SUPPLEMENTAL WATERSHED PLAN AND ENVIRONMENTAL ASSESSMENT FOR THE

FLORENCE FLOOD RETARDING STRUCTURE
Pinal County, Arizona

FINAL

Prepared by:

Florence Area Watershed Flood Control District
Florence-Coolidge Natural Resource Conservation District

Assisted by:

United States Department of Agriculture
Natural Resources Conservation Service

and Tetra Tech, Inc.

February 2007

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Final

SUPPLEMENTAL WATERSHED PLAN AND ENVIRONMENTAL ASSESSMENT for the Florence Flood Retarding Structure Pinal County, Arizona February 2007

The Florence Flood Retarding Structure (FRS) was constructed by the Soil Conservation Service (now the Natural Resources Conservation Service) in 1965 under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566), as amended. It is currently owned and maintained by the Florence Area Watershed Flood Control District (FAWFCD). The five-mile-long, 24-foot-high earthen FRS provides flood protection to the Town of Florence and surrounding areas. It lies just east of the Central Arizona Project Canal and generally parallels the alignment of the canal. The Florence FRS is nearing the end of its original 50-year project lifetime. This Supplemental Watershed Plan and Environmental Assessment (Plan/EA) determines the feasibility of rehabilitating the Florence FRS to provide for continued flood protection to downstream residences, public facilities and agricultural fields while meeting dam safety requirements for the NRCS and the Arizona Department of Water Resources (ADWR). This supplemental document has been prepared under the authority of the Watershed Protection and Flood Prevention Act, Public Law 83-566, as amended, the Watershed Protection and Flood Prevention Act of 1954, and as further amended by Section 313, Public Law 106-472, and in accordance with Section 102(2)(c) of the National Environmental Policy Act of 1969, Public Law 91-190, as amended (42 U.S.C. 4321 et seq).

Prepared by: Florence Area Watershed Flood Control District
Florence-Coolidge Natural Resource Conservation District

Assisted by: United States Department of Agriculture
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Supplemental Watershed Agreement No. 3
Florence Flood Retarding Structure

Florence Area Watershed Flood Control District (FAWFCD)

Florence-Coolidge Natural Resource Conservation District (FCNRCD)

(referred to herein as sponsors)

State of Arizona

and the

United States Department of Agriculture
Natural Resources Conservation Service
(Referred to herein as NRCS)

Whereas, the U.S. Soil Conservation Service (SCS) built the Florence Flood Retarding Structure (FRS) (Arizona State ID Number 11.06) in 1965 under the authority of the Watershed Protection and Flood Prevention Act (Public Law 83-566), as amended, and known as the Florence Area Watershed Protection and Flood Prevention Project; and

Whereas, it has become necessary to modify said Florence Area Watershed Protection and Flood Prevention Project and agreement; and to extend the effective life for said Florence FRS beyond its previously evaluated life; and

Whereas this document is being prepared under the authorities of The Watershed Protection and Flood Prevention Act (Public Law 83-566) as amended by the Watershed Rehabilitation Amendments (Public Law 106-472); and

Now, therefore, in view of the foregoing considerations, the Secretary of Agriculture, through NRCS and the sponsors hereby agree on this rehabilitation plan for the Florence FRS Project, and that the works of rehabilitation will be evaluated with consideration of a useful life of 100 years and thus the term of this Agreement cover the term of the useful life. The works of improvement for this rehabilitation project will be installed, operated, and maintained in accordance with the terms, conditions, and stipulations provided for in this rehabilitation watershed plan and including the following:

1. The sponsors will acquire all land rights, easements, or right-of ways as will be needed in connection with the works of improvement.

2. The sponsors hereby agree that they will comply with all of the policies and procedures of the Uniform Relocation Assistance and Real Property Acquisition Policies Act (42 U.S.C. 4601 et. seq. as implemented by 7 C.F.R. Part 21) when acquiring real property interests for

this Federally assisted project. If the sponsors are legally unable to comply with the real property acquisition requirements of the Act, they agree that, before any Federal financial assistance is furnished, it will provide a statement to that effect, supported by an opinion of the chief legal officer of the state containing a full discussion of the facts and law involved. This statement may be accepted as constituting compliance. In any event, the sponsors agree that they will reimburse owners for necessary expenses as specified in 7 C.F.R. 21.1006(c) and 21.1007. The sponsors and NRCS will share the costs of relocation payments in connection with the displacements under the Uniform Act as follows:

	Sponsors	**NRCS**	**Estimated Relocation Payment Costs**
	35%	65%	
Relocation Payment	$0	$0	$0

3. The sponsors will be responsible for the costs of water, mineral, and other resource rights and will acquire or provide assurance that landowners or resource users have acquired such rights pursuant to state law as may be needed in the installation and operation of the works of improvement. The costs associated with the subject rights are not eligible as part of the sponsors' cost-share requirement.

4. The sponsors will obtain all necessary Federal, state, and local permits required by law, ordinance, or regulation for installation of the works of improvement. The cost of such permitting is not eligible as part of the sponsors' cost-share requirement.

5. Only eligible service performed and landrights acquired by the sponsors after November 9, 2000 (date of enactment of PL-106-472), may be credited to the sponsors' cost-share requirement.

6. The percentages of cost-share include construction, engineering services, relocation, land rights, integral land treatment, and project administration. The amount of Federal funds that may be made available for rehabilitation shall be equal to 65 percent of the total rehabilitation costs, but shall not exceed 100 percent of the actual construction costs incurred in the rehabilitation. The sponsors shall be responsible for the non-Federal share of the cost of the rehabilitation project. The value of in-kind contributions provided by non-Federal entities may be credited to the sponsors when determining the total cost of the rehabilitation project and the 35 percent cost-share requirement. The sponsors will not receive cash reimbursement for in-kind contributions that exceed the 35 percent cost- share amount. The actual rehabilitation cost share in consideration of the sponsors in-kind contributions are shown as follows:

Works of Improvement	NRCS	Sponsors	Total
Cost Sharable Items			$0
Rehabilitation of Dam (Construction Costs)	$10,502,400	$4,369,000	$14,871,400
Relocation, Replacement-In-Kind			$0
Sponsors Planning Costs	NA		$0
Sponsors Engineering Costs	NA		$0
Sponsors Project Administration	NA		$0
Land Rights Acquisition Cost	NA	$622,500	$622,500
Kelvin Road and Utility Relocation Costs	NA	$663,800	$663,800
Subtotal: Cost-Share Costs	$10,502,400	$5,655,300	$16,157,700
Cost-Share Percentages [a/]	65.0%	35.0%	100.0%
Non Cost-Sharable Items [b/]			
NRCS Engineering & Project Administration	$1,552,200	NA	$1,552,200
Natural Resource Rights	NA	$0	$0
Federal, State and Local Permits	NA	$0	$0
Relocation, Beyond Required Decent, Safe, Sanitary	NA	$0	$0
Subtotal: Non Cost-Share Costs	$1,552,200	$0	$1,552,200

[a/] Maximum NRCS cost-share is 65% of Cost-Sharable Items not to exceed 100% of Construction Costs (including Replacement-in-Kind; Required Decent, Safe, Sanitary; and flood proofing of downstream properties).

[b/] If actual Non Cost-Sharable Item expenditures vary from these figures, the responsible party will bear the change.

7. The sponsors will be responsible for the operation, maintenance, and any needed replacement of the works of improvement by actually performing the work or arranging for such work, in accordance with agreements to be entered into before issuing invitations to bid for construction work. The sponsors will obtain agreement with landowners or operators to operate and maintain the land treatment practices for the protection and improvement of the watershed. The sponsors will provide leadership for the preparation of an Emergency Action Plan prior to construction and will update it annually.

   A new O&M agreement effective for the life of the installed measures will be developed for the Florence FRS and associated measures utilizing the NRCS National Operation and Maintenance Manual, and will be executed prior to construction. The O&M agreement will specify responsibilities of the sponsors and will include detailed provisions for retention, use, and disposal of property acquired or improved with PL-106-472 cost share funds. Annual operation, maintenance and replacement costs are estimated to be $98,800.

8. The costs shown in this agreement are preliminary estimates. Final costs to be paid by the parties hereto will be the actual costs incurred in the installation of works of improvement.

9. This agreement is not a fund-obligating document. Financial and other assistance to be furnished by NRCS in carrying out the Rehabilitation Plan is contingent upon the fulfillment of applicable laws and regulations and the availability of appropriations for this purpose.

10. This agreement does not commit the NRCS to assistance of any kind beyond the 100-year project life.

11. A separate agreement will be entered into between NRCS and the sponsors before either party initiates work involving funds of the other party. Such agreements will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

12. This Rehabilitation Plan may be amended or revised only by mutual agreement of the parties hereto, except that NRCS may de-authorize or terminate funding at any time it determines that the sponsors have failed to comply with the conditions of this agreement. In this case, NRCS shall promptly notify the sponsors in writing of the determination and the reasons for the de-authorization of project funding, together with the effective date. Payments made to the sponsors or recoveries by NRCS shall be in accord with the legal rights and liabilities of the parties when project funding has been de-authorized. An amendment to incorporate changes affecting a specific measure may be made by mutual agreement between NRCS and the sponsors having specific responsibilities for the measure involved.

13. No member of or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this plan, or to any benefit that may arise there from; but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.

14. By signing this agreement the recipient assures the U.S. Department of Agriculture that the program or activities provided for under this agreement will be conducted in compliance with all applicable Federal civil rights laws, rules, regulations, and policies.

15. The sponsors agree to participate in and comply with applicable Federal, state and local flood plain management and flood insurance programs before project construction commences. The Flood Control District of Pinal County will continue to adopt, administer and enforce floodplain management regulations, for the purpose of the delineation of floodplains and floodways; the preservation of the capacity of the floodplain to carry and discharge floods; the minimization of flood hazards; and the regulation of the use of land in the floodplain; participation in flood insurance programs. This includes working with local units of government to zone the designated 100-year floodplain, special flood hazard areas, and the designated floodways as defined in the Official Flood Studies. Floodplain regulations shall be based on adequate technical data, competent engineering advice and dam breach impact maps will be provided by competent technical authorities.

16. Activities conducted under this agreement will be in compliance with the nondiscrimination provisions as contained in the Titles VI and VII of the Civil Rights Act of 1964, as amended the Civil Rights Restoration Act of 1987 (Public law 100-259) and other nondiscrimination statutes, namely Section 504 of the Rehabilitation Act of 1973, Title IX of the Education Amendments of 1972, the Age Discrimination Act of 1075, and in accordance with regulations of the Secretary of Agriculture (DR43003). The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer."

17. Certification Regarding Drug-Free Workplace Requirements (7 CFR 3017, Subpart F).

By signing this watershed agreement, the sponsors are providing the certification set out below. If it is later determined that the sponsors knowingly rendered a false certification, or otherwise violated the requirements of the Drug-Free Workplace Act, the NRCS, in addition to any other remedies available to the Federal Government, may take action authorized under the Drug-Free Workplace Act.

Controlled substance means a controlled substance in Schedules I through V of the Controlled Substances Act (21 U.S.C. 812) and as further defined by regulation (21 CFR 1308.11 through 1308.15);

Conviction means a finding of guilt (including a plea of nolo contendere) or imposition of sentence, or both, by any judicial body charged with the responsibility to determine violations of the Federal or State criminal drug statutes;

Criminal drug statute means a Federal or non-Federal criminal statute involving the manufacturing, distribution, dispensing, use, or possession of any controlled substance;

Employee means the employee of a grantee directly engaged in the performance of work under a grant, including: (i) all direct charge employees; (ii) all indirect charge employees unless their impact or involvement is insignificant to the performance of the grant; and, (iii) temporary personnel and consultants who are directly engaged in the performance of work under the grant and who are on the grantee's payroll. This definition does not include workers not on the payroll of the grantee (e.g., volunteers, even if used to meet a matching requirement; consultants or independent contractors not on the grantees' payroll; or employees of sub recipients or subcontractors in covered workplaces).

A. The sponsors certify that they will or will continue to provide a drug-free workplace by:

(1) Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance is prohibited in the grantee's workplace and specifying the actions that will be taken against employees for violation of such prohibition;

(2) Establishing an ongoing drug-free awareness program to inform employees about:

(a) The danger of drug abuse in the workplace;

(b) The grantee's policy of maintaining a drug-free workplace;

(c) Any available drug counseling, rehabilitation, and employee assistance programs; and

(d) The penalties that may be imposed upon employees for drug abuse violations occurring in the workplace.

(3) Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required by paragraph (1);

(4) Notifying the employee in the statement required by paragraph (1) that, as a condition of employment under the grant, the employee will:

(a) Abide by the terms of the statement; and

(b) Notify the employer in writing of his or her conviction for a violation of a criminal drug statute occurring in the workplace no later than five calendar days after such conviction;

(5) Notifying the NRCS in writing, within ten calendar days after receiving notice under paragraph (4)(b) from an employee or otherwise receiving actual notice of such conviction. Employers of convicted employees must provide notice, including position title, to every grant officer or other designee on whose grant activity the convicted employee was working, unless the Federal agency has designated a central point for the receipt of such notices. Notice shall include the identification number(s) of each affected grant;

(6) Taking one of the following actions, within 30 calendar days of receiving notice under paragraph (4)(b), with respect to any employee who is so convicted:

(a) Taking appropriate personnel action against such an employee, up to and including termination, consistent with the requirements of the Rehabilitation Act of 1973, as amended; or

(b) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State, or local health, law enforcement, or other appropriate agency.

(7) Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraphs (1), (2), (3), (4), (5), and (6)

B. The sponsors may provide a list of the site(s) for the performance of work done in connection with a specific project or other agreement.

C. Agencies shall keep the original of all disclosure reports in the official files of the agency.

18. Certification Regarding Lobbying (7 CFR 3018) (applicable if this agreement exceeds $100,000).

A. The sponsors certify to the best of their knowledge and belief, that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the sponsors, to any person for influencing or attempting to influence an officer or employee of an agency, 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 sponsors 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 sub recipients shall certify and disclose accordingly.

B. 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.

19. Certification Regarding Debarment, Suspension, and Other Responsibility Matters - Primary Covered Transactions (7 CFR 3017).

A. The sponsors certify to the best of their knowledge and belief, that they and their principals:

(1) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;

(2) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of, fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(3) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State, or local) with commission of any of the offenses enumerated in paragraph (1)(b) of this certification; and

(4) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State, or local) terminated for cause or default.

B. Where the primary sponsors are unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this agreement.

Signatures:

Florence Area Watershed Flood Control District By _____

P.O. Box 1727 Title _____
Address

Florence, Arizona 85232 Date _____
City, State Zip Code

The signing of this agreement was authorized by a resolution of the governing body of the Florence Area Watershed Flood Control District and adopted at a meeting held on:

_____.
(date)

_____ _____
Secretary Address Zip Code

Date _____

Florence-Coolidge Natural Resource Conservation District By _____

P.O. Box 2150 Title _____
Address

Coolidge, Arizona 85228 Date _____
City, State Zip Code

The signing of this agreement was authorized by a resolution of the governing body of the Florence-Coolidge Natural Resource Conservation District and adopted at a meeting held on:

_____.
(date)

_____ _____
Secretary Address Zip Code

Date _____

Natural Resources Conservation Service
United States Department of Agriculture

Approved by:

_____

David L. McKay
State Conservationist

Date: _____

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1.0 SUMMARY OF WATERSHED PLAN

Project Name: Florence Flood Retarding Structure (FRS)

County: PINAL State: ARIZONA

Congressional District: 1

Sponsors: Florence Area Watershed Flood Control District (FAWFCD)
Florence-Coolidge Natural Resource Conservation District (FCNRCD)

Description of Recommended Plan: Alternative 4 is the Recommended Plan. Alternative 4 includes measures to rehabilitate the Florence FRS in order to meet the project purpose of providing for continued flood protection for the Town of Florence, Arizona, and surrounding areas.

Resource Information:

Existing Conditions Land Use	Flood Hazard Area below the Dam (Acres)	Regulated Watershed above the Dam (Acres)	Unregulated (1) Area (Acres)
Rangeland/Desert Scrub	980	36,390	5,250
Agricultural	4,880	0	0
Urban	1,250	2,780	0
Total Area	**7,110**	**39,170**	**5,250**
1) Unregulated area that drains to the CAP embankment just downstream of the principal spillway.			

Land Ownership:

Land Ownership	Flood Hazard Area below the Dam (Acres)	Regulated Watershed above the Dam (Acres)
Federal Government	455	14,474
State of Arizona	980	14,540
State of Arizona - Prisons	350	1,283
Pinal County	100	0
FAWFCD	30	64
Town of Florence	380	0
Private	4,815	8,809
Total	**7,110**	**39,170**

Number of Farms:

Number of Farms	21
Average Size (acres)	232.4
Prime and important farmland (acres):	4,880
Number of minority farmers:	7
Number of limited resource farmers:	7

Project Beneficiary Profile (Town of Florence):

Population:	17,054
Median per capita income:	$11,278
Families living below the poverty level:	7%
Median value owner-occupied housing units:	$88,000
Minority population:	39%

Wetlands (acres): None

Highly Erodible Cropland (acres): 4,880

Endangered Species: No threatened or endangered species, or species of concern, including plants and animals, are known to occur in the project area.

Cultural Resources: No significant or National Register-eligible cultural resources are present in the project area.

Problem Identification: The Florence FRS is a five-mile-long, 24-foot-high earthen structure provides flood protection to the Town of Florence and surrounding areas. It is nearing the end of its original design life of 50 years and is being evaluated at the request of the FAWFCD and the Florence-Coolidge Natural Resource Conservation District (FCNRCD) because of concerns about deficient capacity in the auxiliary spillway. The FRS has been identified as a high-hazard class dam by the NRCS and the Arizona Department of Water Resources (ADWR) and does not meet current NRCS safety and performance criteria.

Alternative Plans Considered:

The project alternatives that were considered as part of this study include the following:

- Alternative 1 – No Federal Action.
- Alternative 2 – Decommissioning with downstream flood mitigation.

- Alternative 3 – Rehabilitation by raising the FRS crest, reinforcing the auxiliary spillway, and providing additional flood storage.
- Alternative 4 – Rehabilitation by raising the FRS crest and widening the auxiliary spillway, reinforcing the auxiliary spillway, and providing additional flood storage.

Project Purpose: Flood Prevention.

Principal Project Measures: The Recommended Plan includes measures to rehabilitate the Florence FRS to meet current safety and performance standards. Measures include: raising the crest; widening and reinforcing the auxiliary spillway; and other needed measures.

Project Costs:

	PL 83-566 Funds		Other Funds		Total	
Structural Measures	$	%	$	%	$	%
Dam Rehabilitation	10,502,400	67.8	4,991,500	32.2	15,493,900	87.5
Relocation of Utilities and Kelvin Road	0	0.0	663,800	100.0	663,800	3.7
Technical Assistance	1,552,200	100.0	$0	0.0	1,552,200	8.8
Total	12,054,600	68.1	5,655,300	31.9	17,709,900	100

Project Benefits:

Category	**Annual Benefits** [(1)]
Agricultural flood damage reduction	$180,000
Non-agricultural flood damage reduction	$4,440,000
Total	$4,620,000

1) The proposed rehabilitation will provide an estimated $4,620,000 in annual flood damage reduction benefits, as shown in the above table. However, as the "no action alternative" also provides essentially this same benefit stream, rehabilitation does not have positive "incremental NED benefits." The benefits of the proposed rehabilitation are outlined in the plan, and are directly tied to addressing documented structural inadequacies.

Environmental Values changed or lost: None.

Major Conclusions: The rehabilitation of the Florence FRS will upgrade the dam to meet current NRCS and ADWR dam safety criteria and performance standards for a high hazard dam. It thereby provides greater protection and reduces the risk of loss of life to the people that live and work below the dam.

Areas of Controversy: None.

Issues to be Resolved: None.

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2.0 INTRODUCTION

The Florence Area Watershed Flood Control District (FAWFCD) and the Florence-Coolidge Natural Resource Conservation District (FCNRCD) as sponsors, with assistance from the U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS), propose to rehabilitate or decommission the Florence Flood Retarding Structure (FRS), located in Pinal County, Arizona. This Supplemental Watershed Plan and Environmental Assessment (Plan/EA) and associated technical studies were initiated in response to needs identified by the sponsors as outlined in their Application for Federal Assistance submitted to the NRCS. This Plan/EA determines the feasibility of rehabilitating the FRS in order to provide for continued flood protection for the Town of Florence, Arizona, and surrounding areas. This Plan/EA evaluates alternatives to address inadequacies in the FRS in storage volume, auxiliary spillway capacity, and auxiliary spillway integrity.

This Plan/EA is being prepared by the sponsors, with assistance from NRCS, to comply with the requirements of the National Environmental Policy Act of 1969 and its implementing regulations, set forth in 40 CFR Parts 1500-1508; the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (March 10, 1983) established pursuant to the Water Resources Planning Act of 1965 (Public Law 89-80), as amended by Executive Order 12322 (September 17, 1981); Public Law 83-566, as amended, the Watershed Protection and Flood Prevention Act of 1954, and as further amended by Section 313, Public Law 106-472; and NRCS policies and guidelines. This Plan/EA assists the NRCS in determining whether the selected alternative will have a significant impact on the quality of the human environment.

Tables A through R in the main text summarize planning data that is relevant to the given discussion. Tables 1 through 6, as specified in Section 504 of the NRCS National Watershed Manual (1992) are attached separately in Section 11. Supporting technical information is summarized in Appendices A through E. Contents are briefly summarized below:

Appendix A. Letters and Comments: Includes copies of letters and review comments on the draft version of this document as provided by Federal, State, and local agencies.

Appendix B. Support Maps: Dam break inundation mapping from previous studies.

Appendix C. Investigation and Analysis Report.

Appendix D. Supporting Information: Feasibility level design drawings and cost estimates.

Appendix E. Project Map as specified in Section 504 of the National Watershed Manual (NRCS 1992).

Detailed technical information is provided in a separate technical documentation that includes

the following documents:

Biological Resources Summary Memorandum (Tetra Tech 2006a). Summarizes field data from a January 2006 site visit and describes threatened and endangered species and species of concern.

Documentation for Hydrology and Hydraulics (Tetra Tech 2006b). Summarizes hydrologic, hydraulic, and sediment yield analyses conducted to support the economics and design. A companion report describes the methods and results of an incremental analysis to determine the hazard class and the Inflow Design Flood.

Economic Evaluation (Tetra Tech 2006c). Summarizes and updates previous economic analyses and provides supporting documentation for plan formulation.

Geotechnical Evaluation (Ninyo & Moore, 2006). Summarizes previous geotechnical studies, site observations, and limited engineering analyses.

The technical documentation and this Plan/EA are on file and may be viewed at the USDA – Natural Resources Conservation Service, 230 North First Avenue, Suite 509, Phoenix, Arizona 85003-1706. All information and data, except as otherwise noted, were collected during the watershed planning investigations by the NRCS and their consultants.

2.1 Purpose and Need for Action

The FRS is classified by the Arizona Department of Water Resources (ADWR) and NRCS as a high hazard structure that does not meet current safety and performance standards. It has a known deficiency in the embankment (cracking), and known inadequacies in storage capacity, auxiliary spillway capacity, and analyses conducted during this study document an inadequacy in auxiliary spillway integrity. There is a risk to downstream structures and inhabitants if no action is taken to rehabilitate the structure.

The sponsors have addressed the embankment deficiency by means of a “Cracking Repair Project” that was completed in October 2006. The repair project included installation of a central filter drain along the length of the dam and is funded under the NRCS Watershed Operations program. The remaining inadequacies in storage volume, auxiliary spillway capacity, and auxiliary spillway integrity are considered under this rehabilitation study.

The purpose of the proposed rehabilitation effort is to provide continued flood protection and to reduce the risk of loss of life due to catastrophic dam failure and flooding. Action is needed to address public health and safety issues surrounding a flood control dam that does not meet existing safety and performance standards for a high hazard potential structure. If rehabilitated, the FRS would provide continuing, reliable flood protection to the downstream areas, and would comply with State and Federal dam safety and floodplain standards.

2.2 Background

The FRS provides a substantial flood protection benefit to the Town of Florence and surrounding areas. In 2003, the FAWFCD (sponsor) completed a Benefit Cost Study for the FRS and estimated that the dam provided $4.38 million in average annual flood protection benefits (2002) price level. The Economic Evaluation (Tetra Tech 2006c) conducted during this study refined the original analysis and estimated that the FRS provides $4.62 million in average annual flood protection benefits (2006 price level). The FRS protects the Town, Pinal County government facilities, Arizona State Prisons facilities, the Central Arizona Project Canal (CAP), two large irrigation canals, streets and highways, numerous residential and commercial properties, and large areas of Prime Farmland.

In early 2005, the sponsors completed an Initial Assessment and Emergency Spillway Capacity Alternatives Report for the Florence FRS. In August 2005, the FAWFCD and FCNRCD entered into an intergovernmental agreement with the Natural Resources Conservation Service (NRCS) to select a Consultant to perform engineering services to plan, design, and construct the rehabilitation needed to address the identified inadequacies. In December 2005, the sponsors initiated the planning phase. This Plan/EA is being prepared during this phase.

2.3 Previous Studies

Previous studies related to this study are listed in the following table.

Table A. List of Previous Studies

Florence Area Watershed – Preliminary Investigation, USDA-SCS, July 1959.
Watershed Protection PL-566, Florence Watershed – Sedimentation, W.F. Mildner, E.M. Flaxman, USDA-SCS, July 21, 1960.
Geology Report – Florence Area Watershed. W.F. Mildner, USDA-SCS, October 1960
Watershed Workplan, Florence Area Watershed, Pinal County, Arizona. Prepared by Pinal County and the Florence-Coolidge Soil Conservation District, October 1961.
Benefit-Cost Analysis for Florence Flood Retarding Structure, prepared for the Florence Area Watershed Flood Control District by Dibble and Associates, February 2003.
Design of Emergency Spillway – Florence Retarding Dam Structure, prepared for the Florence Area Watershed Flood Control District by Dibble and Associates. Task 1 - Data Collection and Evaluation, November 2003 Task 2 – Precipitation Data Evaluation, December 2003 Task 3 – Rainfall Runoff Modeling and Existing Conditions Evaluation, August 2004 Task 4 – Evaluation of Design Alternatives, December 2004 Task 5 – Final Report, July 2005
Emergency Action Plan, Florence Retarding Dam, prepared for the Florence Area Watershed Flood Control District by Dibble and Associates, January 2004.
Florence FWRS Rehabilitation, Technical Assistance Report, USDA-NRCS National Design, Construction & Soil Mechanics Center, Design & Construction Staff, May 2004 - Fort Worth, Texas.
Florence Dam Repair - Design Report. USDA-NRCS Engineering Staff, July 2004, Phoenix Arizona.

Table A. List of Previous Studies

Cultural Resources Management Evaluation of the Florence Floodwater Retarding Structure, USDA-NRCS, July 2004, Phoenix Arizona.
Florence Dam Repair – Construction and Material Specifications. USDA-NRCS Engineering Staff, August 2005, Phoenix Arizona.
Florence Dam Repair – Final Design Drawings. USDA-NRCS Engineering Staff, September 2005, Phoenix Arizona.
Cultural Resources Management Evaluation for the Emergency Spillway, Florence Floodwater Retarding Structure, USDA-NRCS, December 2005, Phoenix Arizona.

2.4 Existing Dam Condition

2.4.1 Location

The Florence FRS is located just east of the Town of Florence in Pinal County. It lies just east of the Central Arizona Project Canal and generally parallels the alignment of the canal. The southern end is located near State Highway 79 and the northern end is located 2.5 miles northeast of Kelvin Road (Figure 1). The five mile long structure, outlet works, and flood pool lie within the following sections (Gila and Salt River Baseline & Meridian).

Township 4 South, Range 10 East – 21, 27, 28, 32, 33

Township 5 South, Range 9 East – 1, 12

Township 5 South, Range 10 East – 5, 6, 7

At the center of the FRS, the latitude is 33 degrees 01’ 50” (33.0306 degrees), and the longitude is 111 degrees 21’ 03” (111.3509 degrees). The northeast end of the FRS is located at 882,630 East and 749,390 North (Arizona State Plane, Central Zone, NAD83). The southwest end of the FRS is located at 886,260 East and 731,180 North (Arizona State Plane, Central Zone, NAD83).

The majority of the FRS, outlet works, and the flood pool are located on land that is currently owned by the Arizona State Land Department (ASLD), but is leased to the FAWFCD under permanent lease. The remainder is held by the FAWFCD in either fee simple or is subject to easements in favor of the District. The FRS protects the Town of Florence from flood flows originating on a 61.1-square-mile watershed, much of which is slated for future development (Figure 2).

2.4.2 Embankment

The Florence FRS was constructed by the Soil Conservation Service in 1965 and is currently owned and maintained by the Florence Area Watershed Flood Control District (FAWFCD). The 1965 as-built drawings provided by the NRCS include plans, profiles, cross sections, and details of the FRS embankment, principal spillway, gated outlets, auxiliary spillway, outlet channel and associated culverts, stilling basin at the Gila River, Kelvin Road crossing, and the Kelvin Road

culverts. The 1965 as-built plans show a FRS crest elevation of 1,572.6 feet, an auxiliary spillway crest elevation of 1,565.2 feet. Minimum ground elevations at the downstream toe are typically 1549 feet to 1551 feet, with one isolated section (near station 119+00) that has a downstream toe elevation of 1,546 feet[1]. The maximum height of the FRS, measured from crest to downstream toe, 26.6 feet[2] at near station 119+00. However, the dam is typical less than 24 feet high.

The drawings also show a crest length of 27,165 feet (5.145 miles), a top width of 14 feet, and side slopes of 2H:1V on the downstream side and 3H:1V on the upstream side (Figure 3). In the early 1980's, the southern portion of the embankment was re-aligned to accommodate the Central Arizona Project Canal. The overall length of the embankment after the re-alignment (as shown on the construction drawings for cracking repair project) is 26,509 feet (5.021 miles).

The sponsors, with assistance from NRCS recently constructed a central filter drain throughout the length of the FRS. The drain is generally 2 feet thick, with 4-foot-thick sections where the principal spillway and gated drain pipes pierce the embankment. The project was completed in October 2006 and addresses the embankment deficiency due to cracking. A typical cross section is shown in Figure 4.

2.4.3 Principal Spillway

The principal spillway is located at the northern end of the FRS (Figure 5) and consists of a 120-foot-long, 42-inch-diameter reinforced concrete pipe (RCP) with a hooded inlet structure on the upstream end and a reinforced concrete impact basin at the downstream end. The inlet has a 10-foot-long by 3.5-foot-wide horizontal opening and a 7.5-foot-long transition to the upstream end of the pipe. The inlet is surrounded by a trash rack constructed of 2.5-inch diameter piping spaced at 2.25-foot intervals. The principal spillway was inspected in January 2006 and September 2006. Photos from the inspections are included in Figure 6.

The principal spillway also includes an outlet channel that extends 5,900 feet from the outlet at the dam to the ultimate outfall at the Gila River. The outlet channel consists of the overchute at the CAP canal, a splitter structure and siphon under the Florence-Casa-Grande and Florence canals, a 2,060-foot-long section of reinforced concrete channel, a St. Anthony Falls (SAF) type drop structure, and the 2,220-foot-long section of earthen channel that ends at the Gila River.

The flood pool behind the FRS is also be drained by gated outlet structures located at stations 116+25 and 147+70 (just north and south of Kelvin Road). The gated outlets consist of 30-inch

[1] Unless otherwise noted, all elevations in this report relate to the original design as shown in the as built drawings. The vertical datum for the original design is not known and a reliable equation for elevations in the original design, and the cracking repair plans (vertical datum is NAVD 1988) cannot be determined. The apparent elevation difference between the two plan sets is 2.8 feet.
[2] ADWR (July 2005) lists the dam height as 21 feet.

diameter RCPs that drain directly to the Florence-Casa Grande Canal. The gates are operated by the San Carlos Irrigation and Drainage District (SCIDD) and are used to drain the flood pool. These pipes are not considered part of the principal spillway and are not included in the principal spillway rating for hydrologic or hydraulic analyses.

2.4.4 Auxiliary Spillway

The auxiliary spillway is an unlined earth channel that curves through a 157-degree arc around the northern abutment of the FRS (Figure 7). The crest of the spillway is located at the end of the arc so the left side of the control section matches up against the *outside* of the FRS embankment. The right side is cut into an existing earthen hillside. Both sides of the auxiliary spillway have 2H:1V side slopes. The bottom width is 400 feet and a crest elevation is 1,565.25. The maximum depth from auxiliary spillway crest elevation to the top-of-dam elevation is 7.35 feet.

The 1965 as-built drawings show that the crest width in direction of flow is 50 feet and is armored by a 1.5-foot-thick layer of riprap. The inlet approach channel leading to the crest is approximately 1,200 feet long and consists of three segments. The first segment begins at a point where the existing ground elevation is 1,561.2 feet and extends approximately 894 feet to an elevation of 1,564.2 feet (slope = 0.0036 ±). The next segment is 343 feet long and is flat (slope = 0.00 feet/feet). The third segment is a 50-foot section from elevation of 1,564.2 to the crest elevation of 1,565.25 and has a slope of 0.0210 feet/feet. The earthen exit channel is approximately 560 feet long and extends from the auxiliary spillway crest to a point where the existing ground elevation is 1561.0 feet (slope = 0.0076 feet/feet).

2.5 Inadequacies of Structure

2.5.1 Storage

The FRS will not pass the 10-day Principal Spillway Hydrograph (PSH), given future hydrologic conditions, without overtopping the auxiliary spillway crest (elevation 1,565.2 feet). As shown in the table below, the auxiliary spillway crest would have to be raised to a minimum elevation 1,568.5 feet in order to provide safe passage for the 10-day PSH.

Table B. Principal Spillway Hydrograph – Maximum Water Surface Elevations

Combined Inflow at the Florence FRS (cfs)	10,352
Routed Outflow through Principal Spillway (cfs)	177
Maximum Water Surface Elevation (ft)	1,568.5

2.5.2 Auxiliary Spillway Capacity

The existing auxiliary spillway will not convey the Inflow Design Flood (IDF), which is based

on a 24-hour Probable Maximum Flood (PMF) having a rainfall depth of 13.6 inches. WinTR-20 level pool routing analysis shows that if flows over the top of the structure (elevation 1,572.6 feet) are included in the rating curve, the IDF overtops the FRS by approximately 0.65 feet. If outflows were limited to the existing auxiliary spillway (400-foot bottom width; 2H:1V side slopes), with the assumption that the FRS is raised to contain the increased water surface elevation, the WinTR-20 model shows a maximum water surface elevation of 1,576.2 feet or about 3.6 feet above the top of the existing crest of the structure. A more detailed analysis of this assumption was conducted using one-dimensional full-dynamic-wave flood routing along the length of the FRS (unsteady version of HEC-RAS). The maximum water surface elevation for the IDF is 1,578.6 feet or about 6.0 feet above the existing crest of the structure.

2.5.3 Auxiliary Spillway Integrity

The boring logs on the as built drawings show a preponderance of sand (M, SM) to depths of 10 to 12 feet in the auxiliary spillway and suggest that the auxiliary spillway is highly erosive. Integrity analysis of the auxiliary spillway was conducted using the Earth Spillway Erosion Model described in Chapter 51 of NEH Part 628-Dams and confirm that the spillway will breach during the IDF.

2.6 Status of Operation and Maintenance

Operation and maintenance of the FRS is up to date. As noted previously, the cracking problems have been addressed by a cracking repair project. That project also includes a 6-inch layer of gravel mulch to reduce rilling and erosion on the downstream slope of the embankment. The principal spillway has been inspected and shows no major deficiency. There is some settlement of the reinforced concrete wingwall but it does not directly affect the endwall or the principal spillway and is not considered to be a significant problem. The gated outlets were used to drain the flood pool after some significant rainfalls in August 2006, and there were no problems reported. They gated outlets will be video inspected as part of the design phase. The State Conservationist will verify that O&M is current prior to submitting the current plan for NRCS funding under the rehabilitation authority.

2.7 Sedimentation

The structure has collected little sediment since 1965 and is estimated to have a remaining sediment storage capacity of 840 acre-feet. Based on sediment yield rates estimated during the initial assessment phase[3] this storage is sufficient for 100-years of sediment accumulation.

[3] Spillway Alternative Analysis, Task 3 Report – Rainfall Runoff Modeling and Existing Conditions Analysis (Dibble and Associates, 2004) referred to herein as the “Task 3 Report”.

2.8 Breach Analysis and Hazard Classification

The FRS is designated as a high hazard (class c) structure[4]. High-hazard-potential structures are defined as, "Dams located where failure may cause loss of life, serious damage to homes, industrial and commercial buildings, important public utilities, main highways, or railroads." In addition, because of the potential loss of lives and property damage that could occur in the event of failure, the structure was classified by ADWR as an "Intermediate" structure with a "High-Hazard" potential. Breach analyses are discussed under Section 2.10.

2.9 Potential Failure Modes

As noted in the previous section, the NRCS and the State of Arizona both classify the Florence FRS as a high hazard dam with the potential for loss of life if the dam was to suddenly fail. Potential failure modes are listed below.

2.9.1 Hydrologic Capacity

As noted in Table J (see page 43) the auxiliary spillway conveys less than half of the PMF peak discharge for the 6-hour, 24-hour, and 72-hour events. As noted in Section 2.5.2, the 24-hour PMF would overtop the existing dam crest by an average depth 0.65 feet. The completed cracking repair project included regrading the crest and adding a 6-inch layer of gravel on the crest and downstream slope. The crest should be sound and would withstand shallow overflows, but is not designed for overtopping. The overall potential for hydrologic failure of the dam is considered to be moderate.

2.9.2 Seepage

The FRS is a dry dam and the detention time for large events is only a matter of hours or days. Seepage presents a low risk for failure.

2.9.3 Seismic

The FRS lies within the Sonoran zone, which is a relatively stable tectonic region located in southwestern Arizona, southeastern California, southern Nevada, and northern Mexico. This zone is characterized by sparse Seismicity and few Quaternary faults. Based on field observations and review of readily available published geological maps and literature, there are no known active faults underlying the subject site or the adjacent area. Slope stability analyses Geotechnical Evaluation (Ninyo & Moore, 2006) found that the slopes have acceptable factors of

[4] The July 2005 version of TR-60 uses in Low-, Medium-, and High-Hazard-Potential in lieu of Class a, b, and c as defined in the previous version.

safety[5].

2.9.4 Material Deterioration and Embankment Cracking

Field inspection of the principal spillway revealed no evidence of deterioration of the reinforced concrete pipe or the joints (Figure 6). The inlet structure and trash rack are sound. The outlet headwall and the impact structure are sound and show no signs of deterioration. The wingwalls at the end of the outlet structure shows some signs of minor settling; leaving a gap that varies from ¼-inch to ¾-inch between the wingwalls and endwall. The wingwall settling does not directly affect the endwall or the principal spillway and is not considered to be a significant problem at this time. However, the wingwalls should be checked during regular inspections. The potential for failure at the principal spillway is low. The gated outlets are required for complete drainage of the flood pool but are not necessary for conveyance of the PMF. They were operated to drain flows from significant rainfalls in August 2006 with reported problems. However, they should be video inspected[6] for signs of seepage or movement that might indicate a problem with the embankment.

As noted in Section 2.5.3, the auxiliary spillway is constructed in potentially erosive material and does not meet requirements for spillway integrity. Since flows in excess of the 24-hour, 50-year event are conveyed in part by the auxiliary spillway, it could be tested by events much less than the PMF. The potential for an erosional failure of the auxiliary spillway is moderate to high and it is considered to be the most likely point of failure for the FRS.

Embankment cracking at the FRS is well documented and has been addressed by the previously mentioned cracking repair project. Now that the repair project has been completed, the potential for failure from flows piping through embankment cracks is considered to be low.

2.10 Consequences of Dam Failure

In 2004, the FAWFCD conducted a dam-break inundation analysis to determine the areas that would be at substantial risk of loss of life and property in the event of a failure of the Florence FRS. The analysis was documented in the "Florence Retarding Dam Emergency Action Plan" (Dibble and Associates 2004a). The results of the flood inundation analysis performed for five flood scenarios are summarized below. Copies of the flood inundation mapping from the Emergency Action Plan are included in Appendix B – Support Maps.

- The flood wave generated from a structure failure located at Mile 0.25 (west end of the structure near Highway 79) would cause significant flooding in the Town and surrounding

[5] The slope stability analyses were based on soils information collected from previous studies and required some assumptions about soil characteristics. Additional field investigations, testing, and evaluation would be required during a design phase.
[6] The outlets of the pipes will be underwater until after the irrigation season ends in late in October. The inlets have been frequently submerged during the summer of 2006.

areas. The flood inundation map developed for a potential breach failure at this location showed that a significant part of the town is within the flood hazard zone. This location is potentially the worst breach location for the structure.

- The flood wave generated from a structure failure located at Mile 1.60 of the FRS would cause significant flooding of the Arizona State Prison Facility that houses roughly 3,500 inmates.
- The flood wave generated from a structure failure located at Mile 3.4 of the FRS (roughly one mile east of the Kelvin Road crossing over the dam) would cause significant flooding in the agricultural areas just northeast of Florence and the Arizona State Prison. The flooding would affect a few isolated buildings, but not the main population of the Town of Florence.
- The flood wave generated from a structure failure, or an intentional emergency breach at Mile 4.75 of the FRS (near the principal spillway) would cause significant flooding in agricultural area northeast of Florence. As noted in "Design of Emergency Spillway, Task 3 – Rainfall Runoff Modeling and Existing Conditions Evaluation," (Dibble and Associates 2004b), referred to herein as the "Task 3 Report", no buildings or structure are currently found to be within the defined flood hazard zone. The Task 3 Report identified Mile 4.75 as a potential location for an intentional breach that would reduce the possibility of a breach that would affect a greater numbers of people and structures in the Town of Florence.
- A structure failure at any one of the above described locations would likely destroy a section of the CAP, which provides M&I water to Tucson and parts of southern Arizona, the Florence Casa-Grande Canal, which provides irrigation water to a number of irrigation canals and laterals that serve agriculture in central Pinal County.
- The flood wave associated with the maximum combined flood release of 19,900 cfs from the principal spillway and the auxiliary spillway (Miles 4.75 and 5.0) would impact agricultural areas well to the northeast of Florence before joining the Gila River. The Task 3 Report states that no buildings or structure are currently found to be within the defined flood hazard zone for this area

2.11 Regulatory Considerations

ADWR first notified the FAWFCD on November 20, 1984 that the Florence FRS is classified as "Unsafe, Non-emergency" since the structure does not meet current safety and performance standards in embankment cracking, embankment erosion, and an inability to safely pass the Inflow Design Flood. In a February 13, 2006 letter to ADWR, the FAWFCD requested "…written guidance or documentation from ADWR in regards to their most likely future action

for the emergency spillway deficiency, once the embankment repairs are completed." In a response dated March 7, 2006, ADWR stated:

> *Following completion of the crack repairs, the dam will continue to be classified as unsafe due to the spillway inadequacy. The Department intends to work with the dam owner and the NRCS to facilitate the needed further rehabilitation of the dam as timely a manner as possible.*

Based on ADWR's response, it is the opinion of the FAWFCD that ADWR will not issue an order to repair or breach the FRS in the future.

The Pinal County Department of Public Works noted that the inadequacies of the dam could result in it losing certification by the Federal Emergency Management Agency (FEMA). As a result, properties currently protected by the dam would be considered to be in a flood hazard area. Property owners would be subject to policies and regulations for structure in a flood hazard are, and might have to purchase flood insurance.

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3.0 AFFECTED ENVIRONMENT

The following paragraphs describe the existing conditions of the environment in the study area that may be affected by the recommended alternative.

3.1 Climate

The Sonoran Desert has a continental climate with great variability of both diurnal and seasonal temperatures. It is characterized by a summer monsoon season with light rains in the winter. Based on a period of record from 1892 to 2005 for Florence, Arizona (WRCC 2006), the average monthly temperatures range from a low of 37° F in January to a high of 105° F in July. Average monthly rainfall ranges between 0.13 inches in June to 1.43 inches in August, with annual rainfall reaching 9.98 inches in an average year. Winter precipitation falls as snow in the mountains and as either rain or snow at lower elevations. The study area is located below 2,000 feet elevation and snowfall is very rare (<0.2 inches a year).

3.2 Geology

The Sonoran Desert lies in the Basin and Range geologic province. This terrain consists of broad, low-elevation valleys rimmed by long, thin, parallel mountain ranges (Phillips and Comas 2000). The study area is within a typical Basin and Range valley where alluvium and surface deposits created a sedimentary strata consisting of gravel, sand, and clay beds that filled in over bed material of volcanic origin including granite and basalt (Town of Florence 2003).

3.3 Soils

The soils in the study area have been surveyed at a coarse level by the Soil Conservation Service (now NRCS) (SCS 1960). The general geology of the site consists of quaternary alluvium described as valley fill on the toe of an alluvial fan. The soil consists of unconsolidated material consisting of loose to partially-consolidated silty-sand and sand. According to the Soil Conservation Service's General Soil Map of Northern Pinal County (1972), there are three soil associations in the study area including: Gilman-Antho-Pimer, Gunsight-Cavelt-Rillito, and Casa Grande-La Palma.

The Gilman-Antho-Pimer Association consists of deep, medium, moderately coarse, and well-drained soils on floodplains and alluvial fans. These were soils formed in stream alluvium exhibiting less than three percent slopes. Water permeability is moderate. These soils are appropriate for irrigated crops and pastureland, desert rangeland, wildlife habitat, recreation, and building and industrial sites (Town of Florence 2003).

The Gunsight-Cavelt-Rillito Association consists of strongly calcareous soils on partially dissected, undulating to rolling high fans at the base of mountains. The soils are formed in calcareous, mixed old alluvium from a variety of rock types and are adequate for desert

rangeland, wildlife habitat, and isolated recreation and building sites (Town of Florence 2003).

The Casa Grande-La Palma Association consists of deep, strongly alkali or saline-alkali soils exhibiting less than two percent slopes. They are formed from old mixed alluvium and are located on the nearly level valley floor. The association is generally used for irrigated crops and pasture, desert rangeland and wildlife habitat, and isolated building sites (Town of Florence 2003).

3.4 Surface Water

The Florence FRS controls runoff from a 61.1-square-mile drainage area that lies east of the dam. Previous hydrologic analyses (Dibble and Associates 2004b) divided the drainage area into 14 subareas that are drained by ephemeral arroyos. According to the previous studies, the 100-year, 24-hour point rainfall depth would be 3.87 inches and would result in combined inflow peak discharge of 6,895 cfs and a total runoff volume of 6,387 acre-feet at the dam. Rainfall-runoff modeling was updated for the rehabilitation study. The methods, assumptions, inputs, and results are summarized in the Documentation for Hydrology and Hydraulics (Tetra Tech, Inc. 2006a), which is included as a separate technical report. The 100-year, 24-hour rainfall point-rainfall depth is 3.86 inches. Given existing development conditions, the combined 100-year peak discharge at the FRS is 7,035 cfs and the total runoff volume is 6,810 acre-feet. Given the expected future development conditions[7], the combined 100-year peak discharge at the FRS is 7,229 cfs and the total runoff volume is 7,144 acre-feet.

Outflows from the dam are conveyed by the 42-inch diameter principal spillway pipe and the 400-foot-wide auxiliary spillway. Additional drainage is provided by two gated pipes that drain floodwater stored behind the dam into the Florence-Casa Grande Canal.

3.5 Water Quality

The FRS has no direct effect on water quality in terms of designated beneficial uses, impairment of those uses, or pollutants or parameters that exceed standards. The Town of Florence owns and operates two existing wastewater treatment plants that serve municipal customers. Their combined capacity is 2.0 MGD. The Florence wastewater treatment plant currently discharges approximately 840 acre-feet annually, which is utilized to irrigate farmland. The North Florence facility discharges approximately 113 acre-feet annually, which is used for direct recharge and to irrigate a private golf course (Town of Florence 2003). The dam provides flood protection to the Florence wastewater treatment facility. The FRS has no effect on the North Florence facility. The Florence FRS also provides flood protection for the Central Arizona Project Canal (CAP), which provides water for municipal and industrial use to the City of Tucson.

[7] The Pinal County Drainage Design Manual specifies that new developments mitigate the increase in peak discharges, but does not require mitigation of the runoff volume. The future-conditions rainfall runoff model included adjustments that would reflect the expected mitigation for peak discharge.

3.6 Water Conveyance Infrastructure

The Gila River is located approximately 1.5 miles northwest of the FRS, and one mile from the Florence town center. The river drains the region from the northeast to the southwest, and historically provided perennial flows throughout most of the year. The Ashurst-Hayden Diversion Dam (Figure 8) is located on the Gila River, roughly 10-river miles upstream of Florence. It was constructed in 1922 to retain and convey irrigation water from the Gila through the Florence Canal, the North Canal, and the Florence-Casa Grande Canal for cultivation of agricultural crops (Town of Florence 2003).

The FRS lies just upstream of the Florence-Casa Grande Canal and the CAP, and provides flood protection to both facilities. The Florence-Casa Grande Canal is operated by the San Carlos Irrigation and Drainage District (SCIDD) primarily for agriculture crop cultivation. The CAP is owned by the Bureau of Reclamation (USBR) but operations and maintenance are conducted under contract by the Central Arizona Water Conservation District. The CAP extends 336 miles from Lake Havasu City to Tucson, and the portion through Florence was completed in 1985-1986. The CAP conveys Colorado River water for municipal and agricultural use. The FRS also provides flood protection for the connectors and the field level irrigations works that tap into Florence-Casa Grande Canal.

3.7 Sedimentation

The sediment supply upstream of the FRS is primarily contributed by a series of arroyos. The Watershed Work Plan for Florence Area Watershed conducted in October 1961 by Pinal County and the FCNRCD with assistance from the Soil Conservation Service estimated a sediment storage requirement for a 50-year service period of 840 acre-feet. This is based on a sediment yield rate of 0.23 ac-ft/sm/yr and a drainage area of 71.4 square miles[8].

Previous studies (Task 3 Report) revisited the sediment yield and calculated a new rate 0.1375 ac-ft/sm/yr. The report also determined that the existing FRS has an estimated remaining sediment storage volume of 840 acre-feet. Based on the updated yield rate, and the currently defined drainage area of 61.1 square miles, the existing structure has enough sediment storage for a 100-year service life.

3.8 Vegetative Community

The study area is located in the Arizona Upland, the northeastern subdivision of the Sonoran Desert. The terrain contains numerous mountain ranges and valleys. This community is also called the saguaro-palo verde forest (Phillips and Comus 2000). A vegetation survey was completed in January 2006 and findings were documented in the “Florence FRS - Biological

[8] The drainage area of 71.4 square miles is listed in Table 3-Structure Data in the 1961 Work Plan for the Florence Area Watershed.

Resources Summary Memorandum" (Tetra Tech Inc. 2006b). The winter of 2005/2006 was very dry, and the majority of the plant species were dormant at the time of the survey. The watershed above the FRS is comprised almost exclusively of Sonoran desert scrub rangeland and developed lands for the Arizona State Prison. The watershed is currently extensively grazed with additional historic disturbance adjacent to the FRS from its construction.

The crest and the upstream face of the FRS has been maintained to be clear of vegetation but has been colonized by brittlebush (*Encelia farinosa*), triangle bursage (*Ambrosia deltoidea*), saltmeadow plantain (*Plantago argyraea*), prostrate spurge (*Chamaesyce prostrate*), and weedy grasses. The downstream side of the FRS supports higher densities of the woody species listed above, and also includes creosote bush (*Larrea tridentata*).

A bench between 50 and 150 feet wide is present along the upstream toe of the FRS for most of its length. A dirt maintenance road runs along most of the length of this bench at the base of the FRS. This bench is sparsely vegetated due to frequent disturbance. Upstream of this bench, the ground drops into a borrow ditch that appears to have become the main channel for any flow from the arroyos. The channel is between 200 and 250 feet wide and runs along most of the length of the FRS. The material from this channel was excavated to construct the FRS. Vegetation has populated the borrow channel with the following dominant species: littleleaf and blue palo-verde (*Cercidium microphyllum and C. floridum*), honey mesquite (*Prosopis glandulosa var. glandulosa*), chain fruit and diamond cholla (*Opuntia fulgida and O. multigeniculata*) barrel cactus (*Ferocactus wislizenii*), prickly pear (*Opuntia sp.*), creosote bush (*Larrea tridentata*), annual bursage (*Ambrosia deltoidea*), and brittlebush (*Encelia farinosa*). Further upstream from the borrow channel, the vegetation is comprised of the same dominant species with the inclusion of older saguaro cacti (*Cereus giganteus*).

3.9 Wetlands

The National Wetland Inventory has not mapped the study area (NWI 2006). The site was surveyed for the potential presence of wetlands during the January 2006 vegetation survey, although no delineations were conducted. In the original borrow area just upstream of the dam, there is evidence that water now moves along the borrow channel as the main channel (flows from south to north). There are several areas of significant scour with vertical cohesive banks and several areas appear to have had sediments deposited, partially burying woody plants. However, this area ranges from sparsely vegetated to dense stands of mesquite; typically dominated by the same species as occurring on the bench or the FRS. A single dead cottonwood tree was found standing upstream of the FRS next to an old stock tank and corral but there was no evidence of current wetland or riparian conditions. A few small patches of cracked soil were present in three or four locations near the FRS. These areas appeared to have had standing water, but no vegetation was present and it is unclear how frequently or for how long water is ponded.

Overall, no jurisdictional wetlands were observed to be present in the vicinity of the FRS and the original borrow area.

3.10 Fish and Wildlife

The arroyos upstream of the FRS are dry except during heavy rainfall events and do not support fish populations. The Sonoran Desert is home to several species of birds, reptiles, and mammals that use scrub desert habitat, including vultures, hawks, eagles, falcons, roadrunners, owls, hummingbirds, woodpeckers, and songbirds; lizards and snakes; coyote, fox, bobcat, jackrabbits, bats, ground squirrels, mice, and rats (Philips and Comus 2000).

The Florence-Casa Grande Canal and the CAP both support some fish. The FRS has gated outflow pipes that drain to the Florence-Casa Grande Canal. The CAP receives no outflow from the FRS and proposed alternatives will not include or affect this area.

3.11 Threatened and Endangered Species

According to the U.S. Fish and Wildlife Service, there are thirteen species federally listed as threatened or endangered, one proposed endangered species, and two candidate species in Pinal County (USFWS 2006). The species listed as endangered are: Southwestern willow flycatcher (*Empidonax traillii extimus*), Yuma clapper rail (*Rallus longirostris*), lesser long-nosed bat (*Leptonycteris curasoae yerbabuenae*), California brown pelican (*Pelecanus occidentalis californicus*), desert pupfish (*Cyprinodon macularius*), Gila topminnow (*Poeciliopsis occidentalis*), razorback sucker (*Xyrauchen texanus*), Arizona hedgehog cactus (*Echinocereus triglochidiatus var. arizonicus*), and Nichol's Turk's head cactus (*Echinocactus horizonthalonius var. nicholii*). Threatened species include the bald eagle (*Haliaeetus leucocephalus*), Mexican spotted owl (*Strix occidentalis lucida*), loach minnow (*Tiaroga cobitis*), and spikedace (*Meda fulgida*). The proposed endangered species is the Gila chub (*Gila intermedias*). The two candidate species for listing are the yellow-billed cuckoo *(Coccyzus americanus)* and Acuña cactus *(Echinomastus erectocentrus var. acunensis).* The federal threatened or endangered species are listed in Table C (following page).

In addition, the Arizona Game and Fish Department has identified three special status species that have been documented as occurring within three miles of the project location (AGFD letter dated 3/9/2006). These species include two federal species of concern the Gila longfin dace (*Agosia chrysogaster chrysogaster*) and the Sonora sucker (*Catostomus insignis*) and one state wildlife species of concern the Sonoran desert tortoise (*Gopherus agassizii*). As the arroyos upstream of the FRS are dry except during heavy rainfall events and do not support fish populations the Gila longfin dace and the Sonora sucker are not expected to be present at the project site. The Sonoran desert tortoise may have marginally suitable habitat at the project site and may pass through the area but have not been observed.

Table C. Federal Threatened and Endangered Species

Common Name	Scientific Name	Federal Listing Status[1]	Known Occurrence?[2]
Southwestern Willow Flycatcher	*Empidonax trailii extimus*	E	No
Yuma Clapper Rail	*Rallus longirostris yumanensis*	E	No
Lesser Long-nosed Bat	*Leptonycteris curasoae yerbabuenae*	E	No
California Brown Pelican	*Pelecanus occidentalis californicus*	E	No
Desert Pupfish	*Cyprinodon macularius*	E	No
Gila Topminnow	*Poeciliopsis occidentalis*	E	No
Razorback Sucker	*Xyrauchen texanus*	E	No
Arizona Hedgehog Cactus	*Echinocereus triglochidiatus var. arizonicus*	E	No
Nichol's Turk's Head Cactus	*Echinocactus horizonthalonius var. nicholii*	E	No
Bald Eagle	*Haliaeetus leucocephalus*	AD, T	No
Mexican Spotted Owl	*Strix occidentalis lucida*	T	No
Loach Minnow	*Tiaroga cobitis*	T	No
Spikedace	*Meda fulgida*	T	No
Gila Chub	*Gila intermedia*	PE	No
Yellow-Billed Cuckoo	*Coccyzus americanus*	C	No
Acuña Cactus	*Echinomastus erectocentrus var. acunensis*	C	No

[1]AD = Proposed Delisting, C = Candidate Taxon, Ready for Proposal, E = Endangered, PE = Proposed Endangered, T = Threatened
[2] Species that are not known to occur, but have marginally suitable habitat present include the bald eagle, lesser long-nosed bat, yellow-billed cuckoo, and Acuña cactus.

The habitat requirements of these species were reviewed. Most of the species do not have any potentially suitable habitat in the study area, and are thus not likely to occur in the study area. Bald eagles may pass through the study area while foraging but have not been observed; and the lesser long-nosed bat, yellow-billed cuckoo, and Acuña cactus may have marginally suitable habitat at the study site but have not been observed. There are no known occurrences of any of these species in the study area. In addition, the project does not occur in the vicinity of any Proposed or Designated Critical Habitats (AGFD letter dated 3/9/2006). Potential effects of project action on these species are discussed in Section 5.0 and additional species information is provided in Appendix C.

3.12 Health and Human Safety

The FRS currently provides flood control benefits for the population of the Town of Florence and some associated areas. This benefit reduces flooding of roads, residential and commercial development and the prisons. This reduces the potential loss of life from a catastrophic flood event, particularly in the prisons where inmates cannot rapidly move to a safe location. It also allows emergency vehicles to transit area roads without interruption.

3.13 Transportation

The Town of Florence is the connection point for State Route 287 and U.S. Highway 89 (State Route 79). The major local roadways in the Town include Hunt Highway, Main Street/Butte Avenue, and Kenilworth/Cactus Forest Road. Average daily traffic counts on U.S. Highway 89 are 10,100 and on SR 287 are 8,300. Traffic counts within the roadways in the Town exceed 5,000 daily. These roadways are all currently protected by the FRS (Town of Florence 2003). Kelvin Road crosses over the top of the FRS and connects the Florence with prison facilities and other points east of the FRS. The road crosses the existing flood pool and is subject to temporary inundation during flood events. The Florence-Kelvin Highway lies south of the FRS and provides an alternative rout that is not subject to inundation.

3.14 Land Use

The majority of the watershed is occupied by Arizona State Trust Lands which are currently leased for grazing. Interspersed are private lands and lands managed by the Bureau of Land Management (BLM) (Town of Florence 2003). Land use in the study area and the Town of Florence consists primarily of urban, rural residential, agriculture, commercial/prison, and rangeland. The majority of the study area and the associated arroyos have been designated as Recreation Open Space in the Town of Florence Land Use Plan (2003). Other designations include Prison and Rural Residential and Ranchette Residential.

During the planning of the Florence FRS in 1961, a watershed analysis was conducted and land use was described (Pinal County and Florence-Coolidge Soil Conservation District 1961). At that time, the Town of Florence included 150 acres of urban and commercial development with 5,600 acres of valuable irrigated farm land within the floodplain. This area was mostly subdivided and contained numerous dwellings. The 44,080 acres above the dam was described as desert range land used for grazing livestock. Agricultural land has declined and now 4,880 acres downstream of the FRS are agricultural or pasture.

The current existing land use upstream of the FRS (Table D) was estimated on the basis of previous studies, inspection of recent aerial photographs, and field reconnaissance. An estimate of the future land use conditions (Table D) was made based on the Florence General Plan Update (Town of Florence 2003), the Pinal County Comprehensive Plan (Pinal County BOS 2004), and

a preliminary concept development plan provided by the Arizona State Land Department (ASLD 2006).

Table D. Land Use Upstream of the Florence FRS

Land Use	Acres	%
Existing Conditions		
Open Space (Sonoran Desert Scrub)	40,380	90.9
Open Space – Flood Pool (Sonoran Desert Scrub)	1,260	2.8
Low Density Residential	2,030	4.6
Institutional (Prison)	750	1.7
Total (1)	**44,420**	**100.0**
Future Conditions		
Open Space (Sonoran Desert Scrub)	17,800	40.1
Open Space - Flood Pool (Sonoran Desert Scrub)	1,260	2.8
Low Density Residential	7,090	16.0
Medium Density Residential	165	0.4
High Density Residential	17,310	39.0
Institutional	750	1.7
Industrial/Commercial	45	0.1
Total (1)	**44,420**	**100.0**

1) Includes the 39,170 acre regulated area upstream of the dam and the 5,250 acre unregulated area that drains to the CAP embankment just downstream of the principal spillway.

3.15 Land Rights and Relocations

The lands in the vicinity of the FRS are in both private and public ownership and are summarized in the table below.

Table E. Current Land Ownership		
Land Ownership	**Flood Hazard Area below the Dam (Acres)**	**Florence FRS and Flood Pool* (Acres)**
Federal Government	455	90
State of Arizona	1330	670
Pinal County	100	0
Town of Florence	380	0
FAWFCD	30	55
Private	4815	340
Total	**7110**	**1155**
* Dam footprint area plus inundation area for the maximum water surface elevation under the Recommended Plan (Alterative 4)		

3.16 Agricultural Lands

Currently the agriculture industry only makes up 1.7 percent of the work force in Florence, Arizona. Historically, agriculture was the top economic producer of the area, with cotton as the primary crop. Today, crops of cotton, corn, grains, alfalfa, herbs, and some vineyards are present in the vicinity of Florence. The *Benefit-Cost Analysis for Florence Flood Retarding Structure* that was prepared for the FAWFCD (Dibble and Associates 2003) identified 2,176 acres of farmland and pasture land located downstream of the FRS (Dibble and Associates 2003). Based on review of aerial photos and parcel data from the Pinal County Assessor's Office it appears that 4,880 acres of land are devoted to agriculture and pasture. All of the farms in this area are considered to be prime and important farmlands.

3.17 Environmental Justice

The U.S. Census Bureau Website (2006) reports that the population of Florence, Arizona is 17,054 with approximately 35 percent of the residents having Hispanic or Latino ancestry and 4.4 percent Native American. Florence has a low rate of unemployment (0.9 percent, compared with the state average of 3.4 percent and U.S. average of 5.6 percent in 2000), and 7 percent of the residents are living below the poverty line, compared to the 13.9 percent state average. Prison inmates are counted in the total population.

Per capita income in Florence is $11,278 (55.6 percent of the Arizona average, and 52 percent of the U.S. average), which reflects the fact that many of the residents are in prison. Median home values in Florence are $88,000 (72.5% of median for Arizona and 73.5 percent of the U.S.

median). See Table F for additional census data. The significant industry is public administration (48.5 percent) provided by the prisons and County and City government.

Table F. Socio-Economic Data

Location	Population	Median Value of Owner-Occupied Housing		Average Per Capita Median Income		Average Unemployment Rate	
		Value ($)	Relation to State Average	Income ($)	Relation to National Average	%	Relation to National Average
Florence, Arizona	17,054	$88,000	72.5%	$11,278	52.2%	0.9%	16.1%
Pinal County, Arizona	179,727	$93,900	77.4%	$16,025	74.2%	3.9%	69.6%
State of Arizona	5,130,632	$121,300	NA	$20,275	93.9%	3.4%	60.7%
United States	281,421,906	$119,600	NA	$21,587	NA	5.6%	NA
(Source: U.S. Census Bureau 2006)							

Population growth in the Town of Florence increased by 133 percent from 1990 to 2000 (Town of Florence 2003) largely due to the growth of the Arizona State Prison-Florence and Corrections Corporation of America (CCA) facilities. Currently, three-quarters of the Town's population are inmates in state and private facilities. The Town has exhibited a low rate of overall population growth when the impact of the incarcerated segment is removed. The projected residential population growth is expected to grow 5 percent between years 2008-2010, and 8 percent between years 2011-2020 (Town of Florence 2003). The population protected by the Florence FRS is relatively high in minority ethnic groups or disadvantaged economically and includes a high population of prison inmates. This population benefits significantly from the flood control benefits provided by the FRS.

3.18 Air Quality/Noise/Light

Air Quality

Pinal County formed the Pinal County Air Quality Control District in 1967 to provide air quality protection and regulation. Currently, there are ambient air quality standards for particulate matter, sulfur oxide (dioxide), ozone, carbon monoxide, nitrogen dioxide, and lead. There are no air quality ordinances for the Town of Florence.

Noise

The Town of Florence restricts the noise of construction to the daytime hours after dawn and ending at dusk. There are no noise ordinances in Pinal County.

Light

Pinal County has a light pollution code which is intended to restrict the permitted issues of outdoor artificial illuminating devices emitting undesirable rays into the night sky which have a detrimental effect on astronomical observations. This code includes shielding and filtration requirements and prohibitions on specific lighting types. There are no light ordinances for the Town of Florence.

3.19 Cultural Resources

A cultural resource inventory was conducted at the Florence FRS, the area immediately upstream of the FRS, and at the auxiliary spillway to determine if cultural resources that are eligible for inclusion in the National Register of Historic Places would be impacted by proposed alternatives. The inventory included a literature review and records search, and a 100 percent-coverage pedestrian survey. The records search included the expected project areas (FRS and auxiliary spillway) plus one mile surrounding, and was conducted to determine if any resources had been previously recorded in the vicinity of or within the study area. The pedestrian survey was conducted of intact locations that could be disturbed through construction activities associated with the alternatives. Because of the extent of previous disturbance caused during original construction of the FRS, especially in the area immediately upstream from the FRS, the only area that underwent pedestrian survey was at the auxiliary spillway. Portions of the spillway appear to be previously disturbed through blading, though there are some intact, undisturbed areas.

Potential locations for construction of a channel system (under a decommissioning alternative) in the agricultural area northeast of the Arizona State Prison were not surveyed at this time. In addition, the south side of the northern wing of the existing FRS was not surveyed. No construction activities would be undertaken in these un-surveyed areas until cultural resource inventories have been completed and the NRCS has conducted consultation with the Arizona State Historic Preservation Officer (SHPO), per Section 106 of the *National Historic Preservation Act*.

One previously recorded archaeological site was identified during the records search as being located within the auxiliary spillway survey area. Located on the ridge above the spillway, records indicate that it has been destroyed through maintenance and powerline construction, and the pedestrian survey could not relocate it. The pedestrian survey identified two historical-era features and four isolated occurrences of prehistoric artifacts in the spillway survey area. One feature is a concrete post with iron rebar sticking out of the top and a degraded two-by-four set in the ground next to it. The other feature is a corner brace for an abandoned barbed-wire fence. The four isolated occurrences include an undecorated brown ceramic sherd, a quartzite tested cobble or core, a basalt tertiary flake and a quartz primary flake (found together), and a basalt core. None of these resources is considered eligible for listing on the National Register of

Historic Places due to the lack of significance of the resources. The FRS was constructed in 1964 to protect the Town of Florence and agricultural lands. Because the FRS does not meet the National Register threshold of 50 years, it is not considered eligible to the National Register of Historic Places. The area upstream of the FRS was used as borrow to build the structure, and has been extensively disturbed. Thus, there are no National Register-eligible properties within the survey areas at the FRS, the area immediately upstream of the FRS, and the Overflow Spillway.

Two reports detailing the findings of the cultural resource inventories have been prepared (Kelso and Chua 2004; Kelso and DeSimone 2005). Both reports have been submitted by the NRCS to the Arizona SHPO for consultation, per Section 106 of the National Historic Preservation Act and its implementing regulations, 36 CFR Part 800. The SHPO has concurred with the NRCS' determination that no historic properties are located within these areas. These reports were also submitted by the NRCS to the Salt River Pima-Maricopa Indian Community, the Yavapai-Apache Nation, the Pascua Yaqui Tribe, and the Yavapai-Prescott Indian Tribe for consultation. No cultural resources concerns were raised by the Tribes.

A cultural resource inventory, report preparation, and consultation with the Arizona SHPO for the un-surveyed portions would occur prior to any construction activities taking place in those areas. It is unlikely that intact archaeological sites would be identified during the inventory for the study area northeast of the Arizona State Prison due to extensive disturbance caused by plowing of the agricultural fields and construction of the existing canals and irrigation system. However, the irrigation systems themselves would have to be evaluated for eligibility to the National Register and impacts determined. It is unlikely that intact archaeological sites would be identified in the study area due to previous ground disturbance.

3.20 Aesthetics

The Town of Florence is located in the low elevation valley of the Gila River and Sonoran Desert. Typical vegetation includes saguaro-palo verde forest and mesquite-palo verde bosques. The town is urbanized and visible architecture includes many historic buildings as well as newer buildings for the Town of Florence and Pinal County governments. The infrastructure for the Arizona State Prison is visible throughout most of the town. Views are present to the Desert Springs and Tortilla Mountain Ranges to the east, the Pinal Mountains to the northeast, the Superstition Mountains to the North, and the Sacaton Mountains to the west. Air quality is frequently reduced by dust and other particulates and views/visibility can be reduced.

The Florence FRS is located on the edge of town adjacent to the Central Arizona Project canal. It is readily visible and appears as a human constructed levee or small dam. Sparse vegetation occurs on the FRS and serves to blend the structure into its surroundings.

4.0 PLAN FORMULATION AND ALTERNATIVES

4.1 Scope of the Watershed Plan and Environmental Assessment

The scoping process followed the general procedures contained in Section 504.37 of the NRCS National Watershed Manual. The procedures require that environmental and cultural resources be considered early in the planning process by an interdisciplinary team of technical specialists, in consultation with all interested parties. To focus planning efforts on those concerns that may be affected by, or have an effect on potential alternatives, the scoping process was used to solicit comments of diverse viewpoints from stakeholders. This includes farm owners and operators; interested citizens; members of state, local, and Federal agencies; and scientific and special interest groups. The scoping process was used during development of the Florence FRS Watershed Plan and Environmental Assessment to focus planning efforts on problems and opportunities of most importance to all interested parties. Scoping was utilized to narrow the goals of the planning effort and thereby narrow the range of reasonable alternatives. Comments and questions were solicited from local citizens, groups, and local, state, and Federal agencies throughout the planning effort. Areas of potential concern were evaluated and are listed in Table G along with their significance to decision making.

The first public scoping meeting to solicit input on the planning process for the Florence FRS was held on January 25, 2006 in Florence, Arizona. Meeting notices/announcements were published in local newspapers, mailed to approximately 60 stakeholders, and electronic copies sent to the Town of Florence, Pinal County, and the Pinal County Library for posting on their respective websites. The FAWFCD and the NRCS provided a program overview at the meeting. Tetra Tech, Inc. facilitated the meeting and provided an overview of the study and the scheduled activities. Input and comments were collected and documented from interested parties. Table H identifies relevant concerns identified during the public scoping process.

The **overall formulation goal**, as indicated by the sponsors, is to provide for continued flood protection for the Town of Florence, Arizona, and surrounding areas, while meeting all of the standards set by ADWR and the NRCS for safety and reliability of the FRS.

Table G. Identified Concerns

Economic, social, environmental, and cultural issues or concerns	***Degree of concern***	***Degree of significance to the decision making***	***Remarks***
Surface Water	High	High	The existing structure does not pass the PSH without overtopping the auxiliary spillway. The existing auxiliary spillway does not have capacity to convey the PMF.
Water Quality	Moderate	Moderate	A dam breach could result in flooding of the Florence wastewater treatment plant.
Water Conveyance Infrastructure	High	High	The CAP canal just downstream of the structure provides M&I water to Tucson and portions of southern Arizona.
Sedimentation	Moderate	Moderate	The existing structure has adequate sediment storage.
Vegetative Community	Moderate	Moderate	Plans will be developed to minimize effects on vegetation.
Wetlands	Low	Low	There are no wetlands identified in the vicinity of the dam.
Fish and Wildlife	Low	Low	
Threatened and endangered species	High	Low	No occurrences in study area
Health and Human Safety	High	High	Health and human safety is at high risk if no action is taken.
Transportation	High	High	Plans will be developed to minimize effects on transportation.
Land Use	High	High	Land uses downstream of the FRS are at high risk if no action is taken.
Land Rights	Moderate	Moderate	
Agricultural Lands/Highly Erodible Croplands	High	High	Agricultural lands are at high risk if no action is taken.
Demographics, Minority, and Disadvantaged Populations	Moderate	Moderate	Minority and disadvantaged downstream of the FRS are at high risk if no action is taken.
Air Quality/Noise/Light	Low	Low	Plans will be developed to minimize effects on air quality, noise and light
Cultural Resources	High	Low	Few cultural resources have been identified in the vicinity of the dam.
Aesthetics	Low	Low	Plans will be developed to minimize effects on aesthetics.

Table H. Issues Identified during the Public Scoping Process

Issues and Concerns	Remarks
Impact of alternatives on State land	An overall watershed approach that considers impacts on the contributing watershed as well as at the FRS itself; a multi-purpose approach that includes land management, upstream detention, and recreation would provide more opportunities for funding.
Coordinate hydrologic analyses with the range conservationists managing some of this property	Hydrologic models developed during the Initial Assessment Phase will be updated and used in the Planning Phase. Hydrologic analyses will need an estimate of future development on the contributing watershed.
Benefits and Costs	Assumed that alternatives will be looking for the permanent solution and suggested going from a one-dimensional solution to multiple purpose solution, e.g., not just for flood control but maybe an overall watershed management approach.
Permanent solution to address inadequacies	Cracking repairs to address the embankment deficiency and the rehabilitation project to address emergency spillway deficiency are permanent solutions.
Lifecycles of the CAP and irrigation canals	Other factors in the area must be taken into consideration (i.e., plans of Pinal County and Town of Florence for the next 5 to 10 years).
Conceptual land use plan for the Florence area	Recommend coordination with Arizona State Land Department.
The south end of the dam, where it was relocated for the CAP canal, may not be built to FEMA standards; the area protected by that end of the dam may fall into a 100-year floodplain	Any issue at the south end would be addressed as part of the rehabilitation.

4.2 Preliminary Alternatives

Several alternatives were identified for plan formulation based on the technical analyses, public scoping, and suggestions from the FAWFCD, Arizona State Land Department, and the ADWR. These alternatives are listed below:

- No Federal Action. As discussed in Section 2.11 – Regulatory Considerations, the FAWFCD has determined that ADWR will not issue an order to repair or breach the FRS in the future. Therefore, the most likely future condition is that the FRS would remain in place and would continue to operate with previously described inadequacies in storage, auxiliary spillway capacity, and auxiliary spillway integrity. The embankment cracking deficiencies have been addressed by the installation of the central filter drain.
- Breach of the FRS by the sponsors with no downstream flood mitigation. Because of the

length of the FRS, multiple breaches would be necessary.

- Decommission the FRS by removal of the entire structure and stabilization of the site.
- Decommission the FRS by breaching at multiple locations and construction of stable channels to convey flood flows through the Town of Florence to outfalls at the Gila River.
- In conjunction with a decommissioning alternative, other modifications could include:
    - Relocating residents downstream of the FRS.
    - Elevating residential structures downstream of the FRS.
    - Flood-proofing.
    - Installing a flood-warning system.
- Development of a comprehensive watershed management and development plan in conjunction with rehabilitation.
- Rehabilitation of the FRS to meet current State and Federal dam-safety standards. Rehabilitation would include (1) increasing storage volume to contain the PSH with future development on the watershed; (2) increase the capacity of the auxiliary spillway to convey the inflow design flood with appropriate freeboard; and (3) provide revetment to ensure integrity of the auxiliary spillway.
    - Potential rehabilitation alternatives to address the storage of the PSH include the following:
        - Permanently raise the crest of the auxiliary spillway to provide sufficient storage to contain the PSH.
        - Raise the crest of the auxiliary spillway to contain the PSH, but construct fuse plugs or a breakaway berm so that the spillway erodes back to the original crest elevation for significant spillway flows.
        - Increase conveyance through the principal spillway by replacing the existing pipe with one having a larger diameter, or by adding an additional pipe to supplement the flows.
    - Potential rehabilitation alternatives to address the auxiliary spillway capacity include the following
        - Raise the top of FRS to contain the inflow design flood with the existing auxiliary spillway. Provide revetment to ensure integrity of the auxiliary spillway if needed.
        - Widen the existing auxiliary spillway to convey the inflow design

flood.

- Combination of widening the existing auxiliary spillway and raising the top of the FRS to proved conveyance for the inflow design flood.
- Install a labyrinth weir to increase capacity of the auxiliary spillway.
- Construct an additional auxiliary spillway to supplement the existing auxiliary spillway.

- Potential rehabilitation alternatives to address the integrity of the auxiliary spillway include:
  - Roller compacted concrete or soil cement revetment to prevent headcutting.
  - Sheet-pile cut-off wall along the spillway crest to prevent headcutting.

4.3 Alternative Measures Considered

A wide variety of alternative measures were identified for plan formulation. These measures were grouped into the three categories addressing the identified inadequacies: storage, auxiliary spillway capacity, and auxiliary spillway integrity.

Continuing plan formulation efforts focused on further screening of the various measures to either screen out those that were not capable of achieving the purpose of the study, were less productive compared to other measures, and were inappropriate for Federal participation or unsupported by the sponsors, or carried forward for additional development and evaluation. These measures are discussed in the following sections.

4.3.1 Storage

Enlarge Principal Spillway

This measure would entail replacing the existing principal spillway (42-inch RCP) with a larger pipe, or adding an additional pipe to increase outflows and reduce the maximum water surface elevation during the PSH. It would also require enlargement of the 5,900-foot-long principal spillway outlet channel and associated facilities that extend from the dam to the Gila River. The facilities include the overchute at the CAP canal, a splitter structure and siphon under the Florence-Casa-Grande canal, a 2,060-foot-long section of reinforced concrete channel, a St. Anthony Falls (SAF) type drop structure, and the 2,220-foot-long section of earthen channel that ends at the Gila River. This alternative is ruled out because of the difficulty in working around the existing canal structures and obtaining additional rights-of-way to enlarge the outlet channel and the structures. This alterative would primarily affect the PSH. It would do little in terms of reducing the required crest elevation or in reducing the spillway width to contain the PMF.

Permanently Raise the Crest of the Auxiliary Spillway

This would entail permanently raising the crest of the auxiliary spillway to an elevation of 1,568.5 to pass the 10-day PSH through the principal spillway without overtopping the auxiliary spillway. It is ruled out since it would reduce the capacity of the auxiliary spillway and would require further raising of the FRS.

Raise Auxiliary Spillway Crest with a "Fuse Berm" Structure.

This would entail raising the crest of the auxiliary spillway to an elevation of 1,568.5 to pass the 10-day PSH through the principal spillway without overtopping the auxiliary spillway. The crest would be raised by construction of an earthen embankment to the necessary height across the width of the spillway. For purposes of this study, the berm would have a 14-foot top width and 3H:1V side slopes. It would be located on the forebay just upstream of the auxiliary spillway crest. Given an invert elevation of 1,564.2 for the forebay, the height of the fuse berm would be 4.3 feet. A fuse berm of this nature would contain the PSH but would erode during an overtopping event[9]. In the IDF, it is expected that the berm would erode down to the original auxiliary spillway crest elevation of 1,565.2 feet and would allow full capacity of the auxiliary spillway. This approach is adopted for use in the alternatives that address spillway capacity.

4.3.2 Auxiliary Spillway Capacity

Auxiliary spillway capacity can be increased by widening the auxiliary spillway crest, increasing the depth of flow by raising the FRS[10], or by a combination of the two. The table below summarizes the maximum water surface profile based on the one-dimensional full dynamic wave (FDW) analysis using the unsteady version of HEC-RAS for three spillway widths. (Cross section locations are shown in the documentation for Hydrology and Hydraulics.)

[9] The berm could be armored to prevent wash out during relative low overtopping events (e.g. the 500-year event), as long as full wash out was assured in the larger events. If a rehabilitation plan is justified, this would be something to pursue during the design phase.

[10] The existing auxiliary spillway channel is fairly flat and would not likely provide supercritical flow if it the crest was significantly lowered. In order to maintain a good hydraulic control at the auxiliary spillway crest (after washout of the fuse-berm) the existing crest elevation is considered to be a practical minimum. Therefore, additional capacity cannot be obtained by lowering the crest of the auxiliary spillway.

Table I. Maximum Water Surface Elevations, 24-Hour PMF

	Unsteady HEC-RAS Maximum Water Surface Elevations, 24-hour PMF					
	Raise FRS, Existing Auxiliary Spillway Width		Max Widening of Auxiliary Spillway to 2,400'		Raise FRS, Widen Auxiliary Spillway to 800'	
HECRAS Cross Section	WSEL (ft)	Ht. Abv. FRS Crest (ft)	WSEL (ft)	Ht. Abv. FRS Crest (ft)	WSEL (ft)	Ht. Abv. FRS Crest (ft)
0.581	1576.74	4.14	1569.13	0.00	1573.68	1.08
1.163	1577.60	5.00	1570.6	0.00	1575.53	2.93
1.73	1578.03	5.43	1572.95	0.35	1576.27	3.67
2.318	1578.21	5.61	1573.6	1.00	1576.56	3.96
3.106	1578.41	5.81	1574.31	1.71	1576.87	4.27
3.232	1578.44	5.84	1574.43	1.83	1576.93	4.33
3.701	1578.47	5.87	1574.5	1.90	1576.97	4.37
4.051	1578.49	5.89	1574.54	1.94	1576.99	4.39
4.328	1578.50	5.90	1574.6	2.00	1577.02	4.42
4.641	1578.52	5.92	1574.63	2.03	1577.03	4.43
5.19	1578.54	5.94	1574.73	2.13	1577.07	4.47

Raise FRS, Existing Auxiliary Spillway Width

This measure considers raising the FRS to convey the IDF through the existing auxiliary spillway. It would maintain the 400-foot bottom width and would extend the 2H:1V side slopes extended to the ultimate top of dam. Given this assumption, the computed maximum water surface elevation is 1,578.54 and is 6.0 feet (rounded) above the existing top of the FRS. Given a freeboard height of 1.75 feet (Appendix C), the total height increase would be 7.75 feet. This alternative measure is adopted as a potential alternative for rehabilitation.

Maximum Widening of Auxiliary Spillway to 2,400 Feet

This measure considers the maximum widening of the auxiliary spillway and assumes a crest width equal to the width of the flood pool (2,400 feet). This approach would result in significant earthwork and is questionable in terms of proper design for the inlet channel and exit channel of the auxiliary spillway. Even if it could be constructed, the hydraulic analysis shows that maximum water surface elevation is still as much as 2 feet above the existing dam crest elevation of 1,572.6. When the required freeboard is added on it will be even more. This approach is not effective and is ruled out.

Raise FRS, Widen Auxiliary Spillway to 800 Feet

This measure considers a combination of widening the auxiliary spillway to 800 feet and raising the top of the FRS. The 800-foot bottom width was selected as a practical maximum since it basically follows the layout of the existing auxiliary spillway and provides a reasonable plan and profile for the inlet channel, spillway crest, and exit channel. Further widening on the outside edge of the spillway is constrained by an existing electrical substation on the hillside just east of the auxiliary spillway. Widening to the outside would also require extensive earthwork as the top of the hillside is located at an elevation 20 to 30 feet above the auxiliary spillway crest. Further widening to the inside edge would require relocating the north wing of the FRS further south as well as relocation of the principal spillway. As shown in the table, the computed maximum water surface elevation is about 4.47 feet above the existing top of the FRS. Assuming a freeboard height of 1.75 feet, the total height increase would be 6.2 feet. This alternative measure is adopted as a potential alternative for rehabilitation.

FRS Raising Considerations

One option to raise the FRS is to add fill on the upstream and downstream slopes so that the existing centerline is held constant. This would allow for vertical extension of the filter drain, but would require removal and replacement of the erosion protection that was placed on the downstream slope under the cracking repair project. It would also require additional slope preparation work and might require additional right-of-way on the downside. As a result, this approach is ruled out.

A preferred option would be to raise the FRS is to add an earthen buttress to the upstream side of the dam. The new buttress would have a 14-foot top width, a 2H:1V slope on the downstream side and a 3H:1V slope on the upstream side. The 2H:1V slope on the downstream side would be aligned so that it matches up with the existing downstream slope to form a continuous face. The central filter drain would be extended vertically to a point with one foot of the 2H:1V slope on the downstream side of the added fill (Figure 9). The upstream buttress will be founded on collapsible Holocene soils and thus includes an upstream cutoff trench to support the buttress and to limit the subsurface migration of water under the dam when the flood pool is filled. There is ample right-of-way on the upstream side so extension of the upstream toe would not be a problem. However, the inlets to the principal spillway and the two gated outlets would have to be relocated to a point upstream of the new toe. This is approach is adopted for use in the rehabilitation alternatives.

Based on the current version of TR-60 (July 2005), the 14-foot top width of the existing embankment is adequate for the proposed maximum height of 33 feet (under the first case described above). The ADWR requires a top width of 11.9 feet (height/5+5 feet = 34.35/5+5). The proposed top width of 14 feet is sufficient for state criteria as well.

4.3.3 Auxiliary Spillway Integrity

Integrity analyses for the auxiliary spillway were conducted for the following conditions.

- Existing condition with flows limited to the capacity of the auxiliary spillway
- Rehabilitation – Existing auxiliary spillway (400-foot bottom width), raise FRS to contain IDF
- Rehabilitation – Widen auxiliary spillway to an 800-foot bottom width, raise FRS to contain IDF
- Rehabilitation – Widen auxiliary spillway to a 2,400-foot bottom width

The erosion analysis was conducted using the Earth Spillway Erosion Model described in Chapter 51 of NEH Part 628-Dams. The method is included in the NRCS SITES program. The hydrographs for each trial were taken from the WinTR-20 modeling for the 24-hour PMF[11] and were input directly into SITES. The valley floor was set at an elevation of 1,552 feet which corresponds to the approximate elevation at the CAP embankment[12]. The required inputs for soil mechanics were derived based on the boring in the auxiliary spillway shown on the as-built drawings. The logs extend to depths of 10 to 12 feet and show a preponderance of sand (M, SM). It assumed that this material extends to the valley floor.

The results show that the spillway crest is breached in each of the above trials. The following conclusions can be drawn:

1. The existing auxiliary spillway breaches during an event that is much less than the IDF and is therefore deficient in terms of integrity as defined by NRCS criteria.
2. The two adopted rehabilitation alternatives will require revetment to prevent a breach of the auxiliary spillway.
3. Widening to 2,400 feet, which substantially reduces the unit discharge, does not prevent a breach and is further reason not to pursue this alternative.

Revetment to prevent breaching of the auxiliary spillway could consist of sheet pile or a roller compacted concrete facing that extends below grade. During field investigations conducted in February 2006, it was noted that flows in the exit channel of the auxiliary spillway are contained

[11] For the existing condition, the ordinates of the 24-PMF were proportionally reduced to provide a hydrograph that would not over top the existing top of the FRS (based on WINTR-20 level pool routing). The peak for this "existing spillway capacity hydrograph" was 18,750 cfs.

[12] The valley floor parameter is subjective. The 1552-foot elevation at the upstream toe of the CAP embankment was chosen since it is the downstream most point where flows from the auxiliary spillway are confined by either the FRS or existing topography. The longitudinal slope downstream of the CAP canals is still fairly steep, but flows are no longer confined and would likely spread. In addition, the concrete lining of the canal itself will impede initial development of the headcut.

by the 750-foot-long north wing of the FRS main embankment. To prevent erosion and potential embankment failure during spillway flow events, the rehabilitation alternatives will also include additional revetment along the toe of the FRS where it parallels the exit channel.

Sheetpile

Given the sandy soils shown in the boring logs, it appears that sheetpile could be driven at the downstream edge of the spillway crest to arrest any headcutting during the IDF. A reinforced concrete pile cap would be constructed to form a uniform crest elevation of 1,565.2 across the length of the spillway. Given a valley floor elevation of 1,552 feet, the total expected height of the headcut is 13.2 feet. Assuming that the sheetpile would require a toedown equal to twice the exposed height, the total length of pile would be about 40 feet. This approach is applicable to the rehabilitation alternatives (auxiliary spillway widths of 400 and 800 feet). The sheetpile can also be used to revet the toe of the main embankment that parallels the exit channel. Additional revetment will be required above grade to reinforce the left bank (looking downstream) of the auxiliary spillway crest. The right bank will be cut into an existing hillside and does not need protection.

There is some uncertainty in regards to the materials below the depths shown in the boring logs on the as-built plans and there could be layers of material that would impede placement of sheetpile. Therefore, this approach is ruled out for the planning level design. If this approach is reconsidered during an implementation phase, additional subsurface investigations would need to be performed in the spillway area.

Roller Compacted Concrete (RCC)

The auxiliary spillway crest could be armored with an RCC revetment having a compressive strength of 2500 pounds-per-square-inch (psi) at 30 days. A trench would be excavated along the length of the auxiliary spillway on the downstream side and the RCC would be placed at a 1.5H:1V slope. The RCC would extend 18 feet below the crest, to an elevation of 1,547.2, which is approximately 5 feet below the downstream valley floor elevation of 1,552 feet. The RCC would be constructed in 8-foot-wide, 2-foot-high lifts that are offset 3 feet to give the 1.5H:1V slope. The RCC would also extend upstream to cover the top of the auxiliary spillway. It would be 2 feet to 4 feet thick and would have a top elevation of 1,565.2 to match the existing auxiliary spillway crest elevation. At the upstream end, the RCC would have a 1.5H:1V toedown to a depth 8 feet below grade. After completion of the RCC, earth fill would be placed and compacted to restore the original grade of the entrance and exit channels.

The RCC revetment can also be used to protect the main embankment where it parallels the exit channel. The RCC would be constructed in 8-foot-wide, 2-foot-high lifts and would be laid directly against the 2H:1V slope of the FRS. Hydraulic analysis of the exit channel shows a flow depth of approximately 5 feet at the peak of the IDF. Thus the top of the revetment would be

constructed to a height of 8 feet above existing grade and would provide 3 feet of freeboard. This revetment would begin at the upstream end and would reinforce the left bank at the auxiliary spillway crest. It would extend downstream along the face of the FRS to a point near the outlet for the principal spillway. The toedown would be the same as the RCC toedown on the auxiliary spillway.

As in the case of the sheet pile alternative, there is some uncertainty in regards to the materials below the depths shown in the as-built boring logs and subsurface investigations should be included during the design phase. However, since the depth of excavation for the RCC is only 18 feet (roughly 6 feet below the depth of the borings) it has less uncertainty than driving sheet pile to a depth of 42.6 feet. In addition, the RCC approach would better accommodate rock or cobble layers that might impede or prevent sheet pile. As a result, the RCC revetment is the adopted method to address auxiliary spillway integrity.

4.4 Alternative Plans Selected for Detailed Study

The adopted measures described in the preceding section were assembled into a series of four alternative plans that adequately address the purpose:

- Alternative 1 – No Federal Action Plan
- Alternative 2 – Decommissioning with downstream mitigation
- Alternative 3 – Rehabilitation by raising the FRS
- Alternative 4 – Rehabilitation by raising the FRS and widening the auxiliary spillway.

The alternatives are discussed in detail in subsequent sections, and feasibility level designs and cost estimates for Alternatives 2, 3, and 4 are included in Appendix D – Supporting Information. Alternatives and measures not carried forward for further development are summarized in Section 4.5, Alternative Plans Considered but Eliminated from Detailed Study.

4.4.1 Alternative 1 – No Federal Action

The No Federal Action Plan assumes that the FRS will continue to be operated and maintained in its current condition, with known inadequacies in storage, auxiliary spillway capacity, and auxiliary spillway integrity. Given current development on the watershed, the FRS currently has enough storage capacity to safely pass an event somewhere between the 50-year and 100-year return interval events through the principal spillway, without overtopping the auxiliary spillway. Under future development conditions, runoff volume will increase and the FRS will only be able to pass just less than the 50-year flood event[13] without overtopping the auxiliary spillway. The hydraulic studies conducted for the Task 3 Report determined that the auxiliary spillway has a

[13] The hydrologic analyses show that the FRS passes the future conditions 50-year event with 0.06 feet of flow over the auxiliary spillway.

maximum capacity (i.e., with no freeboard) of approximately 18,750 cfs. Since the auxiliary spillway cannot convey peak outflow discharges for the 6-hour, 24-hour, and 72-hour PMF events (see Table J on page 43) without overtopping, it would be classified "deficient" by the ADWR. Since the auxiliary spillway capacity is less than 50% of the peak outflow (Table J) it would also be classified as "unsafe" by ADWR. Further, the hydrologic, hydraulic, and geotechnical analyses completed as part of this study have shown that the auxiliary spillway does not have the integrity to pass the inflow design flood without breaching. The Pinal County Department of Public Works noted that the above described inadequacies could result in the dam being decertified by FEMA. The properties currently protected by the dam would be placed into a flood hazard area and would be subject to flood hazard restrictions.

In October 2006 the NRCS and the FAWFCD completed construction of a central filter drain throughout the length of the FRS. The completed repair project addresses the embankment deficiency due to cracking.

4.4.2 Alternative 2 – Decommissioning with Downstream Flood Mitigation

Alternative 2 would decommission the FRS and would also include the necessary structural measures to convey flood flows up to the 100-year event to an adequate point of disposal at the Gila River, without flooding the Town of Florence. This alternative assumes that the FRS will be breached to prevent impoundments. Alternative 2 would convey flood water and sediment passing through the breaches for up to the 100-year event under future developed conditions. Given the length of the FRS, multiple breaches will be required.

The feasibility level design for this alternative assumes four individual channels (numbered 1 through 4) that will convey flows from the breach openings. Channel 1 and Channel 2 will combine into a single channel labeled Channel "1&2". Channel 3 and Channel 4 will combine into a single channel labeled Channel "3&4". The two combination channels will continue to separate outfalls at the Gila River. A layout of Alternative 2 is shown in Plan Sheet 8 and locations of the breaches are shown on Plan Sheets 3 through 7 (Appendix D). Each channel will initially start as an above-ground feature that will include an embankment to contain the side slopes and direct flows to the northwest. The channels will cross the CAP and Florence-Casa Grande Canal with multiple pipe overchute structures similar to those in place on the CAP. Once past the canals the channels can generally be constructed below ground to the confluences. From the confluences to the Gila River, the channels will be partly below grade and will require an embankment to contain the side slopes.

Channels 1, 2, 3, and 4 would generally follow a relatively steep slope (~1 percent) down the toe of the alluvial fan leading to the Gila River flood plain. They would have high velocities (15 fps to 30 fps) and supercritical flows. For purposes of this study, it is assumed that the channels would be constructed using a rectangular, reinforced-concrete cross section. For the given

discharges, the channels would have bottom widths that vary from 30 feet to 60 feet, and would have typical flow depths of approximately 5 feet. Based on the design criteria in the Pinal County Drainage Manual (Pinal County DPW 2004), the required freeboard for the supercritical sections would be as much as 5 feet so a 10-foot deep channel was adopted as the standard section. The above-ground rectangular concrete channels are designated as "Channel Type I". Below-ground rectangular concrete channels are designated as "Channel Type II" (Plan Sheet 11).

The combined Channels 1&2 and 3&4 are located on the Gila River floodplain and slopes are typically 0.2 percent to 0.5 percent. Flows are subcritical and velocities are typically 6 fps to 10 fps. For the purposes of this study, it is assumed that the channels would be trapezoidal with an earthen bottom and soil-cement protected 1H:1V sideslopes. For the 100-year peak discharges, channel widths would vary from 100 feet to 300 feet and would have typical flows depths of approximately 5 feet. Based on the Pinal County design criteria, the required freeboard for the subcritical sections would be 1 to 2 feet so a 7-foot deep channel was adopted as the standard section. The section is partly below ground and partly above ground and is designated as "Channel Type III" (Plan Sheet 11).

The proposed channels are located in agricultural areas north of Florence. The alignments were laid out to minimize impacts on existing roads and irrigation facilities so the channels are typically contained within existing farm fields. There are a number of locations where the proposed channels cross existing canals, roads and irrigation ditches en route to the Gila River, and are summarized below. Canal and ditch crossings are assumed to be siphons under the proposed channels. Roadway crossings at major roads over the Type II channels would consist of concrete box culverts. Minor road crossings at Type II channels and all road crossings at the Type III channels would consist of dip sections. The number of crossings and the range of crossing lengths for Alternative 2 are summarized below. Typical cross sections for each crossing type are shown on Plan Sheets 11 through 13.

Crossing Type	Number	Crossing Length (ft)
Florence Canal Siphon	4	78 feet to 105 feet
Irrigation Ditch Siphon	15	40 feet to 100 feet
Concrete Box Culvert Crossing	8	40 feet to 57 feet
Dip Section Crossing	17	40 feet to 300 feet

The total estimated construction cost for Alternative 2 is $49,505,500. Total cost including utility relocations, contingency (25%), mobilization (5%), stormwater pollution prevention plan,

construction surveying, supervision and administration (8%), engineering (10%), and real estate is $77,142,750. A copy of the cost estimate for Alternative 2 is included in Appendix D – Supporting Information.

4.4.3 Alternative 3 – Rehabilitation by Raising the FRS, Reinforcing the Auxiliary Spillway, and Providing Additional Flood Storage

Alternative 3 would rehabilitate the FRS so that it will (1) provide sufficient storage for the PSH, (2) provide adequate auxiliary spillway capacity to pass the inflow design flood, and (3) provide auxiliary spillway integrity to prevent breaching during the inflow design flood. The individual elements are addressed below.

4.4.3.1 Storage

The PSH (100-year, 10-day event) is the basis of design for the principal spillway. In order to provide sufficient flood storage without altering the principal spillway conduit, the crest of the auxiliary would be raised by 3.3 feet to a finished elevation of 1568.5 feet. The raised portion would be constructed as an engineered embankment with a 14-foot (minimum) top width and 3H:1V side slopes. The embankment would be designed to erode away when overtopped by a significant flow. It would thus contain the PSH, and allow the spillway crest to return to the original design elevation to provide needed capacity for the inflow design flood.

4.4.3.2 Auxiliary Spillway Capacity

The existing auxiliary spillway has a bottom width of 400 feet with 2H:1V side slopes and a crest elevation of 1,565.2 feet. The top of the FRS elevation is 1,572.6 feet giving a total flow depth of 7.4 feet. The capacity of the auxiliary spillway at maximum depth is 18,750 cfs. The capacity of the spillway at a depth of 6.4 feet (allowing one foot of freeboard) is 14,700 cfs. The percentage of the PMF peak discharge conveyed by the auxiliary spillway is summarized in the Table J. The capacity of the auxiliary spillway can be increased by raising the top of the FRS to provide sufficient depth to convey the IDF with a given freeboard. Given the current configuration, the maximum water surface elevation for the 24-hour IDF would be 1578.54 (Table I), which is approximately 6.0 feet above the existing dam crest elevation of 1572.6 feet. Given 1.75 feet of freeboard[14] the total height increase would be 7.75 feet.

The dam raise would be accomplished by adding an earthen buttress to the upstream side of the dam. The new buttress would have a 14-foot top width, a 2H:1V slope on the downstream side and a 3H:1V slope on the upstream side. The buttress would be aligned so that its downstream slope matches up with the existing downstream slope to form a continuous face. Previous geotechnical studies identified collapsible Holocene soils to a depth of approximately 10 feet in

[14] Determined from wave runup and wave setup summarized in the Documentation for Hydrology and Hydraulics.

the foundation. It is estimated that the excavation of the original borrow trench on the upstream side removed these soils to a depth of approximately 6 feet. Since the new earthen buttress would be founded in this area, the dam raise would include an upstream cutoff trench to support the buttress and to limit the subsurface migration of water under the dam when the flood pool is filled. The cutoff trench would be constructed by excavating in-situ soils and then backfilling and compacting with the excavated material (if suitable) or other suitable fill material. For the feasibility level cost estimate, the cutoff trench is assumed to be 6 feet deep, with a 12-foot bottom width, and 1.5H:1V side slopes (see Plan Sheet 14). Actual dimensions of the trench will likely vary along the length of the dam and would be refined using additional geotechnical data obtained during the design phase.

Table J. Comparison of Auxiliary Spillway Capacity and PMF Peak Discharge

	6-hour Local Storm Peak Discharge (cfs)	24-hour General Storm (3-2-1-4) Peak Discharge (cfs)	72-hour General Storm Peak Discharge (cfs)
Future Conditions Inflow Peak Discharge	52,461	50,372	48,002
Future Conditions Outflow Peak Discharge with dam raised to contain the maximum water surface elevation (1)	39,336	43,842	44,483
Passed by Existing Auxiliary Spillway with no Freeboard (capacity = 18,750 cfs)	48%	43%	42%
Percent Passed by Existing Auxiliary Spillway with 1- foot Freeboard (capacity = 14,700 cfs)	37%	34%	33%

1) The outflow peak discharges assume the dam is raised to contain the maximum water surface elevation are based on the full-dynamic wave analysis for the future condition.

4.4.3.3 Auxiliary Spillway Integrity

Integrity analysis of the existing auxiliary spillway shows that the crest will be breached during the inflow design flood. Revetment would be installed on the auxiliary spillway to prevent breaching during the IDF. At this level of analysis, the preferred approach is to revet the spillway using RCC with a compressive strength of 2500 psi at 30 days. As discussed in Section 4.3 - Alternative Measures Considered, the RCC revetment would extend 18 feet below the crest, to an elevation of 1547.2, which is approximately 5 feet below the downstream valley floor elevation of 1552 feet. The RCC would be placed in lifts that are 8 feet wide and 2 feet thick, with a 3-foot offset to give the 1.5H:1V slope. The RCC would also extend upstream to cover the top of the auxiliary spillway. It would be 4 feet thick and would have a top elevation of 1565.2 to match the existing auxiliary spillway crest elevation. At the upstream end, the RCC would have a 1.5H:1V toedown to a depth 8 feet below grade. After completion of the RCC, earth fill would

be placed and compacted to restore the original grade of the entrance and exit channels.

The minimum thickness of the RCC revetment perpendicular to the face of the auxiliary spillway is 3 feet. The proposed revetment on the 1.5H:1V slope provides an effective thickness of 4.4 feet perpendicular to the face. Given the 8-foot width for each lift, the thickness perpendicular to the face could be reduced to 3.0 feet by flattening the slope from 1.5H:1V to 2.5H:1V. There would be no change in the RCC quantities, but the flattening may aid in constructability. The 1.5H:1V slope on the spillway face is adopted for the feasibility level of design. Adjustments for a flatter slope can be further evaluated in a design phase.

The RCC revetment would also be placed along the front face of the main embankment where it parallels the exit channel. The RCC would be constructed in 8-foot-wide, 2-foot-high lifts and would be laid directly against the 2H:1V slope of the dam. The top of the revetment would be constructed to a height of 8 feet above existing grade give 3 feet of freeboard. This revetment would begin at the upstream end and would reinforce the left bank at the auxiliary spillway crest. It would extend downstream along the face of the FRS to a point near the outlet for the principal spillway. The toedown would be the same as the RCC toedown on the auxiliary spillway.

4.4.3.4 Summary and Cost

A profile of Alternative 3 is shown on Plan Sheets 3 through 7. A plan view of the auxiliary spillway is shown on Plan Sheet 9. Typical sections of the dam raise, the fuse berm, and the revetment are shown on Plan Sheets 14 and 15.

The total construction cost for Alternative 3, including 1.75 feet of freeboard is $12,790,300. Total cost including contingency (25%), mobilization (5%), stormwater pollution prevention plan, construction surveying, supervision and administration (5%), engineering (6%), and real estate is $19,416,000. Copies of the cost estimates are included in Appendix D – Supporting Information.

This alternative would require regrading the Kelvin Road crossing (to a grade that is less than 10%) to accommodate the proposed dam raise, and extending an existing concrete box culvert under Kelvin Road, just east of the dam. It will also require raising of manholes for an existing sewer line that crosses the dam along the Kelvin Road alignment. The construction costs for the Kelvin Road crossing, culvert modification, and utility work are estimated to be $437,100. Total cost including contingency (25%), mobilization (5%), stormwater pollution prevention plan, construction surveying, supervision and administration (10%) and engineering (15%) is $723,300. Since these costs are a necessary part of the dam raise, they are considered to be cost sharable. The total cost of Alternative 3, including Kelvin Road is $20,139,300.

The majority of the cost under Alternative 3 is for raising the earthen embankment. The NRCS and ADWR have different requirements for freeboard and the final height has not been

determined. The cost estimates presented herein are based on 1.75 feet of freeboard, but could be less if freeboard is reduced. Table K compares of the total cost for Alternative 3 (including the Kelvin Road crossing) with 1.75 feet of freeboard with no freeboard. The cost difference attributable to the freeboard is $3,473,600.

Table K. Comparison of Cost for different Freeboard Heights - Alternative 3

Freeboard Height (ft)	1.75	0
Dam Raise Height (ft)	7.8	6.0
Total Cost (1)	$20,139,300	$16,665,700

1) Including Kelvin Road modifications. Cost estimates are included in Appendix D – Supporting Information.

4.4.4 Alternative 4 – Rehabilitation by Raising the FRS and Widening the Auxiliary Spillway, Reinforcing the Auxiliary Spillway, and Providing Additional Flood Storage

Alternative 4 would rehabilitate the FRS so that it will (1) provide sufficient storage for the PSH, (2) provide adequate auxiliary spillway capacity to pass the inflow design flood, and (3) provide auxiliary spillway integrity to prevent breaching during the inflow design flood. The individual elements are addressed below.

4.4.4.1 Storage

As in the case of Alternative 3, the crest of the auxiliary spillway would be raised by 3.3 feet to a finished elevation of 1568.5 feet. The raised portion would be constructed as an engineered embankment with a 14-foot (minimum) top width and 3H:1V side slopes. The embankment would be designed to erode away when overtopped by a significant flow. The engineered embankment would extend across the entire width of the widened auxiliary spillway. It would thus contain the PSH, and allow the spillway crest to return to the original design elevation to provide needed capacity for the inflow design flood.

4.4.4.2 Auxiliary Spillway Capacity

Alternative 4 would include a combination of raising the FRS and widening the existing auxiliary spillway to 800 feet to provide conveyance of the inflow design flood. The 800-foot-wide auxiliary spillway largely follows the layout of the existing auxiliary spillway and provides a reasonable plan and profile for the inlet channel, spillway crest, and exit channel. This configuration avoids the existing substation, but would require relocation of several power poles. The existing diversion berm southeast of the auxiliary spillway would need to be realigned.

Given the widened spillway configuration, the maximum water surface elevation for the 24-hour IDF would be 1577.07 (Table I), which is 4.47 feet above the existing dam crest elevation of 1572.6 feet. Given 1.75 feet of freeboard, the total height of the dam raise would be 6.2 feet. As in the case of Alternative 3, the dam raise would be accomplished by adding an earthen buttress with a 14-foot top width, a 2H:1V slope on the downstream side and a 3H:1V slope on the upstream side. The new buttress would also include the previously described cutoff trench.

4.4.4.3 Auxiliary Spillway Integrity

Alternative 4 would include the same type of RCC revetment discussed under Alternative 3. It would extend 18 feet below the crest, and would be placed in lifts that are 8 feet wide and 2 feet thick, with a 3-foot offset to give the 1.5H:1V slope. It would cover the top of the widened auxiliary spillway with a 4-foot-thick layer and would have a top elevation of 1565.2. Alternative 4 will require the relocation of one or two power poles that fall with the footprint of the widened exit channel.

4.4.4.4 Summary and Cost

A profile of Alternative 4 is shown on Plan sheets 3 through 7. A plan view of the auxiliary spillway is shown on Plan Sheet 10. Typical sections of the crest raise, the fuse berm, and the revetment are shown on Plan Sheets 14 and 15.

The total construction cost for Alternative 4 is $11,288,700. Total cost including contingency (25%), mobilization (5%), stormwater pollution prevention plan, construction surveying, supervision and administration (5%), engineering (6%), and real estate is $17,046,100. Copies of the cost estimates are included in Appendix D – Supporting Information.

As in the case of Alternative 3, this alternative would require regrading the Kelvin Road crossing (to a grade that is less than 10%) to accommodate the proposed dam raise, extending an existing concrete box culvert under Kelvin Road, raising of manholes for an existing sewer line that crosses the dam along the Kelvin Road alignment. For Alternative 4, the construction costs for the Kelvin Road crossing, the culvert extension, and the manhole modifications are estimated to be $400,500. Total cost including contingency (25%), mobilization (5%), stormwater pollution prevention plan, construction surveying, supervision and administration (10%) and engineering (15%) is $663,800. The total cost of Alternative 4, including Kelvin Road is $17,709,900.

The majority of the cost under Alternative 4 is for raising the earthen embankment and the final determination on freeboard has <u>not</u> been made. Cost estimates presented herein are based on 1.75 feet of freeboard, but could be less if freeboard is reduced. Table L includes comparisons of the total cost for Alternative 4 with 1.75 feet of freeboard and no freeboard. The table also includes the total cost for a stepped dam alternative in which the top-of-dam elevation is stepped to match the drawdown of the maximum water surface profile near the outlet. The table also includes the

total cost for a stepped dam alternative in which the top-of-dam elevation is stepped to match the drawdown of the maximum water surface profile near the outlet[15]. For the uniform crest elevation, the cost difference between 1.75 feet of freeboard and no freeboard is $2,925,600. The cost difference between a uniform crest with 1.75 feet of freeboard and stepped crest with 1.75 feet of freeboard is $920,400.

Table L. Comparison of Cost for different Freeboard Heights - Alternative 4

Freeboard Height (ft)	1.75 (Uniform Elev.)	0 (Uniform Elev.)	1.75 (Stepped)
Dam Raise Height (ft)	6.2	4.5	Varies 2.8 to 6.2
Total Cost (1)	$17,709,900	$14,626,800	$16,789,500
Difference (compared to 1.75 feet/uniform crest)	--	$3,083,100	$920,400

1) Including Kelvin Road modifications. Cost estimates are included in Appendix D – Supporting Information.

4.5 Alternative Plans Considered but Eliminated from Detailed Study

The following alternative plans were discussed and briefly evaluated, but were eliminated from detailed study.

Breach of the FRS with no Downstream Flood Mitigation (Sponsor Breach)

A "sponsor breach" would include breaching the FRS at a number of locations to prevent impoundments greater than 5 feet deep[16] in the 100-year event. The number and locations of the breaches would probably be similar to those described under the "decommissioning with downstream mitigation" alternative that is developed in greater detail in subsequent sections. The breaches would allow water and sediment to flood agricultural areas, urban developments, irrigation canals (Florence Canal and the Florence-Casa Grande Canal), municipal water supply infrastructure (Central Arizona Project Canal), and transportation infrastructure. The loss of flood protection and associated downstream impacts to private property, critical facilities, and public infrastructure make this alternative unacceptable to the community which currently benefits from the flood protection provided by the FRS. Thus, this alternative was eliminated from further consideration.

Decommission the FRS by Removal of the Entire Structure and Stabilization of the Site

Complete removal would require excavation and disposal of approximately 1,500,000 cubic

[15] Details on the stepped dam approach are provided in the Documentation for Hydrology and Hydraulics.
[16] Impoundment guideline suggested by ADWR.

yards of compacted fill used to construct the FRS. The removal of the structure would permit water and sediment to flood the entire Town of Florence, state and private prison facilities, buildings for municipal and Pinal County government, irrigation canals (Florence Canal and the Florence-Casa Grande Canal), municipal water supply infrastructure (Central Arizona Project Canal), and transportation infrastructure. It would require much more earthwork and would be much more costly than the above described "sponsor breach" and would provide fewer residual benefits. The loss of flood protection (estimated at $4.62 million per year (Tetra Tech 2006c)) and associated downstream impacts to private property, critical facilities, and public infrastructure make this alternative unacceptable to the community which currently benefits from the flood protection provided by the FRS. Thus, this was eliminated from further consideration.

Relocate Residents and Facilities Immediately Downstream of the FRS

In conjunction with removal or breaching of the FRS, this alternative would involve relocation of more than 12,800[17] residents within the Town of Florence and purchase of the 1200 residential and commercial structures. It would require relocation of the Arizona State Penitentiary (with 380 individual structures), as well as government facilities for Pinal County and the Town of Florence. The farm fields could be purchased, or could be left to the original farmers for cultivation with a flowage easement to allow for future flooding. This alternative would require relocation of the Central Arizona Project Canal, which provides M&I water to Tucson, as well as the Florence-Casa Grande Irrigational Canal and other irrigation facilities. This alternative would provide reliable flood protection, but it is not practical or cost effective because of (1) the numbers of residents, (2) the difficulty in developing comparable corrections facilities in a new location, and (3) the difficulty and expense in relocation the CAP, the Florence-Casa Grande Canal and other irrigation infrastructure, and rerouting of state highways. Thus, this was eliminated from further consideration.

Elevate Residential Structures Downstream of the FRS

In conjunction with removal or breaching of the FRS, this alternative would elevate the foundations of residential and commercial structure to bring the first floor elevation to 1 foot above the 100-year water surface elevation. This alternative would provide reliable flood protection to affected structures only. However, past studies[18] have found that raising individual homes can cost as much as $45,000 per structure. This high cost, coupled with the fact that

[17] The previous Benefit-Cost Analysis for Florence Flood Retarding Structure (Dibble 2003) estimated that 75% of the Town's residents were within the potential flood damage area in absence of the FRS. The estimate of 12,800 is 75% of the total population of 17,054, and is the number that would be affected if the FRS were completely removed. In lieu of complete removal, the FRS could be breached to prevent impoundments, and the breaches could be located to minimize the affect on downstream propertied. In this case, there would be fewer relocations and fewer affected structures.

[18] Based on previous NRCS studies for the Doña Ana Arroyo Watershed Rehabilitation Project (NRCS 2003).

existing canals cannot be raised without interrupting operations or without impeding drainage (i.e., they would function much like the FRS does now) makes this alternative impractical and it was dropped from further consideration.

Floodproofing Residential Structures Downstream of the FRS

In conjunction with removal or breaching of the FRS, this alternative would involve installation of doors and windows that could be sealed to prevent entry of water during a flood event. This alternative would not provide reliable flood protection since the homeowner may be away or asleep when a flood occurs. It also does not prevent inundation of foundations, canals, utilities, or highways. It was dropped from further consideration.

Install a Flood-Warning System

In conjunction with decommissioning or breaching of the FRS, this alternative would involve installation of a system to provide advanced warning of imminent flooding to residents of flood-prone areas, allowing them to implement flood-proofing measures and/or to evacuate to an area of safety. The alternative would be ineffective since the warning time could be very short during a convective storm and may not provide enough advance notice for reliable installation of flood-proofing measures. It also does not prevent inundation of or damages to foundations, canals, utilities, or highways. It was dropped from further consideration.

Development of a Comprehensive Watershed Management and Development Plan in Conjunction with Rehabilitation

This alternative would involve comprehensive management of the 61.1-square-mile watershed above the FRS and would include regulations and/or structural features that would reduce runoff volume[19] to the FRS. Such approaches have been proven to be successful in the Phoenix Metro Area and were recommended by the Arizona State Land Department. Comprehensive planning for the future development on contributing watershed would prevent increases in flood volumes. However, this would not address the current inadequacies of the FRS under existing conditions and at best, would reduce the level of effort in a rehabilitation alternative. Existing flood volumes could be reduced by implementing structural measures upstream of the FRS, however, it would be difficult to site and design these features until actual locations and extent of future development is better known. This approach would also require adoption and enforcement of new regulatory standards over the life of the project. Given these constraints, this approach was dropped from further consideration under this study. However, this approach could be implemented independently by local stakeholders such as the Town of Florence, Arizona Department of Corrections, Pinal County, ASLD, and private landowners, and could potentially

[19] The Pinal County Drainage Manual currently requires developers to mitigate against increases in peak discharge due to new development. However, the requirements do not require reduced runoff *volume*, which has a significant impact on the FRS.

reduce the level of effort in rehabilitating or decommissioning of the FRS.

Construction of an Additional Auxiliary Spillway to Provide Additional Conveyance for the Inflow Design Flood

This alternative would involve construction of one or more additional auxiliary spillways at some point along the FRS. As noted in Section 4.3.2 of this report, a total auxiliary spillway width of 2400 feet would still result in overtopping of the FRS. This approach was also evaluated under the *Design of Emergency Spillway – Florence Retarding Dam Structure,* Task 4 – Evaluation of Design Alternatives, December 2004 (See Previous Studies). That report noted that overtopping of the dam occurred even with an additional spillway width of 4000 feet. Given the results of the auxiliary spillway integrity analysis (Section 4.3.3), it is likely that additional spillways will also require revetment to prevent erosion and failure, which would be very costly given the lengths involved. In addition, construction of such a spillway will expose large sections of the Town of Florence, CAP Canal, Florence-Casa Grande Canal, and/or surrounding agricultural areas that are currently protected by the FRS to potentially large flows for events greater than the 100-year design level and is considered to be unacceptable by the Florence Area Watershed Flood Control District. It was dropped from further consideration.

5.0 EFFECTS OF THE ALTERNATIVE PLANS

The NRCS has the responsibility under NEPA to identify and address effects on the human environment that may occur as a result of the alternative plans. The following paragraphs describe potential effects of the alternatives within each resource category.

5.1 Climate

Climate will not be affected by any of the alternative plans.

5.2 Geology

The geology of the study area will not be affected by any of the alternative plans.

5.3 Soils

Alternative 1 – No Action. This alternative would have no effect on soils.

Alternative 2 – Decommissioning. This alternative would require the excavation of four breaches in the FRS and construction of four channels to convey flood flows safely to the Gila River approximately two miles west of the FRS. The slopes immediately downstream of the FRS are relatively steep. Flood flows are supercritical and require rectangular concrete channel sections, 30 feet to 60 feet wide, with substantial freeboard. Further downstream, the slopes moderate and the channels can be earth bottom (100 feet to 300 feet wide) with soil cement sides. Clearing, excavation, and fill for Alternative 2 are summarized below.

Clearing	225 Acres
Breach Excavation	67,150 CY
Channel Excavation	1,178,160 CY
Channel Reinforced Concrete	50,570 CY
Channel Soil Cement	59,080 CY
Fill and Backfill	183,130 CY
Disposal - Waste Onsite	271,920 CY
Disposal - Haul	676,190 CY

Alternative 3 – Rehabilitation by Raising FRS Crest. This alternative raises the FRS crest by 7.75 feet and provides RCC revetment at the auxiliary spillway. Clearing, excavation, and fill for Alternative 3 are summarized below. Borrow would be taken from within the flood pool. Given a borrow depth of 6.5 feet, and area of approximately 150 acres would be required. The actual

borrow sites will be determined in future design phases.

Clearing - Construction	103 Acres
Clearing - Borrow	150 Acres
Excavation – Auxiliary Spillway	41,000 CY
Excavation - Borrow (includes 25% for shrinkage)	1,591,225 CY
Roller-Compacted Concrete	14,900 CY
Fill and Backfill	1,305,500 CY
Gravel Cover on Crest and Downstream Slope	15,500 CY

Alternative 4 – Raising FRS Crest and Widening Auxiliary Spillway. This alternative raises the FRS by 6.2 feet and widens the auxiliary spillway to a bottom width of 800 feet. As in Alternative 3, it also includes RCC revetment. Clearing, excavation, and fill for Alternative 4 are summarized below. Borrow would be taken from within the flood pool. Given a borrow depth of 4 feet, and area of approximately 150 acres would be required.

Clearing for Construction	142 Acres
Clearing - Borrow	150 Acres
Excavation – Auxiliary Spillway	354,300 CY
Excavation - Borrow (includes 25% for shrinkage)	1,021,760 CY
Roller-Compacted Concrete	17,300 CY
Fill and Backfill	1,053,100 CY
Gravel Cover on Crest and Downstream Slope	13,700 CY

5.4 Surface Water

Alternative 1 – No Action. This alternative will not modify any surface water bodies in the study area. Flood flows up to the storage capacity of the FRS would be conveyed through the principal spillway and would follow the original outlet channel to the Gila River. Floodwaters impounded by the FRS are also drained to the Florence-Casa Grande Canal via gated pipe outlets. Flood flows exceeding the storage capacity of the FRS would begin to overtop the auxiliary spillway. Minor overflows at the auxiliary spillway would likely follow the original outlet channel to the

Gila River. Significant overtopping would like exceed the capacity of the overchute and siphon crossings at the CAP and the Florence-Casa Grande Canal and would likely cause damages.

Alternative 2 – Decommissioning. This alternative would prevent impoundments at the FRS and would convey flood flows from the 61.1-square-mile Florence area watershed to the Gila River though a new system of channels. Since the FRS principal spillway already drains to the Gila River, the channels would change the point of outfall. The new channels would increase flow rates to the Gila River may pass large quantities of sediment that are no longer trapped by the FRS.

Alternatives 3 and 4 – Rehabilitation. These alternatives would not directly affect any perennial surface waters. Flood flows up to the storage capacity of the FRS would be conveyed through the principal spillway and would follow the original outlet channel to the Gila River. Floodwaters impounded by the FRS would also be drained to the Florence-Casa Grande (FCG) Canal via gated pipe outlets. The additional storage capacity provided under these alternatives would reduce the likelihood of spillway overflows that could potentially damage the CAP and Florence-Casa Grande canals. The excavation of borrow material within the flood pool could cause changes in the way the arroyos drain to the FRS, but would not have any significant changes in the overall drainage upstream or downstream of the FRS.

5.5 Water Quality

Alternative 1 will provide continued flood protection up to the 50-year event for the Town of Florence and the Florence waste water treatment facility. Alternatives 2, 3, and 4 will provide continued flood protection up to the 100-year event for the Town of Florence and the Florence waste water treatment facility. Otherwise, the proposed alternatives have no direct effect on water quality in terms of designated beneficial uses, impairment of those uses, or pollutants or parameters that exceed standards.

5.6 Water Conveyance Infrastructure

Alternative 1 would provide continued flood protection up to the 50-year event for the CAP and the Florence-Casa-Grande Canal. The facilities would continue to be vulnerable to breach failure the FRS. Alternative 2 includes overchute structures that would convey flows up to the 100-year event over the existing canals. It would also require relocation of existing irrigation ditches along the proposed alignment. Alternatives 3 and 4 would provide continued flood protection up to the 100-year event for the CAP Canal and the Florence-Casa-Grande Canal. The facilities would be vulnerable to a breach failure of the FRS, but the rehabilitation measures would significantly reduce the possibility of a breach occurring.

5.7 Sedimentation

Alternative 1 – No Action. This alternative would have no effect on the existing sediment

deposition processes. Flood flows would continue to carry sediments down the arroyos and continue to deposit sediment along the upstream pool of the FRS. The FRS currently has adequate sediment storage volume for 100-years.

Alternative 2 – Decommissioning. This alternative would channel flood flows into four channels that outfall to the Gila River. It is likely that large quantities of sediment would be carried downstream and the channels would likely need to be maintained on a frequent basis to maintain their capacity.

Alternatives 3 and 4 – Rehabilitation. Neither of these alternatives would have a significant effect on the existing sediment deposition processes. The rehabilitated FRS would have adequate sediment storage volume for 100-years.

5.8 Vegetation Communities

Alternative 1 – No Action. This alternative would have no effect on vegetation communities.

Construction of Alternatives 2, 3, or 4 would result in the removal of existing vegetation. The acreage of disturbance of each alternative is as follows.

Alternative 2 – Decommissioning. Clearing and excavation over an area of 225 acres for multiple breaches and construction of conveyance channels and levees/banks.

Alternative 3 – Rehabilitation by Raising the FRS Crest. Clearing and excavation of approximately 150 acres for borrow material. Clearing and excavation over a 103-acre area that includes the main embankment of the FRS, the auxiliary spillway area, and the Kelvin Road crossing. No additional access roads are expected. A plant survey has not been conducted of the potential borrow area outside of the existing right-of-way, but it is expected that similar species to those present within the right-of-way would be removed.

Alternative 4 – Rehabilitation by Raising the FRS Crest and Widening the Auxiliary Spillway. Clearing and excavation of approximately 150 acres for borrow material. Clearing and excavation over a 142-acre area that includes the main embankment of the FRS, the auxiliary spillway area, and the Kelvin Road crossing. No additional access roads are expected. A plant survey has not been conducted of the potential borrow area outside of the existing right-of-way, but it is expected that similar species to those present within the right-of-way would be removed.

5.9 Wetlands

There are no wetlands identified in the study area. Wetlands will not be affected or created by Alternatives 1, 3, or 4. Alternative 2 would require construction adjacent to the Gila River. This area has not been surveyed for wetlands. The potential alignment of these channels has not been investigated.

5.10 Fish and Wildlife

Alternative 1 – No Action. This alternative will have no effect on fish or wildlife or their habitats.

Alternative 2 – Decommissioning. There are no fish in the area immediately upstream of the FRS. Since the existing principal spillway already drains to the Gila River, the conveyance channels under Alternative 2 would change the point of outfall and would increase the flow rates and sediment delivery to the Gila River. This would return the reach of the Gila River to a more natural situation with natural flooding and sediment deposition from the alluvial fans. The construction of the outflow channels would remove vegetation and could affect wildlife habitat temporarily. Overall, there would be no significant adverse effects to fish and wildlife.

Alternatives 3 and 4 – Rehabilitation. Fish will not be affected by Alternatives 3 or 4.

Wildlife species present in the study area could be affected by Alternatives 2, 3, and 4. Vegetation would be removed in the areas described in Section 5.8 for each alternative. Wildlife would also be disturbed by construction activities and would likely move away from the construction area. This effect would be short-term during construction. Wildlife would likely move back into the construction area as soon as construction is completed. The loss of vegetation would also be a temporary loss of habitat. The removal of trees would be minimized. Rapid recolonization by species such as triangle bursage and desert broom would rapidly replace any loss of shrub or herbaceous vegetation.

5.11 Threatened and Endangered Species

As discussed under Section 3.11 there are several threatened and endangered species present in Pinal County, but only a few could have potentially suitable habitat in the study area. However, because this habitat is only marginally suitable, they are unlikely to occur other than transiently. Transient species include bald eagle, lesser long-nosed bat, and yellow-billed cuckoo. There have not any observations or known occurrences of threatened and endangered species in the project vicinity. There will be no effect on threatened or endangered species from any of the alternatives. In addition, as the project does not occur in the vicinity of any Proposed or Designated Critical Habitats, there will be no effects to critical habitat designated for threatened and endangered species.

5.12 Health and Human Safety

Alternative 1 – No Action. This alternative would allow the continued risk to human health, safety, and loss of life from a catastrophic flood event. The recently completed cracking repair project addresses embankment inadequacies, but does not address the capacity and integrity problems at the auxiliary spillway.

Alternative 2 – Decommissioning. This alternative would reduce the risk to human health and

safety from a catastrophic flood event by eliminating impoundments and providing effective flood control up to the 100-year event.

Alternatives 3 and 4 –Rehabilitation. These alternatives would reduce the risk to human health and safety from a catastrophic flood event by raising the dam and reinforcing the auxiliary spillway, and by providing effective flood control up to the 100-year event.

5.13 Transportation

Alternative 1 – No Action. This alternative would allow the continued risk to transportation networks from a catastrophic flood event that could lead to road closures and damages. The portion of Kelvin Road that crosses through the flood pool would continue to be inundated in large flood events.

Alternative 2 – Decommissioning. This alternative would reduce the risk to transportation networks downstream of the FRS from a dam break event. The system of proposed channels downstream of the FRS would provide effective flood control up to the 100-year event, but would require bridge and dip sections that will have to be upgraded along with the roadways if there is future development. Decommissioning would limit the impoundment depth behind the FRS to five feet and would thus reduce flooding on the section of Kelvin Road that lies within the existing flood pool.

Alternatives 3 and 4 –Rehabilitation. These alternatives would reduce the risk to transportation networks from a catastrophic flood event and would provide effective flood control up to the 100-year event. The existing Kelvin Road crossing over the dam would be modified with the dam raise. The additional flood storage provided by the fuse berm would result in additional flood inundation (approximately 3 feet in the 100-year, 24-hour event) for the portion of Kelvin Road that crosses through the flood pool. The increase in the duration of flooding on Kelvin road would be a matter of hours. The Florence-Kelvin Highway that lies south of the FRS would not be affected and would continue to provide an alternate route during flood events.

5.14 Land Use

Alternative 1 – No Action. This alternative could have a potential effect on future land use. Currently, flood flows that exceed the FRS capacity are conveyed by the auxiliary spillway at the northern end of the FRS and follow ill-defined topography through agricultural areas to the Gila River. If future development in Florence converts the land use from agricultural to urban, there will be a potential for increased economic damages from flows in excess of the FRS capacity. Pinal County has noted that the dam could be decertified by FEMA. Properties currently protected by the dam would be considered to be a flood hazard area and would be subject to land use restrictions.

Alternative 2 – Decommissioning. This alternative would require the construction of four

conveyance channels from the FRS to the Gila River. The footprint of the channel system will displace approximately 107 acres of existing farm fields and will make corresponding reduction land available for future urban development.

Alternatives 3 and 4 – Rehabilitation. These alternatives would reduce the potential for flows from the auxiliary spillway and would thus reduce potential effects on future land use cited under Alternative 1. As described in following section of Land Rights and Relocations, these alternatives would increase the flood pool area to the new top-of-dam elevation and would require additional easements at either end of the dam, and would limit land use accordingly.

5.15 Land Rights and Relocations

Alternative 1 – No Action. This alternative would not require any new land rights or relocations.

Alternative 2 – Decommissioning. This alternative will require additional land acquisitions for the construction of the four proposed conveyance channels. With the exception of crossings on public right-of-way, the majority of the impacted areas are on private property. The total impacted area and features are summarized below.

Clearing upstream of dam	82.1	Acres
Clearing for breaches	3.0	Acres
Clearing for channels crossing canals	20.9	Acres
Clearing for channels between the canals and the Gila	119.0	Acres
Total Clearing	225	Acres
Overchute structures at CAP and FCG canals	8	Each
Florence Canal Siphons	4	Each
Ditch Siphons	15	Each
Road Crossings – Box Culverts	8	Each
Road Crossings - Dip Sections	17	Each

Alternatives 3 and 4 – Rehabilitation. In Alternatives 3 and 4, the south end of the FRS would have to be extended approximately 1,200 feet further south to a point where the new crest elevation matches existing grade. Approximately 4 acres of additional easement would be required to extend the south wing. Alternative 4 would acquire approximately 8 acres of additional land acquisition for expansion of the auxiliary spillway.

As shown below, the proposed fuse berm in Alternatives 3 and 4 would increase the land area affect by flood storage below the auxiliary spillway crest elevation. The alternatives would also increase the land area below the top-of-dam crest elevation.

	Existing Auxiliary Spillway Crest	Alternatives 3 and 4 Auxiliary Spillway Crest (with fuse berm)
Crest Elevation (ft)	1,565.2	1,568.5
Water Surface Area (acres) *	671	836

*Based on stage-area relations from the Task 3 Report (Dibble and Associates 2004b)

	Existing - Top of Dam Crest	Alternative 3 Top of Dam Crest	Alternative 4 Top of Dam Crest
Elevation (ft)	1,572.6	1,580.4	1,578.8
Water Surface Area (acres) *	1,027	1,341	1,264
Increase from Existing (acres)		326	249

*Based on stage-area relations from the Task 3 Report (Dibble and Associates 2004b)

Implementation of Alternatives 3 or 4 would thus require acquisition of additional easements for these areas.

5.16 Agricultural Lands

Alternative 1 – No Action. This alternative would have a risk of future catastrophic flooding of agricultural lands, irrigation canals and diversions.

Alternative 2 – Decommissioning. This alternative would involve the construction of conveyance channels through agricultural fields and across the irrigation canals. As cited in Sections 5.14 and 5.15, approximately 107 acres of farm fields and the associated roads and ditches will be displaced by the channel network.

Alternatives 3 and 4 – Rehabilitation. These alternatives would provide increased flood protection to agricultural fields and the irrigation canals downstream of the FRS.

5.17 Environmental Justice

Alternative 1 – No Action. This alternative would have a risk of future catastrophic flooding that would affect the health and safety of minority or disadvantaged populations. If the dam were decertified by FEMA, there would be additional restrictions on land use and economic development by minority or disadvantaged property owners.

Alternative 2 – Decommissioning. This alternative would prevent impoundments at the FRS and mitigate flooding within Florence up to the 100-year event. It would require approximately 107 acres of land to construct and maintain the conveyance channels downstream of the FRS. This could disproportionately eliminate agricultural opportunities for minority or disadvantaged

landowners. The construction project could generate short-term jobs for local workers.

Alternatives 3 and 4 – Rehabilitation. These alternatives would rehabilitate the FRS. They would increase flood storage and would thus provide increased flood protection for minority and disadvantaged populations. These alternatives would also increase the capacity and integrity of the auxiliary spillway and would thus reduce the risk of catastrophic failure. These alternatives would provide effective flood control for the minority, disadvantaged and prison populations downstream of the FRS. The construction project could generate short-term jobs for local workers.

5.18 Air Quality/Noise/Light

Alternative 1 – No Action. This alternative would not affect air quality, noise, or light because no action would occur.

Alternatives 2, 3, and 4 will involve the use of heavy construction equipment for excavating and placing material and will require trucks for hauling and disposing of significant quantities of material. These activities will temporarily adversely affect air quality and generate additional noise and light in the construction areas. Activities will be limited to the normal working hours (7:30 am to 8:00 pm) and will only occur over a few months. None of these alternatives would have any long-term adverse effects on air quality, noise levels, or light conditions in the study area.

5.19 Cultural/Historic Resources

Alternative 1 – No Action. No impacts to significant cultural resources would occur from Alternative 1.

Alternative 2 – Decommissioning. The breaching of the FRS would not impact any significant cultural resources. However, impacts could occur to significant resources during construction of the channel system if resources are found during the inventory of the channel system project area.

Alternative 3 – Rehabilitation by Raising the FRS Crest. Construction work conducted for Alternative 3 would be conducted on the FRS, in previously disturbed locations, or in areas inventoried for cultural resources. There are no significant cultural resources located within these project areas, thus no impacts would occur to significant cultural resources from Alternative 3.

Alternative 4 – Rehabilitation by Raising the FRS Crest and Widening the Auxiliary Spillway. Alternative 4 project areas also include the FRS, previously disturbed locations, and areas inventoried for cultural resources. There are no significant cultural resources located within these project areas and no impacts would occur to significant cultural resources from Alternative 4 in these locations. However, impacts could occur to significant resources during construction

activities south of the northern wing of the FRS if resources are found during the inventory of this area.

Alternatives 3 and 4 – Rehabilitation. The borrow areas to obtain material for Alternatives 3 and 4 are located upstream of the FRS. Some of this area was heavily disturbed during original construction of the FRS and it is likely that some of the proposed borrow areas have already been disturbed. However, it is also likely that significant borrow will be obtained in areas that have not previously been surveyed. A field reconnaissance would be necessary to determine the extent of cultural survey that may be necessary in the borrow areas. If Alternative 3 or 4 is selected, no construction activities would occur in these un-surveyed borrow areas until inventories and SHPO consultation is completed.

5.20 Aesthetics

Alternative 1 – No Action. This alternative would have no effect on aesthetics.

Alternative 2 – Decommissioning. This alternative would likely have effects on aesthetics due to the creation of four conveyance channels that will cross the canals through pipes then continue through agricultural fields and portions of the Town of Florence, both above ground and underground.

Alternatives 3 and 4 – Rehabilitation. Given the existing crest height of approximately 25 feet, raising the FRS by 6.2 feet (Alternative 4) or 7.8 feet (Alternative 3) would have an impact on the view from the upstream and downstream sides. The post construction embankment would take a number of years to reestablish the minimal vegetative cover, even with seeding. However, once vegetation is reestablished, the rehabilitated structure will blend in with the landscape as it currently does. Increasing the width of the auxiliary spillway under Alternative 4 would make the spillway more intrusive into the surrounding natural setting, somewhat impacting the viewshed of surrounding cultural resources. The addition of RCC revetment to the outlet side of the auxiliary spillway and the outside face of the northern wing of the FRS under Alternatives 3 and 4 would also make the spillway more intrusive and noticeable. However, these impacts to viewshed would be minor since the FRS and associated structures already exist in the area, along with powerline structures, canals, roads, and other infrastructure.

Finally, dust and noise associated with construction activities under any of the alternatives would introduce visual and auditory elements out of character with surrounding aesthetics. However, this impact would be temporary and have no lasting effects.

6.0 COMPARISON OF THE ALTERNATIVE PLANS

Table M summarizes the extent to which each alternative meets the purpose and need.

Table M. Comparison of Alternative Plans and Effect on Formulation Goals

Alternative	Meets current safety and performance standards and provides for continued flood protection
Alternative 1 – No Federal Action	No
Alternative 2 – Decommission with downstream flood mitigation	Yes
Alternative 3 – Rehabilitation by raising the dam crest, reinforcing the auxiliary spillway, and providing additional flood storage	Yes
Alternative 4 – Rehabilitation by raising the dam crest and widening the auxiliary spillway, reinforcing the auxiliary spillway, and providing additional flood storage	Yes

Under Alternative 1, the Florence FRS would remain in place and would continue to provide flood protection up to the 50-year event, given expected future development conditions on the upstream watershed. The FRS would not meet all of the standards set by ADWR and the NRCS for public safety and reliability. The completed cracking repair project addresses the known deficiencies in the embankment. However the previously described inadequacies in storage, auxiliary spillway capacity, and auxiliary spillway integrity will remain.

Alternative 2 eliminates impoundment by the FRS so that it will no longer need to conform to dam safety criteria or performance standards. Alternative 2 provides a system of channels that will convey floods up to the 100-year event (with future upstream development) through Florence to an adequate point of disposal at the Gila River.

Alternatives 3 and 4 will rehabilitate the FRS so that it will meet ADWR and NRCS dam safety criteria and performance standards. The two rehabilitation plans also best meet other applicable federal requirements by addressing potential civil rights and environmental justice concerns.

6.1 Risk and Uncertainty

A variety of factors contribute to the potential for flood control structure failure, including storm event intensity, control structure construction materials and techniques, and operation and maintenance activities. The Florence FRS has operated for 41 years with few problems and the

FAWFCD has an excellent record in performing maintenance as needed and operating the structures as designed.

6.1.1 Existing Condition

Under Alternative 1 – No Federal Action, the FAWFCD would continue to operate and maintain the dam in its present condition and in accordance with the existing Emergency Action Plan. The completed cracking repair project has corrected the embankment inadequacies, but the dam would continue to have documented structural inadequacies in storage volume, auxiliary spillway capacity, and auxiliary spillway integrity. As a result, there is a risk of auxiliary spillway failure until the FRS is manually breached, decommissioned, or rehabilitated. As noted previously in this report, there is a risk that the dam could be decertified by FEMA, and properties currently protected by the dam would be considered to be a flood hazard area.

The two gated outlets that serve to drain the flood pool have not been video-inspected. Inspection should be conducted during the design phase to verify that the existing conduits are sound and are not showing any signs of seepage.

There is an 8.20 square mile uncontrolled drainage area (labeled “J1” in the H/H Documentation) that drains to the CAP overchute just downstream of the outlets of the principal and auxiliary spillways. The hydrologic analyses show that the peak discharges from the FRS and this uncontrolled area at the overchute are coincident. In relatively frequent events, the combined flows from the principal spillway and the uncontrolled area result in a headwater at the overchute that is near the top of the CAP embankment. Consequently, overflows of the CAP embankment can be expected in larger events, especially if there is any significant flow from the auxiliary spillway. Thus, there is a risk that floodwaters will overtop and possibly erode the embankment, and will discharge into the CAP, even if the FRS is operating normally during a large event.

6.1.2 Alternatives

The proposed alternatives developed in this study are subject to uncertainty because of missing or approximate information. Uncertainties and their effects, and suggestions for future studies are listed below.

6.1.2.1 Mapping for Hydrology and Hydraulics

The hydrologic/hydraulic analyses were based on USGS topographic and DEM data supplemented by cross sections through the flood pool. Detailed survey data and 2-foot (minimum) contour mapping should be developed during the design phase and should be used to recompute a more accurate the elevation-storage relationship. The mapping can also be used to develop additional HEC-RAS cross sections that in turn will reduce potential errors due to interpolation between the widely spaced surveyed cross sections. Field survey in association with

the mapping should include data for the auxiliary spillway, principal spillway, gated outlets, Kelvin Road, and the Kelvin Road culvert. The real estate required for the enlarged flood pool was estimated using the stage-area data provided Task 3 Report and may change with the new mapping and revised hydraulic analysis.

6.1.2.2 Mapping for Design

The alternative designs for the FRS were based largely on dimensions and topography shown in the as-built plans. Recent surveys conducted for the cracking repair project were limited in scope and were not comprehensive enough to be used for design. Detailed survey and 2-foot (minimum) contour mapping should be developed for the FRS embankment, auxiliary spillway, and areas such as Kelvin Road that will require modification. All survey should be tied into new or established monuments that are tied into The Arizona State Plane (NAD83) horizontal datum and the NAVD88 vertical datum.

6.1.2.3 Geotechnical Investigations and Analysis

The borings shown for the auxiliary spillway on the as-built plans are only 9 feet deep and no other boring in the that area are available. Based on the limited data, the integrity analysis indicates erosion well below a depth of 9 feet. Better subsurface information would reduce uncertainty in the ultimate depth of erosion. This in turn will allow for a better estimate of the toe depth for revetment, and may allow for consideration of sheetpiling in lieu of RCC.

The slope stability analyses were based on soils information collected from previous studies and required some assumptions about soil characteristics. Additional field investigations, testing, and evaluation during the design phase are necessary to confirm these assumptions.

6.1.2.4 Extension of the Central Filter Drain

The designs for rehabilitation alternatives include extending the central filter drain with the dam raise. The centerline of the drain intersects the downstream slope (2H:1V) of the raised section and the current design calls for extending the central filter drain vertically to within 1 foot of this surface. It will thus be capped by 1 foot of earthfill plus 6 inches of gravel mulch. The length of the extension is approximately 2.5 feet. Given a filter cost of $36/CY, the estimated cost based on a 2-foot width and a 26,610-foot length is $180,000 and is already included in the cost estimates for alternatives 3 and 4.

The top elevation of the filter drain (at centerline) will be approximately 1575 feet. It will extend above the water surface elevation of the PSH (1568.5 feet) but will be approximately 3.5 feet below the FBH water surface elevation (1578.6) for Alternative 3 and approximately 2 feet below the FHB water surface elevation (1577.1) for Alternative 4. Preliminary depth-duration analyses show that water surface elevation for the FBH will exceed the top of filter elevation for

approximately 5.5 hours in Alternative 3 and 3.5 hours in Alternative 4. It is not clear if there is a need to extend the filter barrier all the way to the crest of the new earthfill section. The thickness of the proposed embankment at the FBH water surface elevation is approximately 23 feet and may be sufficient for protection from internal erosion during that event.

If the filter does need to be extended to the new top-of-dam, then there is a question of whether or not it should be continuous. If not, a second filter could extend from the new crest centerline down to some point within the original embankment. The two filters in concert would overlap vertically and should intercept any PMF induced flow through a transverse crack. If the new filter overlapped the existing filter by 1 foot, the vertical lengths would be of 8.8 feet (Alternative 3) and 7.2 feet (Alternative 4). Given a filter cost of $36/CY, the estimated cost based on a 2-foot width and a 26,610-foot length would be $624,000 for Alternative 3 and $510,000 for Alternative 4. This would take the place of the above mentioned extension (at $180,000) so the net cost increases would be $440,000 for Alternative 3 and $330,000 for Alternative 4.

If the filter does need to be continuous then it is recommended that the filter be placed parallel to the downstream 2:1 slope starting from the top of the existing filter. This would also have the benefit of increasing the quantity of earthfill in the cross section upstream of the filter. The length of the filter extension would be 6.2 feet and 7.8 feet (alternatives 3 and 4 respectively). The estimated cost would be $554,000 (Alternative 3) and $440,000 (Alternative 4). This would take the place of the above mentioned extension (at $180,000) so the net cost increase would be $374,000 (Alternative 3) and $260,000 (Alternative 4). Another option would be to substitute geotextile for drainfill for the extended portion. Given a unit cost of $4/SY, the estimated cost for a sloping geotextile section would be $164,000 (Alternative 3) to $206,000 (Alternative 4).

6.1.2.5 Auxiliary Spillway Revetment

Integrity analyses for the auxiliary spillway show that a headcut up to 13 feet deep could develop downstream of the auxiliary spillway. Without some sort of revetment, the headcut would migrate upstream and would breach the crest of the auxiliary spillway, allowing for uncontrolled flows from behind the dam. Hydraulic analyses of for the auxiliary spillway face show in the design event (FBH) peak velocities are as high as 30 feet-per-second (fps), and velocities in excess of 20 fps will persist for 10.5 hours.

The Portland Cement Association's (PCA) website[20] states that properly designed soil-cement can withstand the flow of clean water up to a velocity of 20 fps with little erosional damage. It also noted that for higher flow velocities or abrasion erosion conditions, the compressive strength of soil-cement could be increased or RCC could be used. Means for increasing the strength of

[20] http://www.cement.org/water/dams_sc_faqs_erosion.asp

soil-cement include modification to the mixture proportions, increased degree of compaction on exposed soil-cement surfaces, and extending the curing period. In addition, methods for increasing compressive strength of the soil-cement due to mix adjustments include increasing the cement content, changing to a coarser, more well-graded aggregate, or adding coarse aggregate to a finer sand or silty sand.

Because of the potentially high velocities and the limitations of soil cement, the feasibility level design and cost estimate were based on the use of RCC as the revetment material. However, the potential use of soil cement in lieu of RCC should receive further consideration during design phase analyses. The 20fps criterion cited by the PCA, based on "erosional damage," is appropriate for applications in which the soil cement must withstand repeated flows with little or no damage that would require continual maintenance. In the case of an auxiliary spillway revetment, erosional damage is acceptable providing that the revetment does not fail catastrophically, allowing an uncontrolled breach of the dam. It may be possible to construct an adequate revetment with soil cement by using a thicker, bulkier cross section that can sustain surface damage without a failure that would allow high velocity flows on unprotected earth. Repairs would be required after an extreme event, but the frequency of occurrence is so rare that it not be a significant maintenance issue.

For this analysis, the estimated unit cost for in-place soil cement with a compressive strength of 750 psi at 7 days is $65/CY. The estimated unit cost for in-place RCC with a compressive strength of 2500 psi at 30 days $150/CY. For Alternative 3 (14,900 CY of revetment) the potential savings from using soil cement is $1.27 million. For Alternative 4 (17,300 CY of revetment) the potential savings is $1.47 million. The NRCS also noted that lean concrete base (LCB) may also be suitable in this application and would have a cost savings similar to soil cement.

The decision on whether or not to pursue the use of soil cement hinges on hydraulics and the erodibility of the auxiliary spillway. Given the above described uncertainties in the geotechnical characteristics of the auxiliary spillway and potential refinements in hydrology and hydraulics with new mapping, the additional studies should be conducted during a design phase, when better mapping and additional geotechnical data will be available.

6.2 Rationale for Plan Selection

The requirements under "Economic and Environmental Principles and Guidelines ("P&G") for Water and Related Land Resources Implementation Studies" (WRC 1983) to the current study and have been used in planning this action. P&G specifies methodology for calculating economic effects and for evaluating and displaying social and environmental factors in a format unique to P&G. It includes requirements for scoping, public participation, and equal treatment of all alternatives that are equivalent to those for the National Environmental Policy Act (NEPA).

P&G established four accounts to summarize both positive and negative effects of water projects: the National Economic Development (NED) account, the Environmental Quality (EQ) account, the Other Social Effects (OSE) account, and the Regional Economic Development (RED) account. The accounts describe impacts to various elements of the natural and human environment, described explicitly above, and summarize relationships between other elements of NEPA, such as the relationship between short-term use of resources (e.g. land, limited public funds, etc.) and maintenance of long-term productivity (e.g. improved flood protection). The NED, EQ, and OSE accounts are discussed below. RED is not a requirement under P&G and was not considered in this study.

Table N. Summary and Comparison of Candidate Plans – NED Account

	Alternative 1 – No Federal Action	Alternative 2 – Decommissioning with Downstream Flood Mitigation	Alternative 3 – Rehabilitation. Raising Dam Crest, Additional Flood Storage, Reinforce Auxiliary Spillway	Recommended Plan Alternative 4 – Rehabilitation. Raise Dam Crest, Additional Flood Storage, Widen and Reinforce Auxiliary Spillway
Project Investment	$0	$77,142,750	$20,139,300	$17,709,900
National Economic Development Account (NED) (1)				
Beneficial Annual	$0	$0	$0	$0
Adverse Annual (project costs and maintenance)	$0	$3,917,000	$1,102,200	$969,600
Net Beneficial	$0	$(3,917,000)	$(1,102,200)	$(969,600)

1) Alternative 1 has a significantly higher probability of catastrophic damages due to dam failure. The probability of dam failure was not computed and hence no flood damage reduction benefits are shown for Alternatives 2, 3, and 4.

The effects of the alternative plans in terms of the NED account are summarized in Table N above. The project investment cost includes the construction cost, mobilization, contingencies, engineering and design, supervision and administration, construction surveying, stormwater pollution prevention plan, and real estate.

The adverse annual benefits include the investment cost amortized at a discount rate of 4.875% over a period of 100-years plus the annual maintenance costs. The net beneficial amounts are computed as the annual benefits, less the adverse annual costs.

Under Alternative 1 (no-Federal-action plan) the existing Florence FRS would remain in place and would continue to provide flood protection up to the 50-year event to the Town of Florence and surrounding agricultural areas. Flows in excess of the 50-year event would be conveyed by the auxiliary spillway and would impact agricultural areas northeast of Florence. The FRS could be decertified by FEMA, and could place property that is currently protected by the FRS into a flood hazard area. Alternative 2 (decommissioning) and Alternatives 3 and 4 (rehabilitation) would provide flood protection for the 100-year event and thus provide additional flood protection benefits (compared to Alternative 1) for events greater than the 50-year return interval. However, since the benefits are based on infrequent flooding of agricultural areas they are considered to be insignificant for this analysis and were not quantified as part of this study. For the purposes of this study, it is assumed that all four alternatives provide essentially the same annual benefit. Consequently, the decommissioning and rehabilitations alternatives have no incremental flood damage benefits when compared to the no federal action plan. Under this interpretation (which is consistent with P&G) none of the alternatives have positive net benefits, although of the four, Alternative 1 is the least costly and would be identified as the NED Plan. Table O and Table P (following pages) summarize the effects of the alternative plans in terms of the EQ and OSE accounts.

The analyses and computations used to develop the tables follow P&G guidelines. Based on the analyses presented in this Plan/EA, none of the action alternative plans (Alternatives 2,3, and 4) have positive net benefits relative to Alternative 1 and cannot be justified on an economic basis. As a result, Alternative 1 – No Federal Action is the plan that reasonably maximizes the net benefits and is, therefore, identified as the NED Plan. However Alternative 1 does not meet the plan formulation goal of providing continued flood protection for the Town of Florence, Arizona, and surrounding areas, while meeting all of the standards set by ADWR, FEMA, and the NRCS for safety and reliability of the FRS.

Alternatives 2, 3, and 4 meet the formulation goal, however, Alternative 2 has an annual cost that is roughly four times the annual costs for Alternatives 3 and 4 and has significantly greater environmental and social impacts on the area downstream of the dam. Alternatives 3 and 4 both provide for rehabilitation of the existing dam with minimal impact on the downstream area. Of the two, Alternative 4 has lowest annual cost and is selected as the Recommended Plan. If the Recommended Plan is not supported by the public or is not desirable to the sponsors, they could pursue the implementation of any of the three action alternatives presented and analyzed in the Plan/EA, or other action alternatives that may have been eliminated from further study in this Plan/EA.

Table O. Summary and Comparison of Candidate Plans – EQ Account

	Alternative 1 – No Federal Action	Alternative 2 – Decommissioning with Downstream Flood Mitigation	Alternative 3 – Rehabilitation. Raise Dam Crest, Additional Flood Storage, Reinforce Auxiliary Spillway	Alternative 4 – Rehabilitation. Raise Dam Crest, Additional Flood Storage, Widen and Reinforce Auxiliary Spillway
Aesthetics	No effect	Long-term effects due to creation of conveyance channel through agricultural fields and portions of town	Minor effects during construction, no long-term effect	Minor effects during construction, no long-term effect
Air Quality	No effect	Short-term minor adverse effects during construction	Short-term minor adverse effects during construction	Short-term minor adverse effects during construction
Cultural Resources	No effect	Potential to degrade resources along the channel system	No effect	No effect
Fish Habitat	No effect	No significant effect	No effect	No effect
Highly Erodible Cropland	No effect	No effect	No effect	No effect
Important Agricultural Land	No effect	107 acres of agricultural fields impacted	Additional flood protection	Additional flood protection
Soil Resources	No effect	1,245,310 CY of excavated materials	1,632,225 CY of excavated materials	1,376,060 CY of excavated materials

Table O continued on next page.

Table O. Summary and Comparison of Candidate Plans – EQ Account

	Alternative 1 – No Federal Action	Alternative 2 – Decommissioning with Downstream Flood Mitigation	Alternative 3 – Rehabilitation. Raise Dam Crest, Additional Flood Storage, Reinforce Auxiliary Spillway	Recommended Plan Alternative 4 – Rehabilitation. Raise Dam Crest, Additional Flood Storage, Widen and Reinforce Auxiliary Spillway
Surface Water	Potential for auxiliary spillway flows in floods between the 50-year and 100-year event	Flows up the 100-year event conveyed to the Gila River by a new channel system	Additional flood protection. No change in outfall to the Gila River	Additional flood protection. No change in outfall to the Gila River
Threatened and Endangered Species	No effect	No effect	No effect	No effect
Vegetation Communities	No Effect	Removal of 225 acres of existing vegetation	Removal of 249 acres of existing vegetation	Removal of 288 acres of existing vegetation
Water Quality	No effect	Potential effect on Gila River water quality	No effect	No effect
Wetlands	No effect	No effect	No effect	No effect
Wildlife Habitat	No effect	Short-term minor adverse effect during construction	Short-term minor adverse effect during construction	Short-term minor adverse effect during construction

Table P. Summary and Comparison of Candidate Plans –OSE Account

	Alternative 1 – No Federal Action	Alternative 2 – Decommissioning with Downstream Flood Mitigation	Alternative 3 – Rehabilitation. Raise Dam Crest, Additional Flood Storage, Reinforce Auxiliary Spillway	Recommended Plan Alternative 4 – Rehabilitation. Raise Dam Crest, Additional Flood Storage, Widen and Reinforce Auxiliary Spillway
Sediment Damage	No effect	Potential for large quantities of sediment to be carried downstream	Additional sediment protection	Additional sediment protection
Human Health and Safety	Continued risk of loss-of-life for failure due to auxiliary spillway inadequacies	Eliminate risk for dam break flooding and corresponding risk for loss-of-life.	Reduced risk for dam failure and corresponding risk for loss-of-life.	Reduced risk for dam failure and corresponding risk for loss-of-life.

Table P. Summary and Comparison of Candidate Plans –OSE Account

	Alternative 1 – No Federal Action	Alternative 2 – Decommissioning with Downstream Flood Mitigation	Alternative 3 – Rehabilitation. Raise Dam Crest, Additional Flood Storage, Reinforce Auxiliary Spillway	Recommended Plan Alternative 4 – Rehabilitation. Raise Dam Crest, Additional Flood Storage, Widen and Reinforce Auxiliary Spillway
Land Rights and Relocations	No effect	Increased land acquisitions and infrastructure relocations for the construction of conveyance channels	Landrights required for raising FRS. Relocation of existing utilities.	Landrights required for raising FRS and widening the auxiliary spillway. Relocation of existing utilities.
Land Use	Decertification of the FRS by FEMA would affect land use by putting currently protected properties in a flood hazard zone.	Conveyance channels reduce area suitable for farming.	Additional flood protection.	Additional flood protection.
Minority or Disadvantaged Groups	No effect	Potential impacts due to 215 acres of land required for construction and maintenance; potential to generate short-term jobs for local workers	Additional flood protection; potential to generate short-term jobs for local workers	Additional flood protection; potential to generate short-term jobs for local workers
Municipal and Industrial Water	Florence wastewater facility subject to inundation in a dam break flood	No effect	Reduced risk of wastewater facility inundation from a dam break flood	Reduced risk of wastewater facility inundation from a dam break flood
Water Conveyance and Infrastructure CAP Canal	Subject to inundation from auxiliary spillway flows. Subject to inundation and in a dam break flood	Subject to inundation in flood greater than the design capacity of the conveyance structures over the canals.	Subject to inundation from auxiliary spillway flows. Subject to inundation and in a dam break flood	Subject to inundation from auxiliary spillway flows. Subject to inundation and in a dam break flood
Recreation	No effect	No effect	No effect	No effect
Transportation	No effect	Minor temporary effects during construction	Modifications to Kelvin Road crossing. Increased inundation on Kelvin Road through the flood pool.	Modifications to Kelvin Road crossing. Increased inundation on Kelvin Road through the flood pool.

Table Q summarizes the effects of the recommended plan on resources of national recognition.

Table Q. Effects of the Recommended Plan on Resources of National Recognition

Types of Resources	Principal Sources of National Recognition	Measurement of Effects
Air Quality	Clean Air Act, as amended (42 USC 7401 et seq.)	No effect
Coastal Zone	Coastal Zone Management Act of 1972, as amended (16 USC 1451 et seq.)	No effect
Endangered & Threatened Species Critical Habitat	Endangered Species Act of 1973, as amended (16 USC 1531 et seq.)	No effect
Fish and Wildlife Habitat	Fish and Wildlife Coordination Act (16 USC 661 et seq.)	No effect
Flood plains	Executive Order 11988, Flood plain Management	No effect
Historic and Cultural Properties	National Historic Preservation Act of 1966, as amended (16 USC 470 et seq)	No effect
Prime and Unique Farmland	CEQ Memorandum of August 1, 1980: Analysis of Impacts on Prime or Unique Agricultural Lands in Implementing the National Environmental Policy Act, Farmland Protection Policy Act of 1981.	No effect
Water Quality	Clean Water Act of 1977, as amended (33 USC 1251 et seq.)	No effect
Wetlands	Executive Order 11990, Protection of Wetlands; Clean Water Act, Food Security Act of 1985	No effect
Wild and Scenic Rivers	Wild and Scenic Rivers Act, as amended (16 USC 1271 et seq.)	No effect

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7.0 RECOMMENDED PLAN

7.1 Purpose and Summary

The Recommended Plan is Alternative 4 – rehabilitation by raising the dam crest by a height of 6.2 feet, widening the auxiliary spillway to 800 feet, reinforcing the auxiliary spillway with RCC, and providing additional flood storage by means of a constructed earthen fuse berm across the auxiliary spillway crest. Features in the existing dam and the Recommended Plan are compared in Table R.

Table R. Comparison of Existing Dam and Recommended Plan

	Existing Dam	Rehabilitated Dam (Recommended Plan)
Elevation at top of sediment pool (feet)	1554.7	1554.7
Principal spillway crest elevation (feet)	1555.25	1555.25
Auxiliary spillway crest elevation (feet)	1565.2	1565.2 With engineered embankment crest elevation = 1568.5
Auxiliary spillway bottom width and side slopes	400 feet, 2H:1V	800 feet, 2H:1V
Elevation at top of the dam (feet)	1572.6	1578.8
Auxiliary Spillway Material	Earth/Riprap	RCC

The rehabilitated structure will meet the plan formulation goal of providing continued flood protection for the Town of Florence, Arizona, and surrounding areas, while meeting all of the standards set by ADWR and the NRCS for safety and reliability of the FRS. Feasibility level design plans for Alternative 4 (as well as Alternatives 2 and 3) are included in Appendix D – Supporting Information.

7.2 Measures to Be Installed

The features of the Recommended Plan are summarized below.

7.2.1 Principal Spillway and Gated Outlets

1) The Recommended Plan requires removing the existing inlet and trashrack, extending the 42-inch diameter RCP by approximately 40 feet, and constructing a new inlet and trashrack. The gated outlets used for draining the flood pool would be extended by approximately 40 feet, with necessary modification to the gate works and trashracks.

7.2.2 Flood and Sediment Storage

The PSH (100-year, 10-day event) is the basis of design for the principal spillway. In order to provide sufficient flood storage without altering the principal spillway conduit, the crest of the auxiliary spillway will be raised by 3.3 feet to a finished elevation of 1568.5 feet. The raised portion will be constructed as an engineered embankment with a 14-foot (minimum) top width and 3H:1V side slopes that will require approximately 3400 CY of fill. It will be designed to erode away when it is overtopped by a significant flow. It will thus contain the PSH, and will allow the spillway crest to erode back to the original design elevation to provide needed capacity for the inflow design flood. There is a potential to provide additional flood storage and flood protection by setting the crest of the embankment even higher, providing it will reliably erode away during the IDF. This option can be investigated further during the design phase.

Given the average annual sedimentation rate of 0.1375 acre-feet/year, the existing sediment storage of 840 acre-feet is adequate for the 100-year lifetime of the proposed project.

7.2.3 Auxiliary Spillway

The Recommended Plan includes a combination of raising the FRS (see section 7.2.4) and widening the existing auxiliary spillway to 800 feet to provide conveyance of the inflow design flood. The 800-foot wide auxiliary spillway largely follows the layout of the existing auxiliary spillway and provides a reasonable plan and profile for the inlet channel, spillway crest, and exit channel. This configuration avoids the existing substation, but will require relocation of one or two power poles. The existing diversion berm southeast of the auxiliary spillway will need to be realigned. The Recommended Plan will include RCC revetment on the crest and the front face of the auxiliary spillway. The RCC will cover the top of the auxiliary spillway. It will be 2 feet to 4 feet thick and will have a top elevation of 1565.2 feet to match the existing crest elevation. At the upstream end, the RCC would have a 1.5H:1V toedown to a depth 8 feet below grade. After completion of the RCC, earth fill would be placed and compacted to restore the original grade of the entrance channels. Since the spillway crest is located downstream from the existing crest, the slope of the exiting channel will increase from 0.0076 ft/ft to 0.0152 ft/ft.

The RCC revetment on the front face of the auxiliary spillway will extend a minimum of 18 feet below the crest elevation (1565.2 feet) to an elevation of 1547.2. This is approximately 5 feet below the estimated downstream valley floor elevation of 1552 feet. The RCC will be placed in lifts that are 8 feet wide and 2 feet thick, with a 3-foot offset to give the 1.5H:1V slope. The total quantity of RCC for this section will be approximately 10,500 CY.

The RCC revetment will also be placed along the front face of the main embankment where it parallels the exit channel. The RCC in this location will be constructed in 8-foot-wide, 2-foot-high lifts and would be laid directly against the 2H:1V slope of the dam. The top of the revetment would be constructed to a height of 8 feet above existing grade to give 3 feet of

freeboard over the depth of flow in the exit channel. This revetment would tie directly into the RCC on the auxiliary spillway crest. It would extend downstream along the north face of the FRS to a point near the outlet for the principal spillway. The toedown would be the same as the RCC toedown on the auxiliary spillway. The total quantity of RCC for this section will be approximately 6,800 CY.

7.2.4 Top of Dam

The Recommended Plan will raise the top of dam by 6.2 feet to an elevation of 1578.8 feet. This elevation will provide 1.75 feet of freeboard to account for wave runup and wave setup over the maximum water surface elevation, which results from the 24-hour PMF. The finished crest width will have a minimum width of 14 feet and the side slopes of the fill section will be a minimum of 2H:1V on the downstream side and 3H:1V on the upstream side. The centerline of the raised section dam will follow the existing centerline so that the central filter drain can be extended vertically.

Additional fill or camber to account for future settlement is not expected as the dam has been in place for 40 years and is assumed to be fully settled. With proper preparation of the foundation, the additional fill height is not expected to cause additional settlement after rehabilitation[22]. The estimated volume of fill that meets the required elevation for the entire length is approximately 867,500 cubic yards. An additional 20,400 CY of fill will be required to raise Kelvin Road. Borrow will be obtained from the flood pool area upstream of the demand assumes 25% shrinkage. Actual borrow areas will be identified in the design phase.

During construction, the 6,900 CY of gravel mulch and gravel cover that were recently placed on the downstream slope and crest of the dam will be removed and stockpiled. The total quantity of gravel required to cover the crest and slope after rehabilitation is approximately 13,700 CY. Additional gravel will be brought in to supplement the gravel that is stockpiled. The dam crest and the side slopes near the top of the dam will be cleared and scarified. Offsite disposal will be limited to the vegetation and earth removed as part of clearing and scarification.

Generally the near-surface soils at the site consist of geologically young (Holocene or Pleistocene age) ephemeral stream deposits (alluvium). Due to the collapse potential of the foundation soils, over excavation and re-compaction of the foundation materials in a cutoff trench will be needed prior to adding new embankment fill. The cutoff trench will be 6 feet deep, with a 12-foot bottom width, and 1.5H:1V side slopes. Areas to receive new fill should be cleared and grubbed prior to the addition of new fill. In areas where new fill will contact existing embankment fill, scarification of the existing embankment surface or other forms of "tying-in" should be employed so as to reduce the potential for a weak plane to develop at the contact

[22] This would need to be confirmed with additional geotechnical investigations, testing, and analysis during he design phase.

between existing embankment and new fill. New fill should be placed in loose lifts and mechanically compacted. New fill should be placed in horizontal lifts with a relatively uniform thickness not exceeding 12 inches (vertically). For planning purposes, it is estimated that fill soils should be compacted to a relative compaction of 95 percent (relative to the "maximum" dry density according to ASTM D698-00) and at a moisture content approximately 1 percent (plus or minus two percent) below optimum. The embankment should be overbuilt and cut back to the designed dimensions. Care should be taken when tying into and placing filter material. Specialized equipment may be needed to avoid contamination of filter materials during construction.

7.3 Permits and Compliance

The sponsors are responsible for all permits, including a 404 permit; a 402 National Pollutant Discharge Elimination System Permit (NPDES) for Stormwater from Construction Sites, the water quality certification (401 certification), and submittal Form SCS-ADS- 78 (Real Property Assurances).

Compliance with Sections 401 and 404 of the Clean Water Act is required. The sponsors will obtain the 404 permit and Arizona's 401 Certification. It is anticipated that this action can be completed under Nationwide Permit 3, Maintenance.

The final determination of the applicability of NPDES permitting requirements will be made upon completing the design of the proposed project; if applicable, the final construction contract will include NPDES planning and implementation as a responsibility of the construction contractor. Completion of the Final Watershed Plan-EA and a Finding of No Significant Impact will complete all requirements of NEPA.

7.4 Costs

Tables 1 through 6 are included in Chapter 11 of this Plan-EA and present information about the recommended plan in the traditional NRCS format. The costs shown in Tables 1 and 2 for the planned rehabilitation work were estimated using a June 2006 price level. Annual costs were based on a discount rate of 4.875% over a project life of 100-years. Table 3 summarizes important physical characteristics of the dam. Tables 4, 5, and 6 highlight the amortized or annual average dollar costs and benefits for the planned rehabilitation work. An outline of the table contents follows:

- Table 1. Estimated Installation Cost for the Recommended Plan: This table contains three sub-sections that document land status upon which the recommended plan resides, as well as federal and non-federal funding sources respectively. The first sub-section indicates that the Florence FRS is located on non-federal land. The second sub-section shows federal expenditures under the Watershed Protection and Flood Prevention Act

(PL 83-566) by land ownership status. Federal funds will be expended by the NRCS on non-Federal lands. The third sub-section shows other estimated non-federal costs by land status.

- Table 2. Estimated Cost Distribution: This table shows estimated costs to be charged to the PL 83-566 Funds, and those to be borne by the sponsors.
- Table 3. Structure Data-Dams with Planned Storage: This table shows important physical characteristics for the Florence FRS, with the Recommended Plan in place.
- Table 4. Average Annual Cost: This table shows the anticipated installation costs of the Recommended Plan discounted over the evaluation period of 100 years.
- Table 5. Estimated Average Annual Damage Reduction Benefits: This table summarizes flood damage reduction provided by the proposed project. It includes a summary of the agricultural and non-agricultural benefits that the proposed project would provide.
- Table 6. Comparison of Benefits and Costs: This table summarizes the benefits and costs of each analysis unit within the recommended plan and documents the overall benefit-to-cost ratio of the proposed project.

7.5 Installation and Financing

7.5.1 Framework

All works of improvement will be installed in accordance with applicable state and federal regulations. Installation of the work will be accomplished through a Project Agreement, which defines and details the roles and responsibilities of the NRCS and the sponsors.

7.5.2 Planned Sequence of Installation

The major construction elements in the Recommended Plan can be divided into those for the main embankment and those for the auxiliary spillway. The modifications to the auxiliary spillway should be constructed first to address the integrity issues. Tasks will include utility relocations, clearing and excavation of the auxiliary spillway, installation of the RCC revetment, backfill and final grading, construction of earthen embankment.

Given the 5-mile length of the structure, there is considerable flexibility in how construction of the main embankment is carried out. Based on the approach taken in the cracking repair project, the contractor will likely divide the FRS into sections and will complete all of the tasks necessary for raising the dam section by section. Tasks will include utility relocations, removal stockpiling of existing gravel cover, clearing of borrow area, clearing and scarification on the dam crest side

slopes, foundation preparation, fill and compaction to raise the top of the dam, final grading and replacement of gravel cover, and modifications to Kelvin Road

7.5.3 Responsibilities

The responsibilities of the sponsors and the NRCS, set forth in the original work plan, will continue in accordance with this Supplemental Watershed Plan-EA and with the Supplemental Watershed Agreement.

1) The sponsors are responsible for acquiring land rights and relocations of roadways, bridges, and utilities as appropriate.
2) Relocations for roadways will include replacement of the Kelvin Road crossing over the dam, the Kelvin Road culvert crossing east of the dam, and any other drainage structures located on the affected portion of the roadway.
3) Relocations for utilities will include an overhead powerline that crosses the auxiliary spillway, and modifications to sewer manholes along Kelvin Road.
4) The sponsors will provide leadership in updating their existing Emergency Action Plan (EAP) prior to construction and will update the EAP annually with local emergency response officials. NRCS will provide technical assistance in preparation and updating of the EAP. The purpose of the EAP is to outline appropriate actions and to designate parties responsible for those actions in the event of a potential failure of a floodwater retarding structure.

The sponsors are responsible for leading the planning effort and completing the engineering designs. NRCS will assist during construction by providing engineering designs, construction inspection, and quality assurance testing. These relocations are a necessary component of the dam rehabilitation and are thus cost sharable.

7.5.4 Contracting

It is anticipated that improvements installed by this action will be procured using contracts awarded and administered by the sponsors.

7.5.5 Real Property and Relocations

Implementation of the Recommended Plan will require procurement of the following real property rights by the sponsors.

- Additional perpetual easement (approximately 237 acres) for expanding the flood pool to the new top-of-dam elevation.
- Additional perpetual easement (approximately 8 acres) for widening the auxiliary spillway.

- Additional perpetual easement (approximately 4 acres) to extend the south wing of the dam
- The portion of Kelvin Road that crosses the flood pool is subject to inundation under the no-action-plan. The Recommended Plan will have no additional impact on Kelvin Road up to the 50-year, 24-hour event, but the additional storage provided by the fuse berm will increase flood inundation by about 3 feet in the 100-year, 24-hour event. The Florence-Kelvin Highway provides an all-weather access to points east of the FRS and was originally developed as a preferred route for travel east of the FRS. Given that that the impact on Kelvin Road is incremental and infrequent, and given that there is an alternative route, Kelvin Road is not subject to relocation as part of the recommended plan. In accordance with section 502.82 of the National Watershed Manual, a written right or permission to flood the public road must be obtained from the agency having jurisdiction.

The required area needed to install this alternative is shown on a preliminary Land Rights Work Map that is on file with the NRCS. The preliminary Land Rights Work Map has not been prepared by a registered land surveyor and is not adequate for inclusion into an easement or deed. The NRCS will update this map as necessary during the design phase and the sponsors will use the updated map to perform any additional survey necessary to procure needed property rights. Once the sponsors have obtained the needed real property, they must submit Form SCS-ADS-78, Real Property Assurances, to the NRCS. This form certifies that the areas needed for installation are available and that the action can proceed. No land treatments will be installed by this plan, and no additional flowage easements are necessary.

Additional temporary work easements for over excavation, loading, and unloading will be required in the vicinity of the auxiliary spillway. Areas for construction staging and stockpiling can be located with the existing flood pool area, and will not require additional temporary easement.

It appears that no relocations as defined by the Uniform Relocation Act will be needed. However, if any relocations are identified during installation of this undertaking, they must conform with the Uniform Relocation Act and NRCS procedures, which are outlined in NRCS Property Management Regulations.

7.5.6 Other Agencies

- The Recommended Plan will need to receive concurrence from the Arizona State Historic Preservation Office (SHPO).
- The rehabilitation plan will require review and concurrence from the ADWR Dam Safety

Division.

- Hauling on U.S. 89, state highways, and local roadways will likely require a haul-road permit that will be the responsibility of the construction contractor.
- Modifications to Kelvin Road will require coordination among Pinal County, Town of Florence, San Carlos Irrigation and Drainage District, Central Arizona Project, Utilities and U.S. Bureau of Reclamation.

7.5.7 Threatened and Endangered Species

The NRCS has made a determination of no effect on threatened or endangered species.

7.5.8 Cultural Resources

A literature review and pedestrian surveys for cultural resources within the study area were completed in 2006. The literature review and pedestrian survey indicated that there are no cultural resources eligible for inclusion in the National Register within the area around the FRS. Additional cultural surveys may be required once borrow areas are designated during the design phase. The NRCS concurs with the findings and will conduct the required consultation with the SHPO prior to initiation of the design phase. Tribal consultations will also be conducted prior to SHPO consultation. Efforts to identify cultural resources have been conducted in compliance with Section 106 and Section 110 (f) and (k) of the National Historic Preservation Act. No historic properties were identified and no known sites are recorded in the vicinity. If previously unknown sites are uncovered during construction, appropriate actions will be taken by the NRCS in consultation with the Arizona State Historic Preservation Officer and in conformance with NRCS General Manual Part 420-401.

7.5.9 Financing

The sponsors are responsible for 35%of the total rehabilitation cost. The NRCS will provide 65% of the total rehabilitation cost with funding from PL 83-566.

7.5.10 Operation, Maintenance, and Replacement

The FAWFCD will continue to be the owner of the Florence FRS. The operation, maintenance, and replacement program is carried out as prescribed in the Operation and Maintenance Agreement. This agreement between the sponsors and NRCS will be revised, updated, and executed prior to the beginning of construction. The agreement is developed in accordance with the NRCS National Operation and Maintenance Manual, and provides for inspections, reports, and procedures for performing maintenance items and will be in force during the 100-year evaluated project life. Operation includes the administration, management, and performance of non-maintenance actions needed to keep completed measures safe and functioning as planned.

The National Operation and Maintenance Manual will be used as a guide for operation.

Maintenance includes performing work and providing materials to prevent the deterioration of the installed works. Maintenance also includes repairing damage and replacing the measure or its components. Damage to completed measures caused by normal deterioration, drought, flooding from rainfall greater-than-design rainfall, or vandalism is considered maintenance. Maintenance includes both routine and recurring needs such as:

- Annual control of woody species on or near the dam and auxiliary spillway.
- Rodent control on the main embankment.
- Vector control, if necessary.
- Repair and maintenance of the existing drainage structures.
- Other specific items will be identified during design.

Inspections are necessary to ensure that the installed measures are safe and functioning properly. Inspections are to: a) assess the adequacy of OM&R activities; b) identify needed OM&R work; c) identify unsafe conditions, including significant changes in the use of the flood plain below the dams; d) specify ways of relieving unsafe work or performing other needed work; and e) set action dates for performing corrective actions.

The sponsors are responsible for inspecting completed measures. Inspections will be made at least annually on a regularly scheduled basis for the life of the structure and after any major events such as floods or earthquakes. The Operation and Maintenance Agreement will specify any other needed inspections. The NRCS may, depending on the availability of staff, assist the sponsors with the inspections. Inspection reports will be supplied to NRCS following each inspection. The estimated annual cost of operation and maintenance for the Recommended Plan is $98,800 (see Table 4). It includes maintenance for a much larger embankment and an enlarged auxiliary spillway, and is thus higher than the maintenance cost estimated for the existing condition structure shown in Table N.

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8.0 CONSULTATION AND PUBLIC PARTICIPATION

As noted in Section 4.1 – Scope of the Watershed Plan and Environmental Assessment, an initial public scoping meeting to solicit input on the planning process was held on January 25, 2006 in Florence, Arizona. Meeting notices/announcements were published in local newspapers and mailed to approximately 60 stakeholders. Electronic copies sent to the Town of Florence, Pinal County, and the Pinal County Library for posting on their respective websites. Local residents and agency representatives attended the scoping meeting. Input and comments were collected and documented from interested parties.

A Draft Supplemental Rehabilitation Plan/Environmental Assessment for public and agency review was released on December 1, 2006. A public meeting to present the results of the draft document and to solicit public input and comment was held on December 6, 2006 in Florence, Arizona. Meeting notices/announcements were published in local newspapers and mailed to approximately 60 stakeholders. Electronic copies sent to the Town of Florence, Pinal County, and the Pinal County Library for posting on their respective websites. Local residents and agency representatives attended the meeting and provided comments on the Draft Supplemental Watershed Plan/EA. The comments made were used to guide the formulation of alternatives and development of the Final Supplemental Watershed Plan/EA. In addition to the public, the following agencies and groups were invited to participate during any or all of the planning process including and during inter-agency review of documents.

8.1 Federal Government

U.S. Army Corps of Engineers
U.S. Fish and Wildlife Service
U.S. Environmental Protection Agency
U.S. Department of the Interior, Bureau of Reclamation
U.S. Department of the Interior, Bureau of Indian Affairs
Bureau of Land Management

8.2 State and Local Government

Office of the Governor
Arizona State Parks Board, State Historic Preservation Office
Arizona Department of Agriculture
Arizona Department of Corrections
Arizona Department of Water Resources
Arizona Division of Emergency Management
Arizona Department of Environmental Quality
Arizona Game and Fish Department

Arizona State Land Department

Pinal County

Town of Florence

San Carlos Irrigation and Drainage District

8.3 Tribal Contacts

The *Cultural Resources Management Evaluation of the Florence Floodwater Retarding Structure* (NRCS 2005) included the following description of tribal interests:

> *The Florence FRS Emergency Spillway Project is located within the area of traditional interest of the Hopi, the Salt River Pima-Maricopa Indian Community, the Yavapai-Apache Nation, and the Pascua Yaqui Tribe. It appears to be just outside of the area claimed by the Yavapai-Prescott Indian Tribe. The traditional area claims maps available to the NRCS are less than precise. The Salt River Pima-Maricopa Indian Community, the Yavapai-Apache Nation, the Pascua Yaqui Tribe, and the Yavapai-Prescott Indian Tribe will all be provided with copies of this report. The Hopi Cultural Preservation Office has deferred to the Arizona State Historic Preservation Office and the four southern tribes concerning NRCS consultation in this area.*

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10.0 LIST OF PREPARERS

The following individuals participated in the preparation of the Plan/EA.

Table S. List of Preparers

Name	Present Title	Education	Experience (Years)	Registration
Natural Resources Conservation Service				
Don Paulus	Assistant State Conservationist for Programs	B.S. Civil Engineering	24	P.E.
Dino DeSimone	Resource Conservationist Arizona State Office	B.S., Evt. Resources & Agriculture	21	--
Mike Luecker, P.E.	State Hydraulic Engineer Arizona State Office	B.S., M.S.E. Civil Engineering	11	P.E.
Gerard Kelso, Ph.D.	Archeologist Arizona State Office	B.A., Anthropology M.S., PhD Anthropology	20	--
Seth Fiedler	Economist New Mexico State Office	B.A., Economics, M.C.P.	14	--
Tetra Tech, Inc.				
Doug Lantz, Ph.D., P.E.	Project Manager, Senior Hydraulic Engineer	B.S., M.S., Ph.D. Watershed Mgmt.	19	P.E.
Chris Lee, P.E.	Planner/Report Writer	B.S., Civil Engineering,	12	P.E.
Merri Martz	Senior Biologist	M.M.A., Marine Affairs/Wetland Ecology	15	--
Kurt Keilman	Senior Economist	M.A., Economics	10	--
Kathy Roxlau, R.P.A.	Cultural Resources Specialist	M.A., Anthropology	16	Registered Professional Archaeologist (R.P.A.)
Other				
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Tom McDougal, P.E.	Geotechnical Engineer Ninyo & Moore, Inc.	B.S.C.E., M.S.C.E. Civil Engineering	6	P.E.
Robert McMichael, P.E.	Geotechnical Engineer Ninyo & Moore, Inc.	B.S.C.E., M.S.C.E. Civil/Geotechnical Engineering	22	P.E.
Jim Talbot, P.E.	Geotechnical Engineer	B.S., Civil Engineering	46	P.E.

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11.0 NRCS NATIONAL WATERSHED MANUAL TABLES

Table 1. Estimated Installation Cost, Florence FRS, Florence, Arizona

	Number				PL83-566 Funds			Other Funds			Total
Installation Cost Items	Unit	Federal Land	Nonfederal Land	Total	Federal Land	Nonfederal Land	Total	Federal Land	Nonfederal Land	Total	
Structural Measures					(Amounts shown in Dollars) (1)						
Dam Rehabilitation	Each		1	1	$0	$10,502,400	$10,502,400		$4,991,500	$4,991,500	$15,493,900
Relocation of Utilities and Kelvin Road	Each		1	1	$0	$0	$0		$663,800	$663,800	$663,800
Technical Assistance	Each				$0	$1,552,200	$1,552,200		$0	$0	$1,552,200
Total Estimated Cost	Each				$0	$12,054,600	$12,054,600		$5,655,300	$5,655,300	$17,709,900

1) Price Base: June 2006

Table 2. Estimated Cost Distribution-Rehabilitation, Florence FRS, Florence, Arizona

	(Amounts shown in Dollars) (1)						
	Construction	Engineering	Real Property Rights	Water Rights	Relocation Payments	Project Administration	Total
	Installation Cost-Federal Agriculture Appropriations Act of 2000 Funds						
Dam Rehabilitation, Federal Cost Share, (PL-566)	$10,502,400	$846,700	$0	$0	$0	$705,500	12,054,600
	Installation Cost-Other Funds						
Dam Rehabilitation, Local Sponsor Cost Share	$4,369,000		$622,500	$0	$0	$0	$4,991,500
Relocation Costs, Utilities and Kelvin Road, Local Sponsor Cost	$538,600	$75,100				$50,100	$663,800
	Total Installation Cost						
Total Installation Cost	$15,410,000	$921,800	$622,500	$0	$0	$755,600	$17,709,900

1) Price Base: June 2006

Table 3. Structure Data - Dams with Planned Storage, Florence FRS, Florence, Arizona
(Page 1 of 1)

Item	Unit	Florence FRS Recommended Plan Data
Hazard Class of Structure		High (Class c)
Seismic Zone		Zone 1
Uncontrolled Drainage Area (upstream of dam)	Mi^2	61.076
Future Conditions 1-Day Runoff Curve Number[1]		82.4
Time of Concentration [1]	Hours	5.95
Elevation - Top of Dam	Feet	1578.8
Elevation - Crest Auxiliary Spillway	Feet	1565.2
Elevation - Crest of earthen embankment to contain PSH	Feet	1568.5
Elevation - Crest Principal Spillway	Feet	1555.25
Elevation - Sediment Pool	Feet	1554.7
Auxiliary Spillway Type	Roller Compacted Concrete	
Auxiliary Spillway Bottom Width	Feet	800
Auxiliary Spillway Exit Slope	Percent	1.52 %
Maximum Height of Dam	Feet	32.8
Volume of Fill [2]	Cubic Yards	2,491,700
Total Storage Capacity		
Sediment (Elev = 1554.7 feet)	Acre-Feet	840
Floodwater at crest of Auxiliary Spillway (Elev = 1568.5 feet)	Acre-Feet	7,381
Floodwater at Top-of-Dam (Elev = 1578.8 feet)	Acre-Feet	18,433
Surface Area		
Sediment Pool[3] (Elev = 1554.7)	Acres	214
Floodwater Pool (At top of earthen berm, Elev = 1568.5)	Acres	836
Top of Dam (Elev = 1578.8)	Acres	1264
Principal Spillway		
Rainfall Volume (100-year, 24-hour)	Inches	3.86
Rainfall Volume (100-year, 10-day)	Inches	6.29
Runoff Volume (100-year, 24-hour)	Inches	1.92
Runoff Volume (100-year, 10-day)	Inches	2.70
Capacity of Principal Spillway (Top-of-Dam)	$Ft.^3/sec.$	255
Dimensions of Conduit	Inches	42
Type of Conduit		RCP
Frequency Operation-Auxiliary Spillway	%-chance	1.0%
Stability Design Hydrograph		
Rainfall Volume	Inches	6.23
Runoff Volume	Inches	4.16
Storm Duration	Hours	24
Velocity of Flow (Ve,sdh)	Ft./sec.	8.5
Maximum Water Surface Elevation	Feet	1568.97

Table 3. Structure Data - Dams with Planned Storage, Florence FRS, Florence, Arizona
(Page 2 of 2)

Item	Unit	Florence FRS Recommended Plan Data
Freeboard Hydrograph (24-hour PMF (3-2-1-4 distribution)		
Rainfall Volume	Inches	13.6
Runoff Volume	Inches	11.26
Storm Duration	Hours	24
Maximum Water Surface Elevation	Feet	1577.1
Velocity of Flow (Ve,fbh)	Ft./sec.	17.6
Capacity Equivalents		
Sediment Volume	Inches	0.26
Floodwater Retarding Volume	Inches	2.27

1) Composite values for the entire controlled drainage area under future conditions. Actual modeling broke this area into a number of subareas.
2) Total fill = 1,500,000 CY for original dam + 991,700 CY additional fill for the main embankment and cutoff trench.
3) Dam is dry except during storm events.

Table 4. Average Annual NED Cost, Florence FRS, Florence, Arizona

Evaluation Unit	Installation Cost (Plan Year Dollars)	Amortization of Installation Cost	Operation, Maintenance and Replacement Cost	Total
Structural Measures	(Amounts shown in Dollars) (1)			
Dam Rehabilitation	$17,046,100	$838,200	$98,800	$937,000
Relocation of Utilities and Kelvin Road	$663,800	$32,600	$0	$32,600
Total	$17,709,900	$870,800	$98,800	$969,600

1) Price Base: June 2006 Discounted at 4.875% for 100 years.

Table 5. Estimated Average Annual Damage Reduction Benefits, Florence FRS, Florence, Arizona

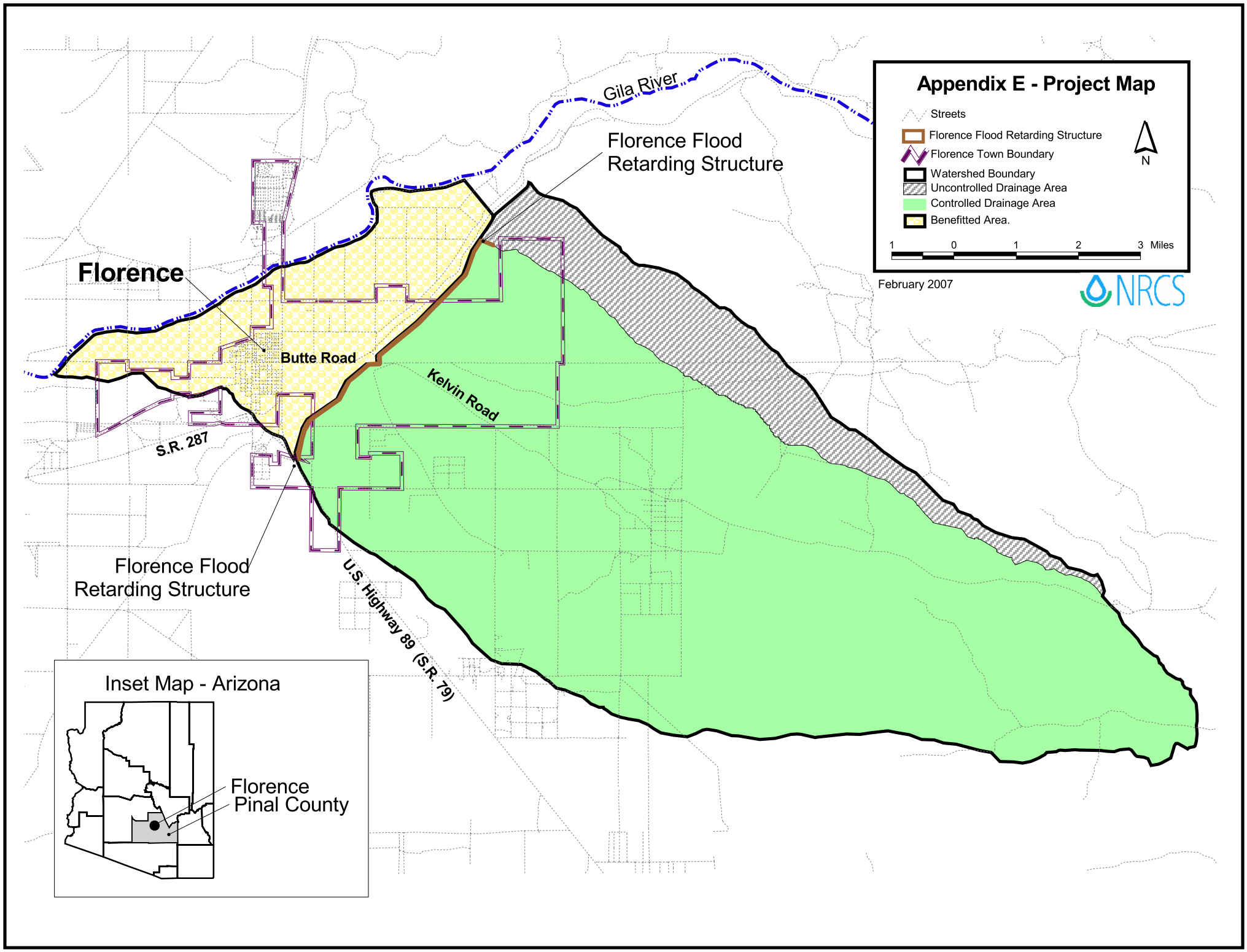
	Estimated Average Annual Damage (1,2,3)		Damage Reduction Benefits (1,2,3)	
Item	Without Project (Dollars)	With Project (Dollars)	Average Annual (Dollars)	Percent Reduction (Percent)
Floodwater				
Nonagricultural	$4,440,000	$4,440,000	$0	0%
Agricultural	$180,000	$180,000	$0	0%
Grand Total	$4,620,000	$4,620,000	$0	0%

1) Price Base: June 2006 Discounted at 4.875% for 100 years.
2) The proposed rehabilitation will provide an estimated $4,620,000 in annual damage reduction benefits. However, as the "no action alternative" also provides this same benefit stream, rehabilitation does not have a positive "incremental NED benefit." The benefits of the proposed rehabilitation are outlined in the plan, and are directly tied to addressing documented structural inadequacies.
3) Under existing conditions, damages and benefits will accrue from floods exceeding somewhere between the 50-year and 100-year event. Under future development conditions, damages and benefits will accrue from floods exceeding the 50-year event. These damages and benefits were not evaluated.

Table 6. Comparison of Benefits and Costs, Florence FRS, Florence, Arizona

Evaluation Unit	Agricultural Related Damage Reduction		Urban Flood Protection	Benefits Total [2]	Average Annual Costs Total	Net Benefits Total	Benefit Cost Ratio [2]
	Direct FP	Indirect FP					
	(Amounts shown in Dollars) [1]						
Structural Measures							
Dam Rehabilitation	$0	$0	$0	$0	$937,000	$(937,000)	0.0:1.0
Relocation of Utilities and Kelvin Road	$0	$0	$0	$0	$32,600	$(32,600)	0.0:1.0
Total Recommended Plan	$0	$0	$0	$0	$969,600	$(969,600)	0.0:1.0

1) Price Base: June 2006 Discounted at 4.875% for 100 years.
2) The proposed rehabilitation will provide an estimated $4,620,000 in annual damage reduction benefits. However, as the "no action alternative" also provides this same benefit stream, rehabilitation does not have a positive "incremental NED benefit" and the benefit cost ratio is considered to be 0.0:1.0. The benefits of the proposed rehabilitation are outlined in the plan, and are directly tied to addressing documented structural inadequacies.


Appendix E - Project Map
Streets
Florence Flood Retarding Structure
Florence Town Boundary
Watershed Boundary
Uncontrolled Drainage Area
Controlled Drainage Area
Benefitted Area.
N
1 0 1 2 3 Miles
February 2007
NRCS
Gila River
Florence Flood Retarding Structure
Florence
Butte Road
Kelvin Road
S.R. 287
Florence Flood Retarding Structure
U.S. Highway 89 (S.R. 79)
Inset Map - Arizona
Florence
Pinal County