys & Mapping		$	30,000
	HTRW Studies		$	6,000
	Cost Estimates		$	12,000
		Subtotal	$	163,000
		Total	$	397,000

TABLE 3. PRELIMINARY CONSTRUCTION COST ESTIMATE

Preliminary Construction Cost Estimate				
Item Description	**Quantity**	**Unit**	**Unit Cost**	**Total**
Mobilization / Site Preparation	1	LS	$ 100,000	$ 100,000
Construction Staking	1	LS	$ 10,000	$ 10,000
Excavation /Grading	659,862	CY	$ 5	$ 3,299,308
Interpretive Site Amenities	1	LS	$ 60,000	$ 60,000
Aquatic / Riparian Habitat Restoration	25	AC	$ 2,500	$ 62,500
Terraced Habitat Restoration	100	AC	$ 2500	$ 250,000
Temporary Irrigation System	100	AC	$ 2175	$ 217,500
Establishment	3	YR	$ 25,000	$ 75,000
Subtotal				$ 4,074,308
Construction Observation	1	LS	5%	$ 203,715
Contingency	1	LS	25%	$ 1,018,577
Total			**$**	**$ 5,296,600**

(Note: Costs in this PRP are preliminary and subject to additional review by US Army Corps of Engineers and local sponsors, Flood Control District of Maricopa County and City of Avondale.)

b. Non-Federal Requirements (Estimate)

LERRD	$ 0
Cash	$1,498,400
Work-in-Kind	$ 0
Annual OMRRR	$ 25,000

11. Federal Allocations to Date.

Preliminary Restoration Plan	$10,000
Ecosystem Restoration Report	$54,000
Plans and Specifications	$ 0
Construction	$ 0

12. Supplemental Information. The development of the proposed plan for the ecosystem restoration of a portion of the Agua Fria River was obtained through a planned process that included evaluation of conformance with project goals and objectives, restoration opportunities and constraints and evaluating the feasibility of implementation.

This proposed plan presents the opportunity to explore further a variety of habitat conditions for riparian areas that are valuable to songbirds and other passerine birds. The potential mix of habitat types in this proposed plan offers the opportunity to provide suitable habitat conditions for a wide range of birds and wildlife, while also providing critical support for birds migrating along the Pacific Flyway.

REFERENCES

Bahre, C. J. *A Legacy of Change: Historic Human Impact on Vegetation of the Arizona Borderlands.* University of Arizona Press, Tucson, AZ. 1991

Broscheid, Bob. *Telephone Interview.* Arizona Game and Fish Department. November 20, 2000.

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Brown, D. E., editor. *Biotic communities: Southwestern United States and Northwestern Mexico.* University of Utah Press, Salt Lake City, UT. 1994.

England, A. S., and Laudenslayer, W. F. The California Desert: An Introduction to Natural Resources and Man's Impact, Volume II. *Birds of the California Desert.* 1995.

Richman, Tom, et al. *Start at the Source.* Forbes Custom Publishing, New York. 1999.

Tellman, B., R. Yarde, and M. G. Wallace. *Arizona's Changing Rivers: How People Affected the Rivers.* Water Research Center, College of Agriculture, University of Arizona, Tucson, AZ. 1997.

U.S. Army Corps of Engineers, Los Angeles District, "Hydrologic Evaluation of Impacts of New Waddell Dam on Downstream Peak Discharges in the Agua Fria River." July 1995.

APPENDIX P.

PUBLIC COMMENTS AND RESPONSES

April 17, 2003

William O Butler, SPL
Environmental Resources Branch Department of the Army
Los Angeles District, Corps of Engineers
911 Wilshire Boulevard, 14th Floor
Los Angeles, California 90013-3401

SUBJECT: Review Comments - Draft Detailed Project Report for the Agua Fria River Ecosystem Restoration Project Report - Contract No. DACA09-99-D-003

Dear Mr. Butler,

The City of Avondale (City) and the Flood Control District of Maricopa County (District) appreciates the opportunity to review the subject report. We have attached a document that has detailed comments to the subject report. Additionally, we have the following general comments:

1. Reference City of Avondale and Maricopa County Flood Control has joint non federal sponsors.

RESPONSE: Comment noted and text revised.

2. City of Avondale will provide irrigation water resources from groundwater, effluent water, and/or other water supply sources.

RESPONSE: Comment noted and text revised.

3. Total budget $5,000,000 federal contribution, but allow the local sponsors to increase the local share as needed and as available.

RESPONSE: Comment noted. This is a budgetary matter that can be further defined during preparation of the Project Cooperation Agreement (PCA).

4. The report assumptions that the City will provide groundwater for the project, again effluent or another water supply may be the answer.

RESPONSE: Comment noted. Text revised.

5. The City and the District need to have the O & M issues defined. Such as establishing a safe harbor agreement so that this area can be maintained. Also the City would like the document to include a recommended maintenance plan.

RESPONSE: Comment noted. Operation and Maintenance (O&M) issues will be defined during the next phase of the project and during preparation of the PCA.

6. Who will design and oversee construction? The District and the City of Avondale would like the first rights of refusal for performing the construction management for this project.

RESPONSE: Comment noted. This is not a feasibility phase item and will be further defined in the PCA.

I again appreciate your inclusion of the City and the District to provided comments. If you need any additional information or clarification of our comments, please contract Mr.Gregory L. Jones of the District at 602-506-5537.

Sincerely

Daniel R. Davis

Director Recreation/Community Services
City of Avondale

Attachment

COMMENT NO. RESPONSE	ELEMENT/ SECTION/ PAGE NUMBER	EXISTING DOCUMENT TEXT/TABLE/GRAPHIC MAP	COMMENT/REQUESTED TEXT REVISION
1. TEXT REVISED	Pg ES-1, 3rd paragraph from bottom	The Flood Control District of Maricopa County (FCDMC) is the non-federal co-sponsor of the Agua Fria …..	The Flood Control District of Maricopa County (FCDMC) and the City of Avondale (COA) are the non-federal co-sponsors of the Agua Fria….
2. TEXT REVISED	Pg ES-1, 2nd paragraph from bottom	Based on the findings of the reconnaissance phase, the FCDMC and USACE initiated the feasibility…	Based on the findings of the reconnaissance phase, the FCDMC, COA, and USACE initiated the feasibility…
3. TEXT REVISED	Through out Document	The Durango Channel.	The Durango Regional Outfall Channel.
4. TEXT REVISED	Pg ES-2, 3rd paragraph from bottom	… and stormwater runoff drains.	… and stormwater runoff drains as shown on exhibit ____.
5. TEXT REVISED	Pg 1.1 Project Purpose and Scope	After further discussion between the USACE and the FCDMC, it was…	After further discussion between the USACE, COA and the FCDMC, it was…
6. TEXT REVISED	Pg. 2-4, 2.3 Public concerns and regional needs.	None	Add to bullet list, "Ground water recharge."
7. TEXT REVISED	Pg 2-5, Surface Water Inputs	The project will take advantage of the 3.5 million gallons per day…	1) Has Avondale agreed to this?
8. TEXT REVISED Specifics to be further defined in PCA.	Pg 2-7, Budget and Administrative	The restoration alternatives are limited by the total project cap of $5,000,000….	This statement is incorrect. The co-sponsors may increase the project costs in excess of the COE's dollar limitation provided that the co-sponsor incures 100% of the costs. As a side note the total project cost could be: (75%) 5,000,000.00 COE

COMMENT NO. RESPONSE	ELEMENT/ SECTION/ PAGE NUMBER	EXISTING DOCUMENT TEXT/TABLE/GRAPHIC MAP	COMMENT/REQUESTED TEXT REVISION
			(25%) 1,666,666.66 Co-sponsors. (100%) 6,666,666.66 Total project cost
9. TEXT REVISED	Pg 3-5, 1st paragraph	(Tamarix pentandra)	(Tamarix ramosissima)
10. TEXT REVISED	Pg 3-5, 1st paragraph	(Atriplex cohescens)	(Atriplex canescens)
11. TEXT REVISED	Pg 3-47, 3.3.3.2	Figure 12, and table 3.3-6 provides a partial listing of existing and modified base flood elevation to reflect the…	Figure 12, and table 3.3-6 provides a partial listing of existing and modified base flood elevation (BFE) to reflect the…
12. TEXT REVISED	Pg 3-54, Second Paragraph	It should be noted that the ADEQ estimates that the TMDL process for the Middle Gila River Watershed should be completed between 2000 and 2002.	**It is already 2003…..**
13. TEXT REVISED	Pg 3-57, 1st paragraph	For this road drainage, stormwater sampling is not required under the NPDES permit,..	For this road drainage, stormwater sampling is not required under the current NPDES permit,..
14. TEXT REVISED	Pg- 3-80, 2nd paragraph	, the study area adjoins the eastern edge of the City of Buckeye.	, the study area adjoins the eastern edge of the City of Goodyear.
15. TEXT REVISED	Pg 3-89, 3.14.3	Southern Pacific Railroad (SPRR)	Union Pacific Railroad (UPRR) – change through out document
16. TEXT REVISED	Pg 4-2, Bullet point	Move water from the AWTP to upstream locations. This would be done only in conjunction with potential recharge project undertaken by the City.	Move water from the AWTP to upstream locations. This could be done in conjunction with potential recharge project.
17. TEXT REVISED	Pg 4-2, Bullet point	Divert water from irrigation channels. This world require cooperation from the water district and the City of Phoenix.	Why the City of Phoenix? They do not control the irrigation water in this area.
18. NOTED: to be	Pg 4-3	3:1 slopes (multiple places)	3:1 is very steep. Can this be changed to 4:1 or flatter?

COMMENT NO. RESPONSE	ELEMENT/ SECTION/ PAGE NUMBER	EXISTING DOCUMENT TEXT/TABLE/GRAPHIC MAP	COMMENT/REQUESTED TEXT REVISION
discussed during P&S			
19. TEXT REVISED	Pg 4-4, Consideration 1	…, the project must also maintain the SPF capacity with a minimum of three feet of freeboard.	…, the project must also maintain the SPF capacity with a minimum of three feet of freeboard per COE agreements and/or requirements.
20. NOTED TEXT REVISED	Pg 4.4, Consideration 2, Outcome:	It was considered economically infeasible to move effluent from the AWTP to the upper part of the project reach,….	1. Where is the analysis to justify this statement? 2. Did the consultant factor in any considerations for the addition costs to acquire water rights, CAP water, recharge credits and/or other means to offset the AMA assured water supply requirements? Note, that Avondale will have to account for every gallon pumped and will be a debit to the total CITY water supply since these wells are in the AMA area.
21. TEXT REVISED	Pg. 4-5, Consideration 4		The District and thee City of Avondale in the visioning session indicated that the desire to have all if not most of the propose features protected from the predominate discharge as a consideration. This is not noted or included in text. What was the basis for choosing the 10-to 15-year event?
22. NOTED	Pg 4-5, Consideration 4:, Outcome	The alternatives were redesigned to include riparian strips located along the sides of the channel that would be protected by brems that could withstand a 10 to 15-year flood event.	The District would like to review and comment on the analysis that demonstrated that the 10 to 15-year flood event is the predominate discharge rate.
23. TEXT REVISED	Pg. 4-8, second to last sentence	effect	affect
24. TEXT REVISED	Pg. 4-9 1st paragraph		Should also include the loss of foraging areas due to development of the current agricultural land use.

COMMENT NO. RESPONSE	ELEMENT/ SECTION/ PAGE NUMBER	EXISTING DOCUMENT TEXT/TABLE/GRAPHIC MAP	COMMENT/REQUESTED TEXT REVISION
25. TEXT REVISED	4-12, Final Alternative: Low Water Use, Basic Concept		How can this be a low water use if you are putting in two new wells for use by the project?
26. TEXT REVISED	Pg. 4-14, Placement of Microhabitat Features		Add nesting platforms for large raptors.
29. TEXT REVISED	Pg 4-17, Major Structural and Other Physical Elements		As indicated in comments 21 and 22, how was 10 to 15-year events chosen.
30. TEXT REVISED	Pg 4-17, Major Structural and Other Physical Elements	Thus, the berm would not be continuous along the length of the restoration site so as to allow inflow and outflow of water.	Thus, the berm could be constructed in over-lapping segments along the length of the restoration site to allow the inflow and outflow of water and provide the protection for the flooding events.
31. TEXT REVISED	Pg 4-19, Hydraulic and Hydrologic Considerations		The District would like electronic copies of the "preliminary Draft Hydrology, Hydraulics, and Engineering Analysis" referenced in appendix I. Please provide the Complete HEC Runs to include both electronic and hard copy input and output reports.
32. TEXT REVISED	Pg. 4-23	Baccharis glutinosa	Baccharis
33. TEXT REVISED	Pg. 4-25, Other		Please include other open water ares or creating nesting

COMMENT NO. RESPONSE	ELEMENT/ SECTION/ PAGE NUMBER	EXISTING DOCUMENT TEXT/TABLE/GRAPHIC MAP	COMMENT/REQUESTED TEXT REVISION
	Wildlife Habitat Resources		platforms.
34. NOTED	Pg. 4-26, Primary Construction and Implementation Considerations	Removal of athel tamarich during the first season….	Please consider leaving the athel tamarisk per the District's e-mail.
35. NOTED To Be Discussed during P&S	Pg. 4-27, Well Construction		The District and the City suggests that there should be a contingency plan incase that construction of the two wells is prohibited.
36. TEXT REVISED	Pg 4-29, 4.3.6	The airport exclusion zone also partly determined the southern limit of the I-10 site and the northern limit of the AWTP site.	The airport exclusion zone also influenced the southern limit of the I-10 site and the northern limit of the AWTP site.
37. TEXT REVISED	Pg. 4-30, 2nd to last pargraph		There has been no commitment by Avondale to provide the water supply via wells. Please revise this paragraph to include other options such as supplies from RID and Effluent from AWTP.
38. TEXT REVISED	Pg. 4-31, 1st paragraph		Why is it assumed that their would be no change in the outflow of the 3.5 MGPD of effluent form the AWTP? Water in Arizona is tightly regulated and the use of recharge of this supply will come to fruition.
39. TEXT REVISED	Pg. 4-33		Please provide an cost analysis of well versus effluent.
40. TEXT REVISED	Pg. 4-41, Waterfowl Habitat		Revise statement that indicates that waterfowl would included water depth of less than 10 inches, since some species need a deeper depth that 10 inches.

COMMENT NO. RESPONSE	ELEMENT/ SECTION/ PAGE NUMBER	EXISTING DOCUMENT TEXT/TABLE/GRAPHIC MAP	COMMENT/REQUESTED TEXT REVISION
41. TEXT REVISED	Pg 4-43, Flooding of Conveyance Capacity	.... the majority of the feature remain intact during more frequent events from 10 to 15 years.	.... the majority of the feature remain intact during more predominated discharge event.
42. NOTED	Pg. 4-48, 1st paragraph		This paragraph is in conflict with other paragraphs that assumed that the AWTP would have a consent discharge. This appears to just justify the use of wells and not explore the options of the Effluent and/or irrigation water supplies.
43. TEXT REVISED	Pg. 4-49, Table, 2nd row		Why the 15 year event. What was the justification for it.... Please replace with the "Predominate discharge event".
44. TEXT REVISED	Pg. 4-51, bullet list	Introduction of water from an external City of Avondale well.	Introduction of water from an external City of Avondale well, RID irrigation turnout, and/or effluent from AWTP.
45. TEXT REVISED	Pg. 4-53, 4.7.6		Please fill in the shaded blanks and the following table.
46. NOTED	Pg. 4-55, 4.8.3		Please see comment number "8" on the cost sharing dollars and limitations above and correct this paragraph respectively. (7,612,000 – 5,000,000 = 2,612,000) 7,612,000-6,666,666 = 945,334 add (Cost share) 1,666,666 2,612,000
47. TEXT REVISED	Pg. 5-9, bullet list		Add bullet, Avondale Assured water supply.
48. TEXT	Pg. 5-14, 5.3.8		What about impacts of water recharge?

COMMENT NO. RESPONSE	ELEMENT/ SECTION/ PAGE NUMBER	EXISTING DOCUMENT TEXT/TABLE/GRAPHIC MAP	COMMENT/REQUESTED TEXT REVISION
REVISED			
49.NOTED	Appendices		Please provide color copies. It is impossible to review and comment on color coded exhibits reproduced in B&W.
50.NOTED /REVISED	Pg. A-9		This is at to grow of a scale and hard to locate the project site. The RID is also located on the east side of the Agua Fria River.
51.TEXT REVISED	Pg. A-32 & 34		Why the exposed bank protection/shotcrete? Can this be buried and landscaped?
52.NOTED	Pg. A-26 through A-34		It would be very difficult to indicate what it is that the preferred alternative will look like to the public with these exhibits. Please add an exhibit for each alternative to show the relationship of the proposed cross sections (33 &34) on a "landscaped plan exhibit. Each site should be it's own exhibit for each alternative to reduce the scale for readability.
52.NOTED	Pg. I-14		See comment 31.
53. TEXT REVISED	Pg. I-15, 5.4		Why/what is the justification for selecting the 10 year event?
54. NOTED	Pg. I-17, Last paragraph of Risk analysis		Why would the COE, City, or the District spend 7.6 million dollars with this recommendation by Tetra Tech to design the project to a 100 year event? This entire section misses the mark and needs to be done over. This was to be the justification for the use of the predominate discharge…..
55. TEXT REVISED	Pg. 3-6	State Route (SR) 74 Bridge Crossing	This should be SR 85
56. TEXT REVISED	Pg. 3-16	upper upper sonoran	) redundant

DRAFT

April 18, 2005

Dan Davis
Director of Community/Recreation
City of Avondale
11465 W. Civic Center Drive
Avondale, AZ 85323-6804

Dear Mr. Davis:

The District has compared the list of review comments that were itemized in the May 19, 2003 letter to the COE, against the latest COE draft report (August 2004). Although the COE has addressed the majority of comments, there are a number of important items that need to be included in the report. These comments are listed below. The COE has the option of addressing both District and City concerns in a number of ways. Edits to the August 2004 report can be made by either editing the existing text, or adding an addendum to the report listing the comments.

Also, there are a number of general issues that aren't fully addressed in the final draft report or in your 4/14/05 letter to the COE that are addressed under Issues below. The District recommends the City address these points with the COE prior to and/or during the Design process.

Issues:

Surface Water Inputs

The City of Avondale will provide irrigation water resources from groundwater, effluent water, and/or other water supply resources. However, what is the required quantity that the City will need to agree to contribute, and will the City get credit for this commitment.

RESPONSE: The quantity of water required to establish and sustain the restoration project is dependent upon the alternative selected. Estimated quantities of water required are presented in Chapter 4 of the Draft Detailed Project Report (DPR). Construction of the water conveyance system would be cost shared; however Operation and Maintenance of the project, which includes water is generally not a cost shared item.

Budget and Administration

There are numerous inconsistencies in the text regarding funding,
"The restoration alternatives are limited by the total project of $5M". This statement is incorrect. The co-sponsors may increase the project costs in excess of the COE's

dollar limitation provided that the co-sponsor incurs 100% of the costs. Cost share cap is $1,666,666, not $1,250,000.
RESPONSE: Comment noted. The Federal cost is limited to a maximum of $5M.

Additionally, The City of Avondale and the District would request that a funding commitment be provided by COE that illustrates when the Federal share of funding will be available for the project.
RESPONSE: The Project Cooperation Agreement (PCA), which is required prior to the commencement of Construction, will stipulate the financial obligations and commitments of both parties to the project. In addition, Section 4.8.1 of the DPR describes the mechanisms for Federal construction funding.

Public Meetings
The local sponsors have requested that the COE perform a public information outreach effort. There are no public meetings in any versions of the report, and the local sponsors are not aware of any occurring.
RESPONSE: The Draft DPR will be circulated for a 30-day public review and comment period. Additionally, the Corps has agreed to participate in public meetings, which the local sponsors have agreed to schedule and coordinate.

Implementation Schedule
The City of Avondale and the District would like a time schedule from COE regarding the project. A critical path schedule with dates of completion and specific deliverables is desired. The schedule in the report should also include all required and planned public meetings and needs to be updated. Table 4.8.1 (pg 4-61) is not realistic and will require revisions.
RESPONSE: Comment noted. Table 4.8.1 has been revised. Scheduling of public meeting(s) will require coordination with the local sponsor(s) prior to updating the text in the DPR.

Construction Management

The City of Avondale and Flood Control District would like the first right of refusal for performing the construction management of this project. This would include the option to use alternative construction methods such as, Design/Build Construction.
RESPONSE: Comment noted. Such discussion is beyond the scope of the DPR and should be addressed during the development of the PCA.

Operations and Maintenance
The City and the District need to have the Operational and Maintenance issues defined. A Safe-Harbor provision should be developed that establishes the base-line conditions at the completion of the capital improvement project. In addition, a recommended maintenance plan should be provided by COE to insure compliance to all required guidelines.
RESPONSE: As Section 4.7.5 of the draft DPR describes, a Monitoring and Adaptive Management Plan would be developed during the Plans & Specifications phase of

the project. Operation and Maintenance issues will be further defined in the PCA. A safe-harbor agreement is beyond the scope of the feasibility phase of the project.

The Following are Recommendations that should amend the plan/project:

1. Athel tamarisk and Tree tobacco
   Flag and preserve Athel tamarisk and Tree tobacco in the project area. These plants do not need to be removed from the project area.
   RESPONSE: Comment noted. The document will be revised.

2. Bird Monitoring
   The Sonoran Audubon chapter is already conducting IBA (Important Bird Area) surveys for the Tres Rios project, the Rio Salado project and IBA designation on the Agua Fria National Monument. They should be the lead group to monitor this area as well. They have the nationally accepted data forms, protocols, and training workshops in place to handle this task. (From July 2004 Report Draft "Birds" pg 4-66).
   RESPONSE: Comment noted.

   Where raptors are known or noted roosting or using electric towers, the towers should be outfitted with anti-electrocution devices if not already so outfitted. Have SRP and/or APS already been in the loop on this?
   RESPONSE: Comment noted.

3. Hydraulic and Hydrologic Considerations
   Prior to the final Design District would like to review the complete HEC runs.
   RESPONSE: Comment noted.

4. Graphics
   In general the graphics associated with the report are hard to read and difficult to identify the project features. Additionally, please put all features referred to in the text on all maps. For example, "Coldwater Park" should be shown on all maps.
   RESPONSE: Comment noted.

General Comments:
RESPONSE: Comments noted. The text will be revised.

1. The entire river is part of the Pacific-Intermountain West Flyway, not just at the confluence with the Gila River.
2. Revise statement that indicates that habitat for waterfowl would include water depth of less than 10 inches; need to accommodate those species that need deeper depth than 10 inches.
3. Change "Brown towhee" to "**Canyon** towhee" (same Latin names).
4. Correct (Brittlebush) spelling to Encelia farinos**a**.
5. Correct (Creosotebush) spelling to Larrea tridentat**a**.

6. Tree tobacco (Nicotiana glauca) is considered naturalized in Arizona (having been here pre-Anglo settlement) so should be noted with "N" not "E".
7. Correct name to **Checkered** garter snake (Thamnophis marcianus); uncommon and a species of concern.
8. Lowland leopard frogs are uncommon and a species of concern.
9. Correct (Mourning dove) name to "Zenaida **macroura**".
10. Correct (Red-tailed hawk) name to "Buteo **jamaicensis**".
11. Swainson's hawk is migratory, not resident.
12. Western meadowlark (in our area) is migratory, not resident.
13. Killdeer is resident.
14. Great blue heron is resident (and common).
15. White-faced ibis is migratory, not resident.
16. Western snowy plover is an extreme rarity in migration and should be removed from this chart.
17. Fulvous whistling duck is a rarity in migration and should be removed from this chart.
18. Correct name to **Common** black hawk.

If you need any additional information or have any questions please call me at 602-506-5537.

Sincerely,

Gregory L. Jones
Regional Planning Manager
Flood Control District of Maricopa County

Community / Recreation Services
11465 W CIVIC Center Drive #
Avondale, Arizona 85
Phone (623) 478-3050
Fax (623) 478-
Website WWW.avondale

May 27, 2005

MAYOR Ronald
J Drake

VICE MAYOR
Betty S Lynch

COUNCIL MEMBERS
Albert Carroll, Jr Jason
M Earp Marie Lopez
Rogers Raymond H
Shuey Charles M Wolf

CITY MANAGER
Charles McClendon

Department of the Army
U.S. Army Corps of Engineers
P.O. Box 532711
Room 1430, Planning Division
Los Angeles, CA 90053-2325

ATTN: Kirk Brus

SUBJ: Review Comments -Draft Project Report for the Agua Fria River Restoration Project -Contract No. DACA09-99-D-003

Dear Mr. Brus:

The City of Avondale ("City") and the Flood Control District of Maricopa County ("District") have reviewed the referenced draft report dated July 2004. In a letter dated May 19,2003, detailed comments were submitted regarding the subject report. The supplemental report appears to address those listed items. Additionally, we have the following general comments:

1. The City of Avondale will provide irrigation water resources from groundwater, effluent water, and/or other water supply resources.

2. The City and the District need to have the Operational and Maintenance issues defined. A Safe-Harbor provision should be developed that establishes the base-line conditions at the completion of the capital improvement project. In addition, a recommended maintenance plan should be provided by COE to insure compliance to all required guidelines.

3. The City of Avondale and Flood Control District would like the first right of refusal for performing the construction management of this project. This would include the option to use alternative construction methods such as, Design/Build Construction.

4. The City of Avondale and the District would like a time schedule from COE regarding the project. A critical path schedule with dates of completion and specific deliverables is desired. This schedule should also include all required and planned public meetings.

5. The City of Avondale and the District would request that a funding commitment be provided by the COE that illustrates when the Federal share of funding will be available for the project.

In addition, there are a number of general issues that were raised by Maricopa County Flood Control District and not fully addressed in the final draft. These items are summarized below:

Surface Water Inputs

The City of Avondale will provide irrigation water resources from groundwater, effluent water, and/or other water supply resources. However, what is the required quantity that the City will need to contribute, and will the City get credit for this commitment?

Budget and Administration

There are numerous inconsistencies in the text regarding funding,
"The restoration alternatives are limited by the total project of $5M". This statement is incorrect. The co-sponsors may increase the project costs in excess of the COE's dollar limitation provided that the co-sponsor incurs 100% of the costs. Cost share cap is $1,666,666, not $1,250,000.

Additionally, The City of Avondale and the District would request that a funding commitment be provided by COE that illustrates when the Federal share of funding will be available for the project

Public Meetings

The local sponsors have requested that the COE perform a public information outreach effort. There are no public meetings in any versions of the report, and the local sponsors are not aware of any occurring.

Implementation Schedule

The City of Avondale and the District would like a time schedule from COE regarding the project. A critical path schedule with dates of completion and specific deliverables is desired. The schedule in the report should also

include all required and planned public meetings and needs to be updated. Table 4.8.1 (pg 4-61) is not realistic and will require revisions.

Construction Management

The City of Avondale and Flood Control District would like the first right of refusal for performing the construction management of this project. This would include the option to use alternative construction methods such as, Design/Build Construction.

Operations and Maintenance

The City and the District need to have the Operational and Maintenance issues defined. A Safe-Harbor provision should be developed that establishes the base-line conditions at the completion of the capital improvement project. In addition, a recommended maintenance plan should be provided by COE to insure compliance to all required guidelines.

The Following are Recommendations that should amend the plan/project:

1. Athel tamarisk and Tree tobacco

   Flag and preserve Athel tamarisk and Tree tobacco in the project area. These plants do not need to be removed from the project area.

2. Bird Monitoring

   The Sonoran Audubon chapter is already conducting IBA (Important Bird Area) surveys for the Tres Rios project, the Rio Salado project and IBA designation on the Agua Fria National Monument. They should be the lead group to monitor this area as well. They have the nationally accepted data forms, protocols, and training workshops in place to handle this task. (From July 2004 Report Draft "Birds" pg 466)

   Where raptors are known or noted roosting or using electric towers, the towers should be outfitted with anti-electrocution devices if not already so outfitted. Have SRP and/or APS already been in the loop on this?

3. Hydraulic and Hydrologic Considerations

   Prior to the final Design District would like to review the complete HEC runs.

4. Graphics

In general the graphics associated with the report are hard to read and difficult to identify the project features. Additionally, please put all features referred to in the text on all maps. For example, "Coldwater Park" should be shown on all maps.

General Comments:

1. The entire river is part of the Pacific-Intermountain West Flyway, not just at the confluence with the Gila River.
2. Revise statement that indicates that habitat for waterfowl would include water depth of less than 10 inches; need to accommodate those species that need deeper depth than 10 inches.
3. Change "Brown towhee" to "Canyon towhee" (same Latin names).
4. Correct (Brittlebush) spelling to Encelia farinosa.
5. Correct (Creosote bush) spelling to Larrea tridentata.
6. Tree tobacco (Nicotiana glauca) is considered naturalized in Arizona (having been here pre-Anglo settlement) so should be noted with "N" not "E".
7. Correct name to Checkered garter snake (Thamnophis marcianus); uncommon and a species of concern.
8. Lowland leopard frogs are uncommon and a species of concern.
9. Correct (Mourning dove) name to "Zenaida macroura".
10. Correct (Red-tailed hawk) name to "Buteo jamaicensis".
11. Swainson' s hawk is migratory, not resident.
12. Western meadowlark (in our area) is migratory, not resident.
13. Killdeer is resident.
14. Great blue heron is resident (and common).
15. White-faced ibis is migratory, not resident.
16. Western snowy plover is an extreme rarity in migration and should be removed from this chart.
17. Fulvous whistling duck is a rarity in migration and should be removed from this chart.
18. Correct name to Common black hawk.

If you need any additional information or have any questions, please feel free to contact me 623-478-3051.

Sincerely,

Daniel R. Davis, Director
Community/Recreation Services

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APPENDIX Q

FACT SHEET

Division: South Pacific
District: Los Angeles

Date: 30 August 2007

Agua Fria Riparian Restoration Project

Section 1135 Ecosystem Restoration Project

DPR FACT SHEET

Current Status: Final Report at SPD. Seek and await Final DPR approval.

1. Project Data:

a. Project Name: Agua Fria Riparian Restoration Section 1135 Ecosystem Restoration Project, Avondale, Maricopa County, Arizona

b. Congressional Delegation:

(i) Senator John S. McCain (R - AZ)
(ii) Senator Jon Kyl (R-AZ)
(iii) Representative Ed Pastor, (D – AZ)
(iv) Representative John Shadegg (R- AZ)

c, Official Name of the Project Being Modified. Skunk Creek and New and Agua Fria Rivers (Arizona Canal Diversion Channel to the Gila River)

d. Date constructed: The bank protection project was completed in 1987 and was cost-shared between the U.S. Army Corps of Engineers and the Flood Control District of Maricopa County, Arizona.

e. Authorized purposes of project being modified: Flood Control. .

2. Location: The proposed project is located in the City of Avondale, in the southwestern region of the Phoenix metropolitan area. The proposed project involves approximately 5 air miles (6 river miles) along the Agua Fria River, extending southward to the confluence of the Gila River.. Within this reach of the River, the width varies from approximately 1200' at its narrowest areas at the northern end of the project site, to roughly 2500' at its widest reaches at the southern portion.

3. Description of Proposed Project:

a. Project Features: During the early 1900's, what was once a densely vegetated and meandering riparian channel corridor was channelized for flood control with high, steep, stabilized levees of soil-cement that allowed minimal plant growth. The proposed project entails regrading to transform the channel from a wide, flat land expanse that creates a sheet flow of water, with rapid evaporation and minimal riparian habitat, into a defined, terraced, desert riverbed that replicates a natural desert wash with lush and frequent riparian habitat. The estimated total project area is approximately 1,000 acres, for an increase in 41 habitat units. .

b. Expected Outputs: The proposed project presents an opportunity to rehabilitate a degraded desert riparian corridor to a condition more similar to that which historically existed at

the project site. The primary objective is restoration of wildlife habitat through eliminating invasive plant species and reestablishing a viable riparian ecosystem to support target wildlife species. Target species supported by Sonoran riparian scrubland vegetative communities include desert cottontail and Gambel's quail, as well as mourning and white-winged doves. The proposed design includes the development of cattail/reed marshes and willow riparian habitats, and would expand and link to the existing riparian habitats downstream on the Gila River. Linking of these habitats would create a synergy that would make them more diverse and valuable. The restoration would also benefit the surrounding communities and citizens of the Phoenix metropolitan area. The project features of increased vegetation and modifying the bank slope gradient would provide visual enhancements and offer wildlife and environmental interpretive opportunities.

c. Importance of Project Benefits. Due to the natural scarcity of water in this desert climate, wetland and riparian habitats are particularly valuable to wildlife, playing a critical role in the life cycles of numerous resident and migratory species. Most available natural water sources in the region have been diverted for human use, causing a dramatic decline in natural riparian areas and perennial streams. The project helps re-establish historic habitat values associated with river corridors in the Avondale area, providing particular benefits for migratory waterfowl, shorebirds, songbirds and small mammals. As a result of this restoration, the project site would offer increased foraging habitat and nesting opportunities for migrating and resident avian species, as well as small mammals, provide wildlife movement corridors and a linkage at the south end to the Gila River. In addition, restored habitat provides for wildlife and environmental interpretation along the river.

4. Views of Sponsor: The local sponsors, the Flood Control District of Maricopa County and the City of Avondale, fully support the proposed action and have been active participants in DPR and EA development and coordination since the project's inception.

5. Views of Federal, State and Regional Agencies: Resource agencies and other public entities have conveyed their support of the project at meetings and in informal comments. Information provided was integral to the plan formulation process and contributed to development and selection of the recommended plan. The river restoration and habitat enhancements proposed along this segment of the Agua Fria River will complement other local agencies' design visions. The Maricopa Association of Governments' (MAG), is a coalition of the Phoenix metropolitan area governments. MAG has established a Desert Spaces Plan to preserve, protect and enhance the natural resources and open space in Maricopa County (Maricopa Association of Governments, 1995). MAG has identified the Agua Fria River as a conservation area in their Desert Spaces Plan. The project's habitat restoration will also complement the Flood Control District of Maricopa County's West Valley Recreation Corridor concept plan, as well as the City of Avondale's Tres Rios Greenway Specific Plan. Additionally, the Tres Rios Arizona Recreation Component Study prepared in December 1997 supports this restoration plan. The U.S. Fish and Wildlife Service and the Arizona Department of Game and Fish generally support projects that restore and enhance habitat values for native species and/or that remove invasive undesirable non-native species. Coordination with these agencies would continue throughout the development of the project.

6. Environmental and Regulatory Compliance Requirements: An Environmental Assessment (EA) has been prepared in accordance with the National Environmental Policy Act (NEPA) of 1969 and integrated with development of the DPR. Public review comments received were addressed by the Corps and incorporated in the EA,. The EA has been finalized with a Finding of No Significant Impacts (FONSI). All appropriate Federal and State statutes will be complied with to include Endangered Species Act (ESA), Fish and Wildlife Coordination Act (FWCA), the Clean Water Act (CWA), Clean Air Act (CAA) and the National Historic Preservation Act (NHPA).

7. Costs and Benefits & future OMRR&R: The implementation cost of the proposed project is estimated at $. This includes preparation of the DPR, planning, design and construction. OMRR&R requirements will be included for the first two years as part of design and construction costs at an estimated average annual cost of $ 129,186.

8. Implementation Schedule and Costs:

	Totals	Federal	Non-Federal	Federal Funding Needs Only			
				CFY	FY+1	FY+2	Balance
DPR	$ 413,500	$ 413,500	-	$ 0	$ 0	$ 0	$ 0
Plans and Specs	$ 446.200	$ 446,200,	-	$ 0	$ 446.2000	$ 0	$ 0
Construction	$ 5,465,500	$	$0	$ 0	$ 5,465,500	$ 0	$ 0
Totals	$ 6.325.200	$ 4,743,900	$ 1,581,300	$ 0	$ 5,911,700	$ 0	$ 0

Non-Federal Requirements:
LERRD: $ 0 (project on land owned by Flood Control District of Maricopa County))
Cash: $
Work-in-kind $
Annual OMRR&R: $ 129,166 (City of Avondale and MCFCD responsibility after second year)

FEDERAL ALLOCATIONS TO DATE:

Preliminary Restoration Plan:	$ 10,000
Detailed Project Report:	$ 403,400
Plans and Specifications:	$ 0
Construction:	$ 0

9. Supplemental Information: The schedule and costs of design and construction may vary depending on alternative contracting options to include use of a design-build or hub-zone contracting vehicle.. These revisions are not expected to be significant.

APPENDIX R

Section 404 Jurisdictional Delineation for Agua Fria River

CESPL-CO-RA March 6, 2007

MEMORANDUM FOR Nedenia Kennedy Los Angeles District

SUBJECT: Jurisdictional Delineation for Agua Fria River
Regulatory File #SPL-2007-00142-SDM

A preliminary jurisdictional delineation has been performed for the Agua Fria River, between Interstate 10 and the confluence with the Gila River, Maricopa County, Arizona (Sections 2, 11, 14, 22, 23 and 27, T1N, R1W). The study area is approximately 5 miles long.

This is a preliminary, planning level jurisdictional delineation. The Agua Fria River within the study area is primarily an ephemeral watercourse. A preliminary calculation shows that approximately 1,000 acres of jurisdictional waters occur within the study area. It is possible, but unlikely that any wetlands occur within the study area. Due to the preliminary nature of this jurisdictional delineation decision, no estimate of jurisdictional waters can be made. Further field work and/or research could identify wetlands within the study area. This preliminary jurisdictional determination will remain in effect for five years from the date of this memorandum unless an unusual flood event occurs. After this five-year period or after an unusual flood event alters stream conditions, the Corps of Engineers reserves the authority to retain the original jurisdictional limits or to establish new jurisdictional limits as conditions warrant.

The Agua Fria River is tributary to the Gila River. The Gila River is tributary to the Colorado River, which is an interstate, navigable waterway. The Section 404 jurisdictional limit for a water of the United States is defined at 33 CFR 328. The jurisdictional limit for a non-tidal water of the United States is determined by the jurisdictional wetland boundary and/or the ordinary high water mark. The presence of the indicators stated in the definition of ordinary high mark (33CFR 328.3(e)) are used to establish the jurisdictional limit of a water of the United States. This preliminary jurisdictional delineation is based on the following:

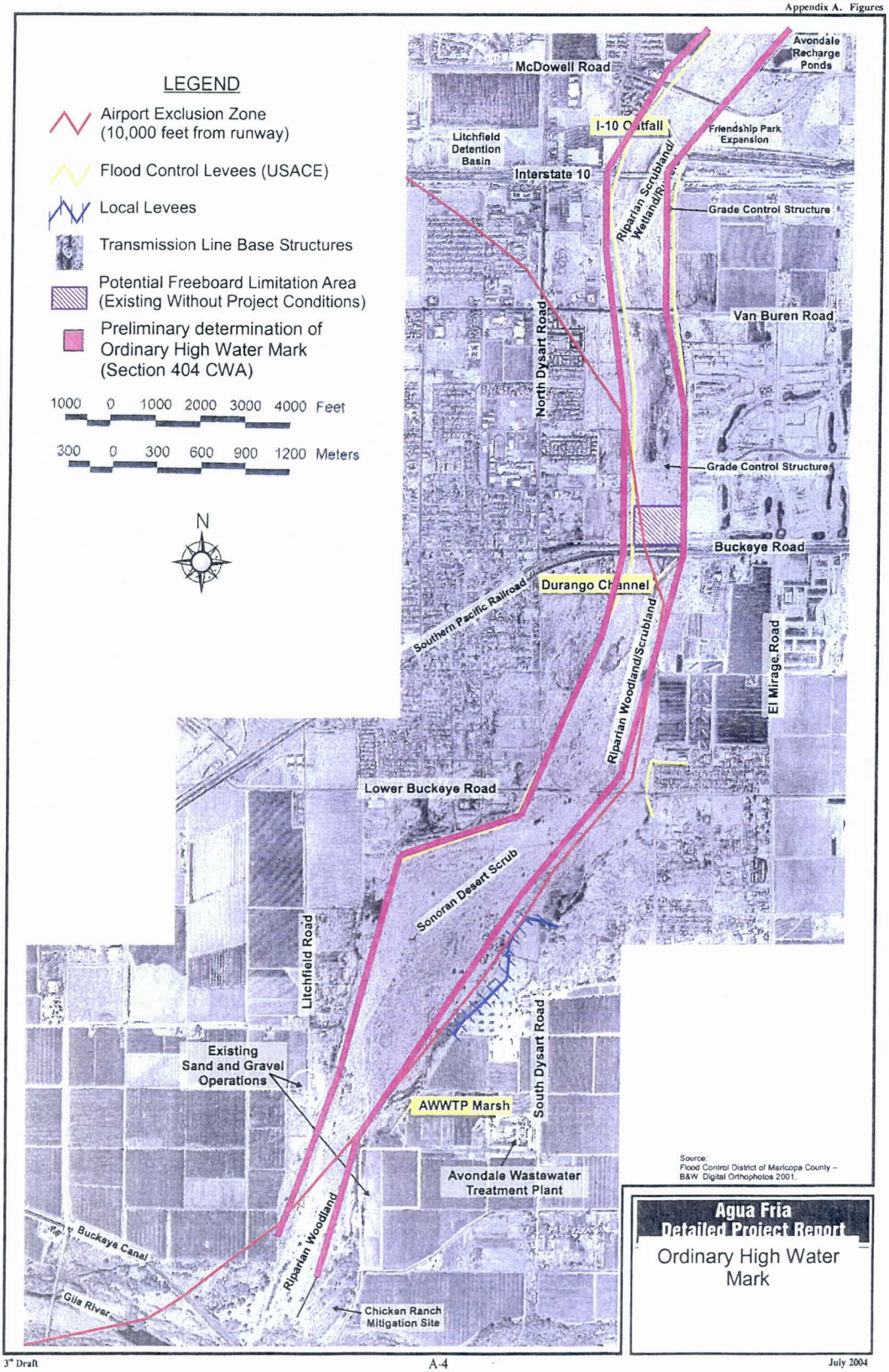
- Aerial photography interpretation: The location of the ordinary high water mark was based on the appearance of scoured areas (i.e. areas that do not show any vegetation on the aerial photo). Other areas that supported some limited vegetation (as interpreted from the aerial photo) were included within the ordinary high water mark.
- Phoenix Metropolitan Street Atlas, 2002 Edition, Phoenix Mapping Service
- Aerial photos dated 2005 obtained from the Maricopa County assessor's office website: www.maricopa.gov/Assessor/GIS/Maps/assessor.mwf. These photos also indicated the delineated floodway in the project area.
- Staff knowledge of precipitation and fluvial dynamics of the region: Senior Project Manager has over 9 years experience in the Arizona Regulatory office. During this time she has performed over 400 jurisdictional delineations in Arizona's ephemeral systems, many of which included field work.

Additional information which could affect the determination of jurisdiction in the Agua Fria River is pending guidance interpreting the June 19, 2006 Supreme Court decision in the

Rapanos and Carabell cases (the decision may be viewed at the following website: http://www.supremecourtus.gov/opinions/05pdf/04-1034.pdf). The Corps and EPA are preparing joint guidance in response to this decision. It is unknown when the guidance will be issued. When the guidance becomes available, this preliminary jurisdictional delineation should be reviewed to ensure compliance with the guidance.

Sallie McGuire

Sallie D. McGuire
Project Manager


LEGEND
Airport Exclusion Zone (10,000 feet from runway)
Flood Control Levees (USACE)
Local Levees
Transmission Line Base Structures
Potential Freeboard Limitation Area (Existing Without Project Conditions)
Preliminary determination of Ordinary High Water Mark (Section 404 CWA)
1000 0 1000 2000 3000 4000 Feet
300 0 300 600 900 1200 Meters
N
McDowell Road
Avondale Recharge Ponds
Litchfield Detention Basin
I-10 Outfall
Friendship Park Expansion
Interstate 10
Riparian Scrubland/Wetland/Riparian
Grade Control Structure
Van Buren Road
North Dysart Road
Grade Control Structure
Buckeye Road
Durango Channel
Southern Pacific Railroad
Riparian Woodland/Scrubland
El Mirage Road
Lower Buckeye Road
Sonoran Desert Scrub
Litchfield Road
Existing Sand and Gravel Operations
AWWTP Marsh
South Dysart Road
Avondale Wastewater Treatment Plant
Buckeye Canal
Gila River
Riparian Woodland
Chicken Ranch Mitigation Site
Source:
Flood Control District of Maricopa County – B&W Digital Orthophotos 2001.
Agua Fria Detailed Project Report
Ordinary High Water Mark