FINAL SUPPLEMENTAL WATERSHED PLAN AND ENVIRONMENTAL ASSESSMENT FOR THE

POWERLINE FLOOD RETARDING STRUCTURE

PINAL COUNTY, ARIZONA

Prepared by:

East Maricopa Natural Resource Conservation District

Flood Control District of Maricopa County, Arizona
FCD 2008C042

Assisted by:
United States Department of Agriculture
Natural Resources Conservation Service

and

Kimley-Horn and Associates, Inc.
7740 N. 16th Street, Suite 300
Phoenix, Arizona 85020
KHA Project No. 091131020

April 2013

Arizona Congressional Representatives at Time of Plan Development:

Senate:

John McCain, U.S. Senator
241 Russell Senate Office Building
Washington, D.C. 20510
(202) 224-2235

Jeff Flake, U.S. Senator
B85 Russell Senate Office Building
Washington, DC 20515
(202) 224-4521

House of Representatives:

David Schweikert, U.S. Congressman
1205 Longworth House Office Building
Washington, D.C. 20510
(202) 255-2190

Final Supplemental Watershed Plan and Environmental Assessment
for the
Powerline Flood Retarding Structure
Pinal County, Arizona

Prepared by:
East Maricopa Natural Resource Conservation District
and
Flood Control District of Maricopa County
2801 W. Durango Street, Phoenix, Arizona 85009

Assisted by:
United States Department of Agriculture
Natural Resources Conservation Service

AUTHORITY

The original watershed work plan was prepared, and works of improvement have been installed, under the authority of the Watershed Protection and Flood Prevention Act of 1954 (Public Law 83-566) as amended. This Supplemental Watershed Plan and Environmental Assessment is authorized under Public Law 83-566 (as amended), and as further amended by Section 313 of Public Law 106-472 and in accordance with Section 102(2)c of the National Environmental Policy Act of 1969, Public Law 91-190, amended (42 USC 4321 et seq).

ABSTRACT

The Powerline Flood Retarding Structure (FRS) was constructed by the Soil Conservation Service (now the Natural Resources Conservation Service – NRCS) in 1968 as part of the Apache Junction-Gilbert Watershed Protection and Flood Prevention Project. The FRS is operated and maintained by the Flood Control District of Maricopa County (District). The 2.5 mile long, 21 foot high earth dam provides flood protection to downstream residents, structures, and infrastructure.

The FRS has developed safety deficiencies and is approaching the original 50-year project lifetime. In May 2007, an earth fissure was identified in close proximity to the downstream toe of the dam. In light of the proximity of this earth fissure to the Powerline embankment, and the presence of other documented earth fissures in the general vicinity of the dam, the Arizona Department of Water Resources (ADWR) classifies Powerline FRS as being in an “unsafe, non-emergency, elevated risk” condition. As such, the Powerline FRS is one of ADWR’s highest priority unsafe dams in the state. The District is currently constructing the Powerline Interim Dam Safety Measure (IDSM). The IDSM consists of a new alignment for a portion of the Powerline FRS based on the results of past investigations indicating a high probability of an earth fissure beneath the existing embankment. In 2009, the District requested Federal planning and implementation assistance for long-term solutions to the identified dam safety deficiencies. This Supplemental Watershed Plan and Environmental Assessment (Plan/EA) determines the feasibility of decommissioning the FRS and replacing the FRS with a constructed channel to provide for continued flood protection while meeting current applicable local, State, and Federal regulations.

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Supplemental Watershed Agreement
Apache Junction-Gilbert Watershed

Between the

Flood Control District of Maricopa County
East Maricopa Natural Resource Conservation District
(Referred to herein as Sponsors)

And the

U.S. Department of Agriculture
Natural Resources Conservation Service
(Referred to herein as NRCS)

Whereas, the Watershed Plan for the Apache Junction-Gilbert Watershed, State of Arizona, executed by the Sponsors named therein and NRCS, became effective on the 13th day of May, 1963; and

Whereas, a supplemental agreement for said watershed, executed by the sponsors named therein and NRCS became effective on the 1st day of March, 1967: and

Whereas, a supplemental agreement for said watershed, executed by the sponsors named therein and NRCS became effective on the 18th day of April, 1979; and

Whereas, in order to carry out the watershed plan for said watershed, it has become necessary to modify said watershed agreement, as supplemented; and

Whereas, application has heretofore been made to the Secretary of Agriculture by the sponsors for assistance in preparing a plan for works of improvement for the Apache Junction-Gilbert Watershed, State of Arizona, under the authority of the Watershed Protection and Flood Prevention Act, as amended (16 U.S.C. Sections 1001 to 1008, 1010, and 1012); and

Whereas, the responsibility for administration of the Watershed Protection and Flood Prevention Act, has been assigned by the Secretary of Agriculture to NRCS; and

Whereas, there has been developed through the cooperative efforts of the sponsors and NRCS a Supplemental Watershed Plan and Environmental Assessment for works of improvement for the Apache Junction-Gilbert Watershed, State of Arizona, hereinafter referred to as the Watershed Plan or plan, which plan is annexed to and made a part of this agreement;

Now, therefore, in view of the foregoing considerations, the Secretary of Agriculture, through NRCS, and the sponsors hereby agree on this Watershed Plan and that the works of improvement for this project will be installed, operated, and maintained in accordance with the terms, conditions, and stipulations provided for in this plan and including the following:

1. Term. The term of this agreement is for the installation period and evaluated life of the project (103 years) and does not commit NRCS to assistance of any kind beyond the end of the evaluated life.

2. Costs. The costs shown in this plan are preliminary estimates. Final costs to be borne by the parties hereto will be the actual costs incurred in the installation of works of improvement.

3. Real property. The sponsors will acquire such real property as will be needed in connection with the works of improvement. The amounts and percentages of the real property acquisition costs to be borne by the sponsors and NRCS are as shown in the Cost-share table in section 5 hereof.

4. Uniform Relocation Assistance and Real Property Acquisition Policies Act. The sponsors hereby agree to comply with all of the policies and procedures of the Uniform Relocation Assistance and Real Property Acquisition Policies Act (42 U.S.C. Section 4601 et seq. as further implemented through regulations in 49 CFR Part 24 and 7 CFR Part 21) when acquiring real property interests for this federally assisted project. If the sponsor is legally unable to comply with the real property acquisition requirements, it agrees 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.

5. Cost-share for Watershed Project Plans. The following table will be used to show cost-share percentages and amounts for Watershed Plan implementation.

Cost-Sharable Items [1/5]			
Construction (Powerline Channel)	$ 15,292,200	$ 6,855,800	$ 22,148,000
Relocation [2/]	$ -	$ -	$ -
Sponsors Planning		$ 716,900	$ 716,900
Sponsors Engineering		$ 651,500	$ 651,500
Sponsors Project Administration		$ 10,000	$ 10,000
Real Property Acquisition Cost		$ -	$ -
Subtotal Cost-Sharable Costs	$ 15,292,200	$ 8,234,200	$ 23,526,400
Cost-Share Percentages	65%	35%	
Non Cost-Sharable Items [3/]			
NRCS Technical Assistance/ Engineering	$ 650,000		$ 650,000
Natural Resource Rights		$ -	$ -
Permits		$ 434,300	$ 434,300
Relocation, beyond required decent, safe, sanitary [4/]		$ -	$ -
Subtotal Non-Cost-Sharable Costs	$ 650,000	$ 434,300	$ 1,084,300
Total Costs	$ 15,942,200	$ 8,668,500	$ 24,610,700

1/ Maximum NRCS cost-share is 65 percent of cost-sharable items, not to exceed 100 percent of construction cost.
2/ Investigation of the watershed project area indicates that no displacements will be involved under present conditions. However, in the event that displacement becomes necessary at a later date, the cost of relocation assistance and payments will be cost-shared in accordance with the percentages shown.
3/ If actual Non-Cost-Sharable item expenditures vary from these figures, the responsible party will bear the change.

4/ Relocation payments for the cost of improvements beyond decent, safe and sanitary requirements is a non-project cost ineligible for assistance under the Act
5/ Estimated costs for cultural and environmental mitigation are included in the construction costs. Refer to **Appendix E** for construction costs.

6. Land treatment agreements. The sponsors will obtain agreements from owners of not less than 50 percent of the land above each multiple-purpose and floodwater-retarding structure. These agreements must provide that the owners will carry out farm or ranch conservation plans on their land. The sponsors will ensure that 50 percent of the land upstream of any retention reservoir site is adequately protected before construction of the dam. The sponsors will provide assistance to landowners and operators to ensure the installation of the land treatment measures shown in the Watershed Plan. The sponsors will encourage landowners and operators to continue to operate and maintain the land treatment measures after the long-term contracts expire, for the protection and improvement of the watershed.

7. Floodplain Management. Before construction of any project for flood prevention, the sponsors shall agree to participate in and comply with applicable Federal floodplain management and flood insurance programs.

8. Water and mineral rights. The sponsors will acquire or provide assurance that landowners or resource users have acquired such water, mineral, or other natural resources rights pursuant to State law as may be needed in the installation and operation of the works of improvement. Any costs incurred shall be borne by the sponsor and these costs are not eligible as part of the sponsors cost-share.

9. Permits. The sponsors will obtain and bear the cost for all necessary Federal, State, and local permits required by law, ordinance, or regulation for installation of the works of improvement. These costs are not eligible as part of the sponsors' cost-share.

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

11. Additional agreements. 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. Amendments. This plan may be amended or revised only by mutual agreement of the parties hereto, except that NRCS may deauthorize or terminate funding at any time it determines that the sponsors have failed to comply with the conditions of this agreement or when the program funding or authority expires. In this case, NRCS shall promptly notify the sponsors in writing of the determination and the reasons for the deauthorization 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 deauthorized. 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. Prohibitions. 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 therefrom; but this

provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.

14. Operation and Maintenance (O&M). 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 an O&M Agreement. An O&M agreement will be entered into before Federal funds are obligated and will continue for the project life (100 years). Although the sponsors' responsibility to the Federal Government for O&M ends when the O&M agreement expires upon completion of the evaluated life of measures covered by the agreement, the sponsors acknowledge that continued liabilities and responsibilities associated with works of improvement may exist beyond the evaluated life.

15. Emergency Action Plan. Prior to construction, the sponsors shall prepare an Emergency Action Plan (EAP) for each dam or similar structure where failure may cause loss of life or as required by state and local regulations. The EAP shall meet the minimum content specified in Part 500.52 of the NRCS Title 180, National Operation and Maintenance Manual (NOMM), Part 500, Subpart F, Section 500.52, and meet applicable State agency dam safety requirements. The NRCS will determine that an EAP is prepared prior to the execution of fund obligating documents for construction of the structure. EAPs shall be reviewed and updated by the sponsors annually.

16. Nondiscrimination Provisions. The U.S. Department of Agriculture (USDA) prohibits discrimination against its customers. If you believe you experienced discrimination when obtaining services from USDA, participating in a USDA program, or participating in a program that receives financial assistance from USDA, you may file a complaint with USDA. Information about how to file a discrimination complaint is available from the Office of the Assistant Secretary for Civil Rights. USDA prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex (including gender identity and expression), marital status, familial status, parental status, religion, sexual orientation, political beliefs, genetic information, reprisal, or because all or part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.)

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By signing this agreement the recipient assures the 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.

17. Certification Regarding Drug-Free Workplace Requirements (7 CFR Part 3021). 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. Section 812) and as further defined by regulation (21 CFR Sections 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 subrecipients or subcontractors in covered workplaces).

Certification:

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 10 calendar days after receiving notice under paragraph (4)(b) from an employee or otherwise receiving actual notice of such conviction. Employers of convicted employees shall 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 numbers 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 sites 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 Part 3018) *(for projects > $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 subrecipients 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 U.S. Code, Title 31, Section 1352. 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 Part 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 3-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 A(2) of this certification; and

(4) Have not within a 3-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.

20. Clean Air and Water Certification.

(Applicable if this agreement exceeds $100,000, or a facility to be used has been subject of a conviction under the Clean Air Act (42 U.S.C. Section 7413(c)) or the Federal Water Pollution Control Act (33 U.S.C. Section 1319(c)) and is listed by EPA, or is not otherwise exempt.)

A. The project sponsoring organizations signatory to this agreement certify as follows:

(1) Any facility to be utilized in the performance of this proposed agreement is (___), is not (_X_) listed on the Environmental Protection Agency List of Violating Facilities.

(2) To promptly notify the NRCS-State administrative officer prior to the signing of this agreement by NRCS, of the receipt of any communication from the Director, Office of Federal Activities, U.S. Environmental Protection Agency, indicating that any facility which is proposed for use under this agreement is under consideration to be listed on the Environmental Protection Agency List of Violating Facilities.

(3) To include substantially this certification, including this subparagraph, in every nonexempt sub-agreement.

B. The project sponsoring organization(s) signatory to this agreement agrees as follows:

(1) To comply with all the requirements of section 114 of the Clean Air Act as amended (42 U.S.C. Section 7414) and section 308 of the Federal Water Pollution Control Act (33 U.S.C. Section 1318), respectively, relating to inspection, monitoring, entry, reports, and information, as well as other requirements specified in section 114 and section 308 of the Air Act and the Water Act, issued there under before the signing of this agreement by NRCS.

(2) That no portion of the work required by this agreement will be performed in facilities listed on the EPA List of Violating Facilities on the date when this agreement was signed by NRCS unless and until the EPA eliminates the name of such facility or facilities from such listing.

(3) To use their best efforts to comply with clean air standards and clean water standards at the facilities in which the agreement is being performed.

(4) To insert the substance of the provisions of this clause in any nonexempt subagreement.

C. The terms used in this clause have the following meanings:

(1) The term “Air Act” means the Clean Air Act, as amended (42 U.S.C. Section 7401 et seq.).

(2) The term “Water Act” means Federal Water Pollution Control Act, as amended (33 U.S.C. Section 1251 et seq.).

(3) The term “clean air standards” means any enforceable rules, regulations, guidelines, standards, limitations, orders, controls, prohibitions, or other requirements which are contained in, issued under, or otherwise adopted pursuant to the Air Act or Executive Order 11738, an applicable implementation plan as described in section 110 of the Air Act (42 U.S.C. Section 7414) or an approved implementation procedure under section 112 of the Air Act (42 U.S.C. Section 7412).

(4) The term “clean water standards” means any enforceable limitation, control, condition, prohibition, standards, or other requirement which is promulgated pursuant to the Water Act or contained in a permit issued to a discharger by the Environmental Protection Agency or by a State under an approved program, as authorized by section 402 of the Water Act (33 U.S.C. Section 1342), or by a local government to assure compliance with pretreatment regulations as required by section 307 of the Water Act (33 U.S.C. Section 1317).

(5) The term “facility” means any building, plant, installation, structure, mine, vessel, or other floating craft, location or site of operations, owned, leased, or supervised by a sponsor, to be utilized in the performance of an agreement or subagreement. Where a location or site of operations contains or includes more than one building, plant, installation, or structure, the entire location shall be deemed to be a facility except where the Director, Office of Federal Activities, Environmental Protection Agency, determines that independent facilities are collocated in one geographical area.

21. Assurances and Compliance.

As a condition of the grant or cooperative agreement, the sponsor assures and certifies that it is in compliance with and will comply in the course of the agreement with all applicable laws, regulations, Executive orders and other generally applicable requirements, including those set out below which are hereby incorporated in this agreement by reference, and such other statutory provisions as a specifically set forth herein.

State, Local, and Indian Tribal Governments: OMB Circular Nos. A-87, A-102, A-129, and A-133; and 7 CFR Parts 3015, 3016, 3017, 3018, 3021, and 3052.

Nonprofit Organizations, Hospitals, Institutions of Higher Learning: OMB Circular Nos. A-110, A-122, A-129, and A-133; and 7 CFR Parts 3015, 3017, 3018, 3019, 3021 and 3052.

22. Examination of Records.

The sponsors shall give the NRCS or the Comptroller General, through any authorized representative, access to and the right to examine all records, books, papers, or documents related to this agreement, and retain all records related to this agreement for a period of three years after completion of the terms of this agreement in accordance with the applicable OMB Circular.

23. Signatures

Flood Control District of Maricopa County
2801 W. Durango St.
Phoenix, Arizona 85009

By: _____
DEPUTY Clerk of the Board
Date AUG 07 2013

The signing of the Supplemental Watershed Agreement for the Apache Junction-Gilbert Watershed Project was authorized by a resolution of the governing body of the Flood Control District of Maricopa County and adopted at a meeting held on August 7, 2013

AUG 07 2013 _____ 7/18/13
Andy Kunasek Date
Chairman, Board of Directors

Timothy S. Phillips, P.E. Date
Chief Engineer and General Manager

_____ 7/17/13
District General Counsel Date

East Maricopa
Natural Resource Conservation District
805 East Warner Road, Suite 104
Chandler, Arizona 85225

_____ 6/4/13
Casey Stechnij Date
Chairman

The signing of the Supplemental Watershed Agreement for the Apache Junction-Gilbert Watershed Project was authorized by a resolution of the governing body of the East Maricopa Natural Resource Conservation District and adopted at a meeting held on June 4, 2013

_____ 6-4-13
Secretary Date

United States Department of Agriculture
Natural Resources Conservation Service
230 North First Avenue; Suite 509
Phoenix, Arizona 85003

Approved By:
_____
Keisha L. Tatem
State Conservationist

Date: 08/23/2013

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1.0 SUMMARY SUPPLEMENTAL WATERSHED PLAN AND ENVIRONMENTAL ASSESSMENT

Project Name: Powerline Flood Retarding Structure (FRS)

County: PINAL State: ARIZONA Congressional District: 6

Authorization: Public Law 83-566 Stat. 666 as amended (16 U.S.C. Section 1001 et. Seq.) 1954

Sponsors: Flood Control District of Maricopa County, Arizona

East Maricopa Natural Resource Conservation District

Proposed Action: Decommission the Powerline FRS by constructing a 100-year flood control channel.

Purpose and Need for Action: The purpose of the proposed project is flood prevention. The Powerline FRS provides flood protection to portions of eastern Maricopa County and western Pinal County, Arizona. The dam is being evaluated due to concerns regarding the foundation (subsidence and potential earth fissure), central filter, embankment cracking, and the inability to safely pass the inflow design flood. The Arizona Department of Water Resources has declared the dam as being in an "Unsafe, Non-Emergency, Elevated Risk" condition.

The Preferred Alternative will meet the project purpose of providing for continued flood protection for the downstream benefitted area and reducing the risk of loss of life due to catastrophic dam failure. 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.

Description of Preferred Alternative: The Preferred Alternative for Powerline FRS is: Decommissioning which includes measures to decommission the Powerline FRS by constructing a 100-year channel (Powerline Channel) upstream of the dam to replace the structure and direct the flows to the Vineyard Road FRS. The existing Powerline FRS and Powerline Interim Dam Safety Measure (IDSM) embankment is anticipated to be completely removed. The Powerline Channel is approximately 12,000 feet long. The channel is trapezoidal in shape, earthlined, and ranges in bottom width from 60 feet at the upstream end to 1,000 feet at the confluence with the Vineyard Road FRS flood pool. Several segments of the Powerline channel will be hardened with concrete. The segments of the channel crossing moderate fissure risk zones will be concrete lined with upstream and downstream permeable backfill trenches. The spoils from the channel excavation and existing FRS and IDSM removal will be stockpiled within the Sponsor's easements. Materials excavated from the channel may be used to for the dam rehabilitation of the Vineyard Road FRS (under a separate but related construction activity).

Resource Information**:**

- Latitude and Longitude: The existing Powerline FRS is located at 33.3619° N Latitude, and 111.5497° W Longitude.
- Hydrologic Unit Number: The 8-digit Hydrologic Unit Code (HUC) for Powerline FRS contributing watershed and downstream inundation area is the Middle Gila Watershed – 15050100.

Climate and Topography: The upstream contributing watershed for the Powerline FRS originates in the southwest facing slopes of the Superstition Mountains with steep mountain topography. The mountains drain onto a wide alluvial fan with various land uses and flattening topography. The downstream inundation area is a largely flat topography with mixed land uses. The climate is typical of the arid southwest with mild winters and hot summers. Rainfall is limited and typically occurs in either the winter wet period or the summer monsoon period.

Watershed size: Approximately 11,264 acres in the downstream breach inundation area; approximately 29,952 acres in the upstream contributing watershed.

Land Uses: The downstream area consists of open space, residential and commercial/industrial developments, agriculture and open space. The upstream contributing watershed consists primarily of open space.

Land Ownership Information (downstream area): Private Land – 87%, State/Local 12%, Federal 1%.

Population and Demographics: The current residential population in the study area downstream of the FRSs is estimated at 91,700. The population at risk of flooding downstream of the Powerline FRS is estimated at 27,100. The majority of the total population encompassing the Powerline, Vineyard Road and Rittenhouse Flood Retarding Structures (PVR FRSs) area is White which comprises 86.9% of the population. The total minority population is 13.1% with the breakdown of racial and ethnic demographics as follows: Black or African American 1.4%; American Indian and Alaskan Native 1.0%; Asian 1.2%; Native Hawaiian and other Pacific Islander 0.2%; Other 6.6%; Population of Two or More Races/Not Hispanic or Latino 2.8%. The percentages of racial, ethnic and total minority populations appear to be consistent with those of the surrounding communities.

The demographics were conducted on the area defined as the 'Social Population Demographics Existing Conditions Study area' (SPDECS) for the Powerline, Vineyard Road, and Rittenhouse FRSs and documented in the "Social, Population and Demographics Existing Conditions Study" (Kimley-Horn July, 2010). The analysis approach was based on Census Track and Block Groups within and adjacent to the SPDECS study area. The source of the data is the decennial Census 2000 data sets from the United States Census Bureau (Census 2000). The SPDECS study is summarized in **Appendix D.**

The median household income for the PVR FRSs area is between $32,055 and $101,124 for an average median household income of $60,789. This represents a slightly higher median household income than the neighboring communities which range between $33,170 (Apache Junction) and $68,032 (Gilbert) for an average median household income of $58,399.

Resource Concerns: The following is a listing of the relevant resource concerns considered during the scoping process.

Aesthetics: Structures are significant features on landscape.

Cultural Resources: Cultural resources surveys and research in the vicinity indicate that there are several archaeological sites located within the area of potential effects (APE) for the project.

Environmental Justice: Minority and disadvantages populations downstream of dam are at high risk if no action is taken.

Fish and Wildlife: No fish present in the project area. Mesquite bosque located upstream of structure.

Flooding: Homes, businesses, and infrastructure are at high risk of flood damages if no action is taken.

Geology: An earth fissure has been discovered adjacent to the Powerline FRS; Land subsidence at Powerline FRS and the northern 1/3 of Vineyard Road FRS is expected to continue in the near future.

Migratory Birds: The project area contains suitable habitat for the western burrowing owl (*Athene cunicularia hypugaea*) which is protected under the Migratory Bird Treaty Act.

Prime Farmland: Prime farmland downstream of structure is at high risk of flood damages if no action taken.

Public Health and Safety: Public health and safety is at high risk in the event of a catastrophic failure of the dam if no action taken.

Transportation: Major local roads are located downstream and area at high risk of flood damage if no action is taken.

Threatened and Endangered Species: The U.S. Fish and Wildlife Service (USFWS) threatened, endangered, proposed, and candidate species list for Pinal and Maricopa Counties, as well as the Arizona Game and Fish Department (AGFD) Heritage Data Management System (HDMS), were reviewed. There are no known occurrences of any threatened or endangered species or critical habitat within the project area.

Suitable habitat is present for the Tucson shovel-nosed snake (*Chionactis occipitalis klauberi*) and dispersal habitat is present for the Sonoran desert tortoise *(Gopherus agassizii).* These are candidate species for the USFWS and may become listed in the future and warrant additional assessment.

Desert tortoise has the potential to occur within the project area. The project contains suitable habitat for the western burrowing owl (*Athene cunicularia hypugaea*) which is protected under the Migratory Bird Treaty Act.

Vegetative Community: Mesquite Bosque located upstream of structure.

Water Resources: The Central Arizona Project canal is located downstream of the structure and is at high risk of flood damages if no action is taken.

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

- No Federal Action/Future Without Project: Powerline FRS remains in unsafe condition until Sponsor's eventual Rehabilitation or Replacement of the dam;
- Decommissioning by Replacing the Powerline FRS with a Channel to Vineyard Road FRS;
- Decommissioning by Replacing the Powerline FRS with Basins and Channels;
- Raise and Rehabilitate the Powerline FRS.

Estimated Project Costs:

Item	PL 83-566 Funds ($)	Other Funds ($)[1/2]	Total ($)
Construction Cost	$15,292,200	$6,855,800	$22,148,000
Technical Assistance	$600,000	$651,500	$1,251,500
Project Administration	$50,000	$10,000	$60,000
Land Rights (Sponsors)	$0	$0	$0
Required Permits (Sponsors)	$0	$434,300	$434,300
Total	$15,942,200	$7,951,600	$23,893,800

1/ The Sponsor's annual operation and maintenance cost for the project is $212,700.
2/ The Sponsor's planning costs for the project is $716,900 which is not included in this table.

Estimated Project Benefits:

An estimated 27,100 current residents, associated homes, businesses, and infrastructure are protected from catastrophic dam failure and flooding. Additional residents and infrastructure will be protected in the future as development continues to occur in the downstream benefitted area.

Category	Average Annual Equivalent Benefits
Beneficial Annual[1/]	$0
Adverse Annual	$1,006,700
Net Beneficial	($1,006,700)
Benefit-Cost Ratio	0.0 to 1.0

[1/] The proposed project will provide an estimated $14,779,300 in average annual equivalent damage reduction benefits. However, as the "no action" or future without project alternative also provides this same benefit stream, the project does not have a positive incremental benefit. The benefits of the project are tied to reducing the risk of catastrophic failure of the existing structures and thus reducing the risk to life and property, as described in the plan.

Funding Schedule: Powerline FRS FY 2022 (Vineyard Road FRS FY 2018; Rittenhouse FRS FY 2024)

Period of Analysis: 103 Years

Project Life: 100 Years

Environmental Effects and Impacts:

1. Cultural Resources – Sites in the area of potential effects that will not be subject to project-related impacts will be avoided by project implementation activities. Data recovery studies will be performed to mitigate impacts to all sites likely to suffer project-related impacts. Based on known sites in the vicinity, the majority of the cultural resources present would be either prehistoric sites without evidence of habitation (which might

include scatters of artifacts on the surface, or artifacts with remnants of just one or a few roasting pits, agricultural features, and/or other non-habitation features) or historical sites (which might include homesteads, farming or ranching features, or simply scatters of historical artifacts). Most of the remaining sites would be smaller prehistoric habitation sites, with up to two relatively large prehistoric habitation sites.

2. Threatened and Endangered Species – Survey protocol for the Tucson shovel-nosed snake has not been published by the USFWS. Prior to construction the status of the Tucson shovel-nosed snake on the USFWS threatened, endangered, proposed, and candidate list will be re-verified (i.e. status changed from candidate to threatened) and coordination with the USFWS will be undertaken to determine if a survey protocol has been established and/or if a survey is required. If this species is observed construction will cease until measures can be taken to ensure the preservation of the snake and/or its habitat. Prior to start of construction, the project area will be canvassed for tortoises and, if any tortoises are discovered, AGFD guidelines (October 2007) will be followed. Prior to start of construction, a survey for burrowing owls will be conducted in the disturbance area following the AGFD protocol (January 2009). As a result of the actions described above, there will be no effect on federally threatened and endangered species or their critical habitat due to implementation of this alternative. The above-mentioned mitigation measures will be utilized to minimize impacts to special status species.
3. Vegetative Community - Areas disturbed associated with construction activities will be hydro-seeded with native mix. Approximately 120 acres of mesquite bosque will be impacted. Mesquite bosque mitigation may include planting new tall-pot mesquite trees (approximately 60 acres) and salvage of some mature mesquite trees and transplanting in designated areas (e.g., along Powerline Channel and potential mitigation area at north end of Vineyard Road FRS). The Sponsor and NRCS will coordinate with ASLD regarding trees along the existing low flow channel along the Powerline FRS. Mitigation plans will be refined during final design.

Major Conclusions: The decommissioning of the Powerline FRS and replacement of the dam with a channel will remove the dam from ADWR jurisdiction. The channel will continue to provide 100-year flood protection for the downstream benefitted area. This alternative will reduce the risk of catastrophic failure of the existing structure and thus reduce the risk of loss of life and property. No significant adverse environmental effects will result from implementation of this project.

Areas of Controversy: None.

Issues to be Resolved: The Powerline channel will need to meet Flood Control District and NRCS design requirements for open channel flow. If portions of the channel include embankment for the purpose of providing channel freeboard, the embankments may need to meet the Federal Emergency Management Agency's (FEMA) requirements for levee certification.

Evidence of Unusual Congressional or Local Interest: None

This report is in compliance with executive orders, public laws, and other statues governing the formulation of water resource projects.

2.0 PURPOSE AND NEED FOR ACTION

2.1 CHANGES REQUIRING PREPARATION OF A SUPPLEMENT

The Powerline Flood Retarding Structure (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. The dam was originally classified by the Soil Conservation Service as a Class C dam. The dam has known deficiencies in the embankment (transverse and longitudinal cracking and erosion holes), located in an area with land subsidence, earth fissures and known inadequacies in auxiliary spillway capacity. There is a risk to downstream structures and inhabitants if no action is taken to rehabilitate or replace the dam.

The NRCS addressed deficiencies due to transverse cracking by means of a repair project that was completed in June 1991. The repair project included installation of a central embankment filter along the dam. The project was funded under the NRCS Watershed Operations program. Current conditions indicate additional transverse and longitudinal cracks as well as erosion holes in the embankment are present. Remaining inadequacies in auxiliary spillway capacity are considered under this study.

The Sponsor is presently implementing an interim dam safety measure (IDSM) to relocate a portion of the Powerline FRS embankment outside of an identified earth fissure high risk zone. The IDSM was designed by the Sponsor's consultant and reviewed and approved by the NRCS and ADWR. The IDSM is presently under construction and is anticipated to be completed in September 2013.

This Supplemental Watershed Plan and Environmental Assessment (Plan/EA) addresses the identified dam safety deficiencies (noted above) by evaluating alternatives to either rehabilitate or replace the Powerline FRS. The Plan/EA determines the feasibility of decommissioning the FRS and replacing the FRS with a constructed channel to provide for continued flood protection while meeting current applicable local, State, and Federal regulations. The changes being made are to replace the Powerline FRS and IDSM with an earthen flood control channel (Powerline Channel) designed for the 100-year flood event and to direct the flows from the channel to the Vineyard Road FRS flood pool.

The **purpose and need** of the proposed project is to provide continued flood protection for the downstream benefitted area and to reduce the risk of loss of life due to catastrophic dam failure. 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.

2.2 BACKGROUND

The FRS provides substantial flood protection benefits to portions of Maricopa and Pinal Counties, City of Mesa, State Lands, and surrounding areas. The FRS protects downstream public infrastructure including streets and highways, and residential and commercial properties.

In June 2000, the Sponsor completed an Individual Structure Assessment for the Powerline FRS and in August 2000 the Sponsor completed an Alternatives Analysis Report for the Powerline FRS. In July 2009, the Sponsor entered into a Memorandum of Understanding with the Natural Resources Conservation Service (NRCS) to cooperatively conduct planning, design and implementation of a preferred alternative needed to address the identified inadequacies. In July

2009, the Sponsor initiated the planning phase. This Plan/EA is being prepared during this planning phase.

The Powerline FRS is one of three earthen flood retarding structures (Vineyard Road FRS and Rittenhouse FRS are the other two) located east of the Central Arizona Project (CAP) canal. The three structures were originally designed by the NRCS to operate as an integrated system as the principal spillways at Powerline FRS and Vineyard Road FRS both discharge into a common channel – the Powerline Floodway. The Rittenhouse FRS principal spillway discharges into the Vineyard Road FRS flood pool. The result is that all three principal spillways eventually flow into the Powerline Floodway. The Powerline, Vineyard Road, and Rittenhouse FRSs Rehabilitation or Replacement Project (Project) was initiated to formulate alternatives to mitigate identified dam safety deficiencies at the three dams. One of the objectives in the formulation of alternatives for the three dams was to maintain the integrated operational relationship of the three dams (or alternatives) to discharge to the Powerline Floodway. This Supplemental Watershed Plan and Environmental Assessment (Plan/EA) presents the alternatives evaluated and preferred alternative for Powerline FRS. The Powerline FRS is a structural plan element of the Apache Junction-Gilbert Watershed Work Plan. A separate Supplemental Watershed Plan/EA has been prepared for the Vineyard Road FRS and Rittenhouse FRS as these two dams are structural elements of the Williams-Chandler Watershed Work Plan.

2.3 EXISTING DAM CONDITION

2.3.1 LOCATION

The Powerline FRS is located in northwest Pinal County, Arizona. The structure is east of the City of Mesa and south of the City of Apache Junction. The Powerline FRS is one of three flood retarding structures designed and constructed by the NRCS to provide flood control benefits to portions of Maricopa and Pinal County (the other two dams are Vineyard Road FRS and Rittenhouse FRS). The contributing watersheds originate in the southwest-facing slopes of the Superstition Mountains. The total watershed area contributing to the three structures is 147 square miles and includes Weekes Wash and Siphon Draw. Queen Creek Wash is located south of the structures. The Central Arizona Project Canal (CAP) is aligned west of the structures. The PVR FRSs alignments extend south from Baseline Road to the Ocotillo Road alignment, approximately 12 miles in length. A project map for the Powerline FRS and associated features is provided in **Appendix B**.

The 2.54-mile long Powerline structure, outlet works, and flood pool lie within the following sections (Gila and Salt River Baseline & Meridian): Township 1 South, Range 8 East, Sections 5 and 8.

The FRS, outlet works and the flood pool are located on land that is owned by the State of Arizona. The Sponsor has obtained easements from the State of Arizona to operate and maintain the dam and appurtenant structures. The Powerline FRS provides 100-year flood protection from flood flows originating from a 47-square-mile watershed. The City of Apache Junction and the State of Arizona (State Land Department) have prepared or are in the process of preparing land use plans to areas both upstream and downstream of the dam.

2.3.2 EMBANKMENT AND RESERVOIR POOL

The FRS is a homogeneous earthen embankment 13,398 feet (2.54 miles) in length, with a maximum height of 26.1 feet. The embankment was constructed with local borrow materials from the upstream low flow channel and flood pool areas. The embankment crest elevation was designed at 1,591.1 feet, and the auxiliary spillway was designed at 1,585.3 feet to provide 5.8 feet of freeboard. The reservoir capacity is 4,194 acre-feet which provides for 175 acre-feet of sediment and 4,019 acre-feet of flood water. At full capacity, the sediment pool area and flood pool area would be 88 acres and 456 acres, respectively. The maximum recorded impoundment for the Powerline FRS was 952 acre-feet with a flood stage of 11.0 feet on January 11, 1993. Other historical storms of note include an October 1972 storm, where the reservoir stage may have reached the auxiliary spillway crest and floodwaters may have flowed through the auxiliary spillway. The FRS flood pool under normal operations is dry, only temporarily impounding water in response to runoff events. The FRS does not have a permanent water pool.

A central filter was installed in the Powerline FRS in 1991 which extends along the entire length of the embankment (from Stations 17+83 to 150+70). The filter has an average depth of 18 feet and a maximum depth of 42 feet. The depth of the filter was established by the NRCS on the basis of its 1986 crack location investigation.

A typical section of the Powerline FRS embankment is provided in **Appendix C** as **Figure C-1**.

2.3.3 PRINCIPAL SPILLWAY

Flows entering the impoundment are routed through a low-flow channel to the principal spillway. The spillway is an ungated, 156-foot long, 36-inch diameter RCP located at the southern abutment of the FRS. The pipe is situated on a concrete cradle and five seepage cutoff collars are spaced at 20-foot intervals along the pipe. At the upstream inlet of the spillway, there is a trash rack to filter debris and the spillway discharges into a concrete lined channel through an outlet structure. The downstream outlet of the principal spillway features an energy dissipater, and the principal spillway discharge capacity is 203 cubic feet per second (cfs) at the crest elevation of the auxiliary spillway.

An exhibit of the Powerline FRS principal spillway is provided in **Appendix C** as **Figure C-2**.

2.3.4 AUXILIARY SPILLWAY

The Powerline FRS auxiliary spillway is located at the southern abutment of the FRS. The spillway is a 600-foot wide excavated earthen open channel with a capacity of 25,000 cfs. The control section of the auxiliary spillway is a compacted, benched sill, located one foot above a level upstream approach channel. The approach channel is on a constructed bend that directs flow around the southern abutment of the FRS.

An exhibit of the Powerline FRS auxiliary spillway is provided in **Appendix C** as **Figure C-3**.

2.3.5 POWERLINE NORTH DIVERSION CHANNEL

The Powerline North Diversion Channel is located north of the FRS as shown in **Appendix C**. The Powerline Diversion begins at Southern Avenue and flows between Desert Shadows Middle School and Apache Junction High School. The diversion mostly consists of a gently sloping swale lined with a 5-foot-wide section of concrete. Near the southern limit of the schools, the swale transitions to an approximately 8-foot-deep by 10-foot-wide channel. The channel is unlined and there is an

approximately 5-foot-high earthen embankment on the west side of the channel. The diversion channel extends from the school properties to Baseline Road, crossing under U.S. Highway 60 through two 6-foot-high by 10-foot-wide concrete box culverts and crossing under Baseline Road through three 4-foot-diameter corrugated metal pipes. The channel flows along the east side of the Apache Creek Golf Course between U.S. Highway 60 and Baseline Road. The channel within this area appears to be engineered and ranges from approximately 10 to 20 feet in width and 5 to 15 feet in depth. The banks typically have slope ratios of 1H:1V to 1.5H:1V. In general, the bank on the east side of the channel is higher than the bank on the west side of the channel, and the bank on the east side of the channel is cut by a number of erosion gullies.

An exhibit of the Powerline North Diversion Channel is provided in **Appendix C** as **Figure C-8**.

2.3.6 POWERLINE FLOODWAY

Outflow from the Powerline, Vineyard Road and Rittenhouse FRSs eventually flow into the Powerline Floodway. The Floodway is approximately 8.5 miles in length, extending from the principal outlet of Powerline FRS to the East Maricopa Floodway (EMF) near the northwest corner of the Williams Gateway Airport. The Powerline Floodway carries flows from the principal spillways of both Powerline FRS and Vineyard Road FRS to the EMF.

2.4 INADEQUACIES OF STRUCTURE

The Arizona Department of Water Resources (ADWR) conducts inspections of jurisdictional dams throughout the state. Powerline and Vineyard Road FRSs were inspected on January 30, 2012 and Rittenhouse was inspected on January 31, 2012. ADWR issued a Notice of Safety Deficiency letter for Powerline FRS. The following items were listed as Safety Deficiencies for Powerline FRS:

- Foundation Concerns
- Questionable Adequacy of Central Filter

ADWR identified one maintenance action item for the Powerline FRS. ADWR noted that the action item as removing rodent burrowing on the structure in a timely manner.

ADWR has reviewed the size and hazard potential classifications for the dam. The classification has not changed from intermediate size and high hazard potential.

2.4.1 FOUNDATION CONCERNS

In May 2007, an earth fissure was identified in close proximity to the downstream toe of the dam. In light of the proximity of this earth fissure to the Powerline embankment, and the presence of other documented earth fissures in the general vicinity of the dam, ADWR continues to classify Powerline FRS as being in an “unsafe, non-emergency, elevated risk” condition. As such, the Powerline FRS is one of ADWR’s highest priority unsafe dams in the state. On February 28, 2011, ADWR approved the District’s permit application for the interim mitigation of fissure risk.

2.4.2 QUESTIONABLE ADEQUACY OF CENTRAL FILTER

In a May 8, 2008 ADWR Inspection Report for the Powerline FRS, it was noted that during a recent geotechnical investigation that involved excavation of a shallow trench that exposed the upper portion of the central filter, there were similarities between the filter materials and the

compacted embankment soils. Photo-documentation of this condition is presented in **Appendix E** of the report entitled "Earth Fissure/Ground Subsidence Instrumentation Installation Report and Monitoring Plan" (AMEC 2007). Noted similarities included "soil stiffness that supported vertical trench walls and cracking that extended into the central filter material." ADWR notes that this observation is contrary to the standard of practice for granular filter design wherein the filter should be free-flowing and self-healing. The April 13, 2012 ADWR inspection letter noted that it was ADWR's understanding that the adequacy of the filter will be further investigated during the overall rehabilitation design.

2.4.3 Updated Hydrologic/Hydraulic Investigations

Updated hydrologic/hydraulics (H/H) investigations and studies were conducted during the planning study for the Powerline FRS. These studies evaluated the operational response of the structure and principal and auxiliary spillways for existing land use and future land use conditions for multi-frequency events (2-yr through 500-yr). The investigations completed a probable maximum precipitation/probable maximum flood (PMP/PMF) study to determine a planning level recommendation for the PVR structures for the inflow design flood (IDF). The results indicate that the 6-hr PMF is the more conservative over the 24-hr and 72-hr events. The study recommended a reduction of the planning PMP/PMF to approximate an anticipated reduction of the PMP should a future site specific PMP study be conducted for the three PVR watersheds. The updated H/H evaluations also conducted NRCS SITES modeling for the three dams to determine the principal spillway hydrograph (PSH), stability design hydrograph (SDH), and the integrity or freeboard hydrograph (FBH). The SITES study included an allowable stress evaluation of the earth lined spillways and a breach analyses.

The results for Powerline FRS indicates that:

- Overtopping of the dam crest during the existing and future conditions 6-hour PMP,
- Existing conditions principal spillway hydrograph draw down is longer than 10 days (14.4 days),
- Future conditions principal spillway hydrograph draw down is longer than 10 days (14.8 days),
- Auxiliary spillway erodes during the existing and future conditions stability design hydrograph, and
- Auxiliary spillway breaches during the existing and future conditions freeboard design hydrograph.

2.5 Regulatory Considerations

As noted in Section 2.6, ADWR issued a Notice of Safety Deficiency to the Sponsor in February 2009 declaring the dam as "Unsafe, Non-Emergency, Elevated Risk". The dam currently remains under this designation.

3.0 SCOPE OF PLAN/EA

The scoping process followed the general procedures contained in the Water Resources Council's Principles and Guidelines and Section 501.35 of the NRCS National Watershed Program 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.

The scoping process was used during development of the Powerline FRS Supplemental Watershed Plan and Environmental Assessment (Plan/EA) to focus planning efforts on problems and opportunities of most importance to all interested parties. Scoping was utilized to focus the goals of the planning effort and thereby narrow the range of identified alternatives. Comments and questions were solicited from local citizens, groups, and local, State, and Federal agencies throughout the planning effort. Public and/or agency comments were received. Several identified concerns were identified by the Sponsors and project team and are listed in **Table 3-1** below.

Three public meetings were held during the planning process for the Powerline, Vineyard Road, and Rittenhouse (PVR) Flood Retarding Structures Rehabilitation or Replacement Project. The first meeting was held on November 4, 2010. This purpose of this meeting was to introduce the public to the project location and purpose and need for the project. The second meeting was held on February 1, 2011. The purpose of this meeting was to solicit input from the public regarding planning alternatives for the PVR project. Meeting notices/announcements were published in local newspapers and mailed to several Federal and State agencies. The Sponsor provided a program overview at both public meetings. At the second meeting Kimley-Horn and Associates, Inc. provided an overview of the study alternatives that were developed and presented for public input. Several comments were received by the public at the second public meeting.

The third public meeting was held on February 12, 2013 during the public review period. The purpose of this meeting was to present the preferred alternative as described in the draft Plan/EA and to solicit comments and questions regarding the proposed project. No comments were received from the public.

The **purpose and need** for the project 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.

Table 3-1 Evaluation of Identified Concerns

ITEM/CONCERN	Relevant to the proposed action?[1/]		RATIONALE
	Yes	No	
SOILS			
Upland Erosion		X	No concerns in study area.
Stream Bank Erosion		X	No concerns in study area.

Table 3–1 Evaluation of Identified Concerns (continued)

ITEM/CONCERN	Relevant to the proposed action?[1/]		RATIONALE
	Yes	No	
SOILS			
Geology	X		An earth fissure has been discovered adjacent to the Powerline FRS; Land subsidence at Powerline FRS and the northern 1/3 of Vineyard Road FRS is expected to continue in the near future.
Sedimentation		X	No concerns in study area.
Prime and Unique Farmland	X		Structures provide flood protection to downstream Prime Farmland.
WATER			
Surface Water Quality		X	No impaired streams or lakes in study area.
Surface Water Quantity	X		Structure spillways do not have adequate capacity to safely convey probable maximum flood.
Groundwater Quantity		X	Groundwater pumping in area has contributed to land subsidence and earth fissures.
Clean Water Act		X	No concerns in study area.
Regional Water Mgt Plans	X		Structures provide flood protection for Central Arizona Project Canal.
Floodplain Management	X		Home, businesses, and infrastructure are at high risk of flood damages in the event of a catastrophic failure of the dam if no action is taken.
Wetlands		X	None Present
Wild and Scenic Rivers		X	None Present
Ecologically Critical Areas		X	None Present
Sole Source Aquifers		X	None Present
AIR			
Air Quality		X	No concerns in study area.
Clean Air Act		X	Air permit required for construction activities
PLANTS			
Threatened and Endangered Species		X	No occurrences in study area.
Essential Fish Habitat		X	No fish habitat in study area
Invasive Species		X	Minimal invasive species present on study area

Table 3–1 Evaluation of Identified Concerns (continued)

ITEM/CONCERN	Relevant to the proposed action?[1/]		RATIONALE
PLANTS			
Natural Areas		X	No natural areas in study area
Riparian Areas		X	No riparian areas in study area
Forest Resources		X	Not Applicable
Parklands		X	None Present
Vegetative Communities	X		Mesquite Bosque located upstream of structure
ANIMALS			
Fish and Wildlife Habitat	X		No fish present in study area. Mesquite Bosque habitat located upstream of structure.
Threatened and Endangered Species		X	No occurrences in study area.
Invasive Species		X	Minimal invasive species present on study area
Migratory Birds/Bald and Golden Eagles	X		Potential habitat for western burrowing owl.
HUMANS			
Aesthetics	X		Structures are significant features on landscape
Flood Damages	X		Substantial downstream damages from flooding from catastrophic dam failure is no action taken
Cost, Sponsor	X		Action will require significant expenditure of funds.
Cost, NED	X		Action will require significant expenditure of funds.
Historic Properties/Cultural Resources	X		Cultural Resources have been identified in the vicinity of the structures.
Environmental Justice	X		Minority and disadvantaged populations are at high risk in the event of a catastrophic failure of the dam if no action is taken
Local and Regional Economy		X	Structures provide flood protection to downstream benefitted area.
Scientific Resources		X	Not Applicable
Potable Water Supply		X	No potable water system within study area.
Public Health and Safety	X		Public Health and Safety is at high risk in the event of a catastrophic failure of the dam if no action is taken
Recreation		X	Opportunities for recreational elements

[1/] Concerns relevant to the proposed action must be considered in the analysis of alternatives

4.0 AFFECTED ENVIRONMENT

This section describes the current physical, biological, ecological, economic, and social environment for the watershed and other areas of the project impact. This provides the context for determining the effects of alternatives. Some conditions will be constant throughout the evaluated life of the project, while others will be subject to change because of social, economic, and political influences.

4.1 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. The average monthly temperatures range from a low of 45.9° F in January to a high of 106.3° F in July. Average monthly rainfall ranges between 0.03 inches in June to 1.01 inches in July, with annual rainfall reaching 6.56 inches in an average year.

4.2 GEOLOGY

The Powerline, Vineyard Road, and Rittenhouse FRS (PVR) study area is near the junction of the Mexican Highland and Sonoran Desert sections of the Basin and Range physiographic province, just southwest of the boundary between the Basin and Range and Transition Zone physiographic provinces. The boundary between these two provinces is marked by the western edge of the Superstition and Goldfield mountains, which rise abruptly above the valley floor. These mountain ranges also mark the eastern margin of the down-dropped Phoenix Basin, which underlies much of the Phoenix metropolitan area and extends westward to the Sierra Estrella and White Tank Mountains. The Phoenix Basin formed between approximately 8 and 15 million years ago after cessation of the volcanic activity that formed the bulk of the Goldfield and Superstition mountains.

The Phoenix Basin is subdivided into several sub-basins. The study area is within the Mesa-Chandler sub-basin. On the west, this sub-basin is partially separated from the central Phoenix Basin by the bedrock highs of the Tempe Butte area. The Mesa-Chandler sub-basin is bounded by the Goldfield and Superstition mountains on the north and northeast, by Mineral Mountain on the east, and by the Santan Mountains on the southwest.

Alluvial fans and pediments have developed along the Superstition and Goldfield mountain fronts during the last approximately five million years of relative tectonic stability. The pediments are broad, gently sloping erosional surfaces that consist of shallow bedrock covered with a thin veneer of alluvial fan deposits. Bedrock is often exposed in drainages that have cut through the thin alluvial deposits or is exposed in inselbergs (knobs and small hills of bedrock that rise above the alluvial fan surfaces, such as Hawk Rock).

Farther west of the mountain fronts, the basin is dominated by a thick sequence of alluvial fan deposits. Alluvial fans are gently sloping masses of alluvium deposited by streams and washes that flow from mountains onto the floor of a valley. As streams emerge from the mountains, they diverge into multiple channels, water begins to percolate into the subsurface, flows diminish and sediment carried by the streams is deposited. Coarser materials (e.g., boulders, cobbles and gravel) tend to be deposited near the apex of fans, whereas finer-grained materials (e.g., sand, silt and clay) are transported to the distal portions of fans. As gradients flatten toward the distal portions of fans, sediments become finer grained and less permeable, and drainage channels often converge.

The Powerline, Vineyard Road, and Rittenhouse FRS have been the subject (particularly Powerline and the northern 1/3 of Vineyard Road FRS) of previous geohazard investigations and analyses including studies as part of this planning study. The Powerline and Vineyard Road FRS are located in a region of local land subsidence. The purpose of the geohazard investigations were to evaluate potential impacts of ground subsidence and earth fissuring on the existing structures and on the selection and subsequent development of rehabilitation designs and/or replacement alternatives for flood protection afforded by the Powerline, Vineyard Road and Rittenhouse Flood Retarding Structures (FRS). The results, findings and conclusion of the studies were used by the project team in its development and evaluation of dam rehabilitation and/or replacement alternatives.

There are known earth fissures in the project area near Hawk Rock and one known earth fissure located immediately downstream of the Powerline FRS embankment at about Station 115+45. There also is a high probability that the earth fissure near Station 115+45 extends beneath the existing embankment. It is suspected that subsidence patterns at the Powerline FRS will continue into the future, potentially causing further development of fissures in this area.

The studies have developed, through various techniques and methods, earth fissure risk zone mapping for the PVR structures. **Figure C-8** in **Appendix C** is the earth fissure risk zones prepared for the PVR structures. As depicted in the risk zone map, Powerline FRS has portions of the dam within all four zones. Vineyard Road FRS is within two zones, and Rittenhouse FRS falls within one zone (the lowest probability zone). The zones are defined below.

In general terms, the earth fissure risk delineating process has evolved to include 4 general earth FRZs that are broadly similar from site to site, although the exact definitions of the FRZs vary from one site to another. The numbering system used to identify the four zones has changed through time and from site to site, so a better understanding of the level of risk is provided by the actual definition than by the zone number. The four FRZ definitions can be summarized as follows:

- Zone 1: An area with a known earth fissure(s), a high probability for the presence of earth fissures without surface expression, or a high probability for the future development of earth fissures.
- Zone 2: An area that in the future is likely to experience tensional ground strain that could cause earth fissures, yet no earth fissures have been identified to date. An area with a moderate probability for the future development of earth fissures.
- Zone 3: An area that has or is likely to experience some tensional ground strain, though not great enough to result in earth fissures. An area with a low to moderate probability for the future development of earth fissures.
- Zone 4: An area that has not, and is not expected to, experience tensional ground strain. An area with a low probability for the future development of earth fissures.

The key terms used in the FRZ definitions are the presence of known fissures or the high, moderate, low to moderate or low probability for the future development of earth fissures.

4.3 SOILS

The soils in the majority of the Powerline FRS watershed are classified by NRCS in hydrologic soil group (HSG) B and D. In the vicinity of the dam the soil is the Mohall loam to Mohall clay loam

association (HSG D). At the higher elevations in the Powerline FRS watershed the soils are classified as Gachado-Lomitas-Rock Outcrop to Rock Outcrop (HSG B). The watershed is approximately 10- 20 percent vegetated with desert scrub on flat terrain to desert trees along wash corridors.

4.4 SURFACE WATER

The Powerline FRS controls runoff from a 47.1 square mile drainage area that lies east of the dam. The Powerline FRS receives surface flows from several major washes including Weeks Wash and Siphon Draw Wash. During high flow events the surface water originating from the foothills of the Superstition Mountains collect at the Powerline FRS and are gradually released to a channel (Powerline Floodway) located at the south end of the Powerline FRS. The Powerline Floodway discharges to the East Maricopa Floodway. Outflows from the dam are conveyed by the 36-inch diameter principal spillway pipe and the 600-foot-wide earth-lined auxiliary spillway.

Numerous hydrologic surface water evaluations (e.g. rainfall-runoff volumes) have been conducted as part of the planning study for the Powerline, Vineyard Road, and Rittenhouse FRS Rehabilitation or Replacement Project. These evaluations provide the hydrologic basis of the evaluation of existing conditions at the three dams and the basis of evaluation of planning rehabilitation or replacement alternatives. The evaluations were conducted for various storm frequency events, existing and future land use conditions, and planning alternatives.

A summary of the hydrologic and hydraulic evaluations is provided in the "*Investigation and Analysis Supporting Information*" in **Appendix D**. Electronic PDF files of the hydrologic and hydraulic studies and evaluations are provided on the enclosed compact disk (CD).

4.5 WATER QUALITY

The Powerline FRS and watershed are located in the Arizona Department of Water Resources Phoenix Active Management Planning Area (AMA). The AMA was established pursuant to the 1980 Arizona Groundwater Management Act. The other AMAs include the Santa Cruz AMA, the Tucson AMA, the Pinal AMA, and the Prescott AMA. A review of the on-line Phoenix AMA water database indicates that there are no perennial streams and that there are no impaired lakes or streams located within the watershed. The washes within the watershed are ephemeral flowing only in response to rainfall events. When flows do occur in the washes, the stormwater runoff typically becomes laden with sediment. This stormwater flows from the watershed into the Powerline FRS impoundment.

The Powerline 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.

4.6 WATER CONVEYANCE INFRASTRUCTURE

The Powerline Floodway, discussed in Section 2.2.6 above, conveys discharges from the principal spillways from both the Powerline FRS and the Vineyard Road FRS. The floodway conveys flows from the dams to the East Maricopa Floodway (EMF). The Powerline Floodway, approximately eight miles long, has a number of side inlets along the length of the floodway to capture and convey offsite flows in addition to the flows from the dams.

The Central Arizona Project (CAP) comprises a 336-mile-long system of aqueducts, tunnels, pumping plants, and pipelines. The CAP is managed and operated by the Central Arizona Water Conservation District (CAWCD). The CAP canal passes through the study area, entering in Apache Junction between Meridian Road and Ironwood Road, running in a south-southeasterly direction approximately parallel to and downstream of the PVR dams. The average width of the canal is 80 feet across.

4.7 SEDIMENTATION

The Watershed Plan summarizes the sedimentation investigation conducted for Powerline FRS. The structure was designed to provide a total cumulative sediment storage capacity of 175 ac-ft for 50-years of sediment storage. On a 100-year basis this amounts to 350 ac-ft.

The Flood Control District of Maricopa County recently completed an updated projected sediment yield estimation for the three dams (*Sediment Yield Estimation for Powerline FRS, Sediment Yield for Vineyard Road FRS, and Sediment Yield Estimation for Rittenhouse FRS, FCD, Dec. 2010*). The District's results indicate a sediment yield of 0.238 ac-ft/mi^2 for Powerline resulting in a 100-year sediment volume of 810 acre-feet. The District's results indicate a sediment yield of 0.272 ac-ft/mi^2 for Vineyard resulting in a 100-year sediment volume of 1,422 acre-feet. The District's results indicate a sediment yield of 0.151 ac-ft/mi^2 for Rittenhouse watershed resulting in a 100-year sediment volume of 641 acre-feet. The District does not have records of actual sedimentation rates. A summary of the sedimentation estimation is provided in the "*Investigations and Analysis Report*" in **Appendix D**.

For this planning study and based on the previous sediment yield investigations under the original watershed workplans and subsequent studies, design criteria for alternatives that involve a dam rehabilitation a frequency based sediment volume of 100-years was recommended. This would estimate the sediment to a dam rehabilitation alternative (using the District updated sediment yields) of the three structures to be 810 acre-feet, 1,422 acre-feet, and 641 acre-feet for Powerline, Vineyard Road, and Rittenhouse, respectively. This frequency and volumes allow for the potential of future projected sediment being delivered to the structures beyond what is currently being actually recognized and for allowance of accumulation of sediment over time.

4.8 VEGETATIVE COMMUNITY

The project area is within Lower Colorado River Valley Subdivision of the Sonoran Desert Scrub community. The majority of the project area is flat and sparsely vegetated, with the majority of the vegetation occurring along the ephemeral washes. Very dense mesquite bosques, containing velvet mesquite (*Prosopis velutina*), blue paloverde (*Parkinsonia florida*), catclaw acacia (*Acacia greggii*), and cottonwoods (*Populus fremontii*) are present near and adjacent to the FRSs. The mesquite bosques provide valuable food, shelter, and travel corridors for multiple mammal, avian, and reptile species. Additionally, higher plant species diversity was observed within the mesquite bosques. The majority of the mesquites observed within the bosque ranged from 20-30 feet in height. The width of the mesquite bosque ranged from 200 feet to over 650 feet.

The most common plants observed in the upland areas were creosote bush (*Larrea tridentata*) and within and along the washes the velvet mesquite (*Prosopis velutina*) was the dominant plant species. A non-inclusive listing of plant species observed during the "windshield survey" is included in **Table 4-1**. Multiple grasses (native and non-native), weedy species, and wildflowers

were also observed. The overall vegetation cover within the project area is approximately 10-20 percent. However, along the larger washes and within the mesquite bosques, vegetation cover is much higher approximately 60-80 percent.

Table 4-1 Non-Inclusive Listing of Vegetation

Common Name	Scientific Name	Comments
velvet mesquite	*Prosopis velutina*	Dominant species washes/near cattle ponds
blue paloverde	*Parkinsonia florida*	Sporadic occurrences
catclaw acacia	*Acacia greggii*	Sporadic occurrences
ironwood	*Olneya tesota*	Sporadic occurrences
Mexican paloverde	*Parkinsonia aculeata*	Isolated occurrence
desert hackberry	*Celtis pallida*	Sporadic occurrences, near large areas of mesquite
fremont cottonwood	*Populus fremontii*	Two trees observed in southern portion of project area
desert broom	*Baccharis sarothroides*	Common throughout
creosote	*Larrea tridentata*	Dominant species in upland areas
desert globe mallow	*Sphaeralcea ambigua*	Sporadic occurrences
brittle bush	*Encelia farinosa*	Common throughout
barrel cactus	*Ferocactus* spp.	Occasionally observed, more common in southern portion of project area
saguaro	*Carnegiea gigantea*	Occasionally observed.
Arizona grape	*Vitis arizonica*	Associated with mesquite bosques, larger washes, and cattle ponds

4.9 WETLANDS /SIGNIFICANT NEXUS ANALYSIS

Kimley-Horn prepared a Significant Nexus Analysis (SNA) for the PVR FRSs Rehabilitation or Replacement Project (Kimley-Horn, May 2012) in order to determine if the project area contains areas considered jurisdictional by the U. S. Army Corps of Engineers (Corps) under Section 404 of the Clean Water Act (CWA). The SNA was submitted to the Corps of Engineers in June 2012 and the Corps has submitted the SNA to the U.S. Environmental Protection Agency (EPA) in January 2013.

In October 2008, a 6.9-mile reach of the Lower Gila River from Powers Butte to Gillespie Dam was designated a “traditional navigable water” or TNW by the U.S. Army Corps of Engineers (Corps). Therefore, the nearest TNW to the project area is the Lower Gila River from Powers Butte to Gillespie Dam. The project limits consist of the District’s modified easement area (6,237 acres) with the Arizona State Land Department (ASLD), which includes the FRSs, flood pool areas, Powerline Floodway, and maintenance access roads. This SNA includes the project limits and

extends to the TNW via the Powerline Floodway, the East Maricopa Floodway (EMF) and Gila River.

The waters analyzed do not significantly affect the chemical, physical, and biological integrity of the downstream TNW, therefore, the waters appear not to be jurisdictional waters of the U.S. Concurrence of no waters of the U.S. on the project site has been received by the Corps in their letter dated February 11, 2013. Further discussion of the SNA is provided in the "*Investigation and Analysis Report*" in **Appendix D**.

4.10 FISH AND WILDLIFE

Kimley-Horn conducted a Biological Evaluation (BE) study for the PVR FRSs Rehabilitation or Replacement Project and is documented in the report titled "*Powerline, Vineyard Road and Rittenhouse Flood Retarding Structures Rehabilitation or Replacement Project - Biological Evaluation*" (Kimley-Horn, July 2010) and is summarized in the "*Investigation and Analysis Report*" in **Appendix D**.

The purpose of the biological evaluation was to document the existing habitat conditions of the project area, and document any species or species specific habitat observed during field biological reconnaissance visits. This assessment focused on gathering general habitat information for the project area and the potential for any threatened, endangered, candidate, or other sensitive species or associated species habitat to occur within the project area.

The majority of the project area is flat and sparsely vegetated, with the majority of the vegetation occurring along the ephemeral washes. Very dense mesquite bosques, containing velvet mesquite (*Prosopis velutina*), blue paloverde (*Parkinsonia florida*), catclaw acacia (*Acacia greggii*), and cottonwoods (*Populus fremontii*) (very rare) are present near and adjacent to the FRSs. The mesquite bosques provide valuable food, shelter, and travel corridors for multiple mammal, avian, and reptile species. Additionally, a higher plant species diversity was observed within the mesquite bosques. The majority of the mesquites observed within the bosque ranged from 20-30 feet in height. The width of the mesquite bosque ranged from 200 feet to over 650 feet. There are no fish in the project area.

4.11 THREATENED AND ENDANGERED SPECIES

The U.S. Fish and Wildlife Service (USFWS) threatened, endangered, proposed, and candidate species lists for Pinal (dated March 5, 2012) and Maricopa (dated January 19, 2012) Counties were reviewed by a qualified biologist to determine species potentially occurring in the project vicinity. A qualified biologist reviewed these lists and determined that no threatened, endangered species or critical habitat would be affected by a future proposed project. Suitable habitat is present for the Tucson shovel-nosed snake (*Chionactis occipitalis klauberi*) and dispersal habitat is present for the Sonoran desert tortoise (*Gopherus agassizii*). These are candidate species that may become listed in the future.

The Arizona Game and Fish Department's (AGFD) Heritage Data Management System (HDMS) provided a list of special status species dated April 5, 2012 that have been documented as occurring within three miles of the project area. The AGFD online review tool did list two species of concern: Tucson shovel-nosed snake and pocketed free-tailed bat (*Nyctinomops femorosaccus*).

Additionally, the project contains suitable habitat for the western burrowing owl (*Athene cunicularia hypugaea*) which is protected under the Migratory Bird Treaty Act. Therefore, these species are discussed in more detail below. Species included in the USFWS threatened, endangered, proposed, and candidate list but were excluded from further evaluation are provided in the Biological Evaluation Report.

Sonoran Desert Tortoise

The Sonoran Desert tortoise is currently listed as a candidate species by the USFWS and will likely be listed as threatened or endangered with critical habitat designated in the future. According to the AGFD the Sonoran Desert tortoise is found from northern Sinaloa, Mexico north to southern Nevada and southwestern Utah and from south central California to southeastern Arizona. The Sonoran Desert tortoise is only found south east of the Colorado River while the Mojave population is found north and west of the Colorado River. In Arizona, the Sonoran Desert tortoise occurs primarily on rocky slopes and bajadas of Mojave and Sonoran desert scrub. Adequate shelter is one of the most important habitat features for the Sonoran Desert tortoise. Loose soils are required to excavate burrows, which are typically found under rocks and boulders and occasionally under vegetation. The Sonoran Desert tortoise typically consumes a variety of annual/perennial grasses, forbs, and succulents. According to the AGFD, recently a microhabitat selection study was conducted east of Phoenix on the Florence Military Reservation. Tortoise were found to use gently rolling alluvial fans bisected by desert washes, as opposed to boulder-strewn hillsides, and selected habitat with a higher percentage of vegetative canopy cover. Based on this information, desert tortoises could utilize the project area as dispersal habitat.

Tucson Shovel-Nosed Snake

The Tucson shovel-nosed snake is currently listed as a candidate species by the USFWS and will likely be listed as threatened in the future. The Tucson shovel-nosed snake is found in more productive creosote-mesquite floodplain habitats, with soils described as soft, sandy loams, with sparse gravel at elevations ranging 785 – 1,662 feet above sea level. The project area has suitable habitat throughout, particularly in areas containing ephemeral washes where soils are suitable for burrowing. The snake is known to be present only in Pima and Pinal counties, but a historical record of this species exists in Maricopa County just south of Gila Bend, Arizona.

Pocketed Free-Tailed Bat

The pocketed free-tailed bat is currently listed as a U.S. Forest Service Sensitive species. The pocketed free-tailed bat is found in arid lower elevations usually around high cliffs and rugged rock outcrops. The pocketed free-tailed bat is found in a variety of plant associations including desert shrub and pine-oak forests. Typical roost sites include rock crevices during the day, and may include human built structures. During dry seasons the bat will utilize water sources with open access and a large available surface area to obtain water. Elevation ranges from 190 to 7,520 feet. The project area contains multiple stock tanks which the pocketed free-tailed bat could utilize as a source of water. Suitable prey for the bat is also likely to be present within the project area. However, the project area does not contain any high cliffs, rugged rock outcrops, or human structures which the bat could utilize as roost sites. Therefore, it is unlikely that the pocketed free-tailed bat is present within the project area.

Western Burrowing Owl

The burrowing owl is protected under the Migratory Bird Treaty Act and Arizona State Law, Title 17-101, 235, 236 (USFWS 2003). As defined in the Arizona Game and Fish Departments Burrowing Owl Survey Protocol, suitable habitat for burrowing owl nesting habitat typically consists of dry, treeless, short-grassland or prairie plains. In the desert environment, they nest in areas of short, open scrublands such as mesquite (*Prosopis* spp.), creosote bush (*Larrea tridentata*), rabbit-brush (*Chrysothanmus nauseous*), and four-wing saltbush (*Atriplex canescens*). Burrowing owls will nest in human-modified landscapes such as: abandoned lots within rapidly developing urban areas, airports, golf courses, agricultural fields, irrigation canals, storm drains, roadsides, and parking lots. In the western United States, burrowing owls do not dig their own burrows, and therefore, depend on the presence of burrowing mammals. The project area does contain suitable habitat for the burrowing owl. The majority of the suitable habitat for the burrowing owl is northeast of the mesquite bosque areas, where there are fewer trees and more open areas.

4.12 TRANSPORTATION

Major existing transportation corridors near the Powerline FRS, Vineyard Road FRS, and Rittenhouse FRS are Loop 202 (5 miles east of Powerline FRS), US 60 (0.5 mile north of north end of Powerline FRS), Baseline Road (just north of Powerline FRS), and Ironwood Drive (located west of the dams).

Future transportation freeway corridors are currently being planned within the study area by the Arizona Department of Transportation (ADOT). These include State Route 24 and the North-South Freeway. Potential alternative alignments of these freeways cross within the Sponsor's modified easement. Some alignments are shown to cross the actual dam embankment or near the Rittenhouse auxiliary spillway.

Local transportation planning by the City of Apache Junction indicates a network of future planned local roads within the modified easement at Powerline FRS.

4.13 LAND USE

The majority of the Powerline FRS watershed (upstream of the dam) is owned by Arizona State Land Department Trust Lands (ASLD) and the US Forest Service (Tonto National Forest). Downstream of the dam is State Trust Lands, CAP (Bureau of Reclamation), and private lands. Land use in the study area upstream of the dam is open desert. Downstream of the dam is open desert, rural residential, and master planned subdivisions. Municipalities located near the dams include the City of Apache Junction, City of Mesa, and Town of Queen Creek.

Future planning efforts for the vast majority of the surrounding project study area is within the ASLD Superstition Vistas planning area. Superstition Vistas includes approximately 175,000 acres of raw desert land. Scenario B of the Superstition Vistas Scenario Report (East Valley Partnership, 2009) includes the following:

- This (scenario) is designed around multiple pedestrian-friendly, mixed-use areas, concentrated on the transit system and around major roadways. These areas are urban, town and village centers and include attached housing products mixed with retail and employment.

- Due to the breadth of housing choices, the organization of uses and a sustained effort to catalyze economic development, Scenario B attracts employers and has a better balance of jobs and housing than Scenario A.
- In this scenario, Superstition Vistas would have about the same jobs-to-household ratio as the region as a whole.
- The housing mix is designed to appeal to a broad spectrum of the population to support both workforce and higher-end housing. The housing types offer more choice than those currently under construction in the area. There are more apartments, condos and townhouses, as well as single-family homes. There is also more mixed-use development.
- The transportation system includes commuter rail and light rail, and higher densities are focused around the transit stops. Land uses and transportation networks are designed to facilitate pedestrian, transit, and bicycle travel, rather than just the car. Streets form a connected pattern to disperse traffic and increase transportation efficiency. Many of the new industries are sited along major transportation routes.
- There is greater preservation of the surrounding habitat areas than Scenario A and a somewhat smaller footprint, with less development in the foothills.

4.14 LAND RIGHTS AND RELOCATIONS

The lands in the vicinity of the FRS are in both private and public ownership. Land Ownership Information (for the downstream area) of the PVR structures is: Private Land – 87%, State/Local 12%, Federal 1%. No land rights acquisitions or relocations are anticipated for this project.

4.15 IMPORTANT AGRICULTURAL LANDS

Currently agriculture and rangelands make up a minor percentage of the economic base surrounding the PVR dams (but none are located upstream or downstream of the Powerline FRS). Today, crops of cotton and alfalfa are present in the downstream vicinity of the Vineyard Road and Rittenhouse FRS's. All of the farms downstream of the PVR dams are not considered to be prime farmlands.

4.16 DEMOGRAPHICS, MINORITY, AND DISADVANTAGED POPULATIONS

Data on racial and ethnic minority populations for the PVR FRSs Social Population and Demographics Existing Conditions Study (SPDECS) area is provided in the report titled "*Social Population and Demographics Existing Conditions Study for Powerline, Vineyard Road and Rittenhouse Flood Retarding Structures Rehabilitation or Replacement Project*" (Kimley-Horn, July 2010). The majority of the total population encompassing the Powerline, Vineyard Road and Rittenhouse Flood Retarding Structures (PVR FRSs) area is White which comprises 86.9% of the population. The total minority population is 13.1% with the breakdown of racial and ethnic demographics as follows: Black or African American 1.4%; American Indian and Alaskan Native 1.0%; Asian 1.2%; Native Hawaiian and other Pacific Islander 0.2%; Other 6.6%; Population of Two or More Races/Not Hispanic or Latino 2.8%. The percentages of racial, ethnic and total minority populations appear to be consistent with those of the surrounding communities.

The demographics were conducted on the area defined as the 'Social Population Demographics Existing Conditions Study area' (SPDECS) for the Powerline, Vineyard Road, and Rittenhouse FRSs and documented in the "Social, Population and Demographics Existing Conditions Study" (Kimley-Horn July, 2010). The analysis approach was based on Census Track and Block Groups within and adjacent to the SPDECS study area. The source of the data is the decennial Census 2000 data sets from the United States Census Bureau (Census 2000). The SPDECS study is summarized in **Appendix D –** *Investigations and Analysis Report*.

The median household income for the PVR FRSs area is between $32,055 and $101,124 for an average median household income of $60,789. This represents a slightly higher median household income than the neighboring communities which range between $33,170 (Apache Junction) and $68,032 (Gilbert) for an average median household income of $58,399.

4.17 AIR QUALITY/NOISE/LIGHT

Air Quality

The project area is located within non-attainment areas for the following pollutants: Ozone 8-hour and PM_{10}.

Pinal County administers air quality in Pinal County through the Pinal County Air Quality Control District (PCAQCD). The PCAQCD code of regulations (October, 2010) includes construction site rules which would be applicable to construction activities for the PVR project.

Noise

Pinal County noise ordinance is known as the "Excessive Noise Ordinance". The ordinance includes limiting sound levels for land use districts and construction start/stop times for construction of buildings and other projects.

Light

Pinal County has an outdoor lighting code within the County's zoning ordinance which is intended to restrict the permitted issues of outdoor artificial illuminating devices emitting undesirable rays into the night sky. This code includes shielding and filtration requirements and prohibitions on specific lighting types.

4.18 CULTURAL RESOURCES

A review of NRCS project documentation for the flood retarding structures indicates that there were no known cultural resource considerations during original design and construction of the dams. There are also no known cultural considerations during the repairs of the dams conducted by the NRCS during 1978 to 1991.

A Class III cultural resource survey was completed in December 2009 for geotechnical studies related to the PVR FRSs Rehabilitation or Replacement Project. The survey entitled, *Class III Cultural Resources Survey Along the Powerline, Vineyard, Rittenhouse Flood Retarding Structures Between Queen Creek and Apache Junction, Pinal County, Arizona* (Jones and Florie 2009) included the results of a "site file check" as well as those of the field survey for the specific geotechnical work that was to be performed. The review area for the PVR FRSs 2009 cultural resource study is a one mile buffer around the PVR FRSs structures.

The 2009 Class III report was prepared in compliance with the National Historic Preservation Act of 1966 (as amended); Arizona State Antiquity laws (A.R.S. § 41-841 *et seq*); and the State Historic Preservation Act (A.R.S. § 41-861 through § 41-864). The site file check for the review area (including the one mile buffer) that was conducted as a component of that report included site records and project files at the State Historic Preservation Office (SHPO) and the AZSITE cultural resource database. Hereinafter, the site file check component of the 2009 Class III survey effort is referred to as the "2009 cultural resource study".

Previous Research

The 2009 cultural resource study indicated that at least 59 cultural resource investigations/surveys have taken place within the review area. Most of these previous survey areas are linear in nature and cut across the review area. Nine of these surveys are over 10 years old and therefore would require re-evaluation and resurvey in accordance with SHPO guidance. Two other investigations were extensive block surveys, conducted for the Lost Dutchman Heights project areas. These surveys covered portions of the review area in the vicinity of the Powerline FRS.

Previously Recorded Cultural Resources

Within the review area there were 72 previously recorded archaeological sites and one archaeological district identified in the 2009 cultural resource study. Though the vast majority of these sites are prehistoric artifact scatters, some with features of habitation sites (approximately 69), there are several historic sites and an archaeological district.

Of the 72 previously recorded sites, seven have been determined eligible for the National Register of Historic Places (NRHP); 33 are Recommended as eligible for the NRHP; two have been Determined as not eligible; six are Recommended as not eligible; and 24 have not been evaluated. The archaeological district is Recommended as eligible. (Note: Sites "Determined" eligible/not eligible have been evaluated by the SHPO; sites "Recommended" have been evaluated only by their recorder and not the SHPO).

Class III Cultural Resources Survey

The Sponsor conducted a Class III cultural resources survey for the area of potential effects (APE) for the Preferred Alternative ("*Draft Class III Cultural Resources Survey for the Flood Control District of Maricopa County Vineyard Road and Rittenhouse Flood Retarding Structures Project*", Archeological Consulting Services April, 2013). The purpose of the survey was to conduct a site inventory of the APE for identification and location of cultural resource sites. The site survey was completed in April 2013. The cultural resources survey identified potential sites that may require mitigation prior to construction. Mitigation may be conducted in a phased approach in consultation with the SHPO, Indian tribes who have identified the project area as part of their ancestral territory, land owners, and cooperating entities.

The Class III survey identified 10 newly recorded sites. In addition, 11 previously recorded sites are known to occur within the APE. These 11 sites were documented recently as part of the Lost Dutchman Heights project area survey as well as other smaller surveys along the CAP canal. The Class III report noted for the 11 previously recorded sites that four of the sites have been mitigated in previous cultural studies. The remaining 7 sites, if these cannot be avoided, the Class III report recommends testing for either Phase I date recovery or determination for eligibility in the National Register.

Data recovery is recommended for 4 of the 10 newly recorded sites, if these cannot be avoided,. Three of the newly recorded sites were recommended as ineligible for inclusion in the National Register. The eligibility of 3 of the newly recorded sites could not be determined at the survey level. If these sites cannot be avoided, the Class III report recommends that archeological testing be conducted.

Based on the known sites in the APE, the majority of the cultural resources present are either prehistoric sites without evidence of habitation (which includes scatters of artifacts on the surface, or artifacts with remnants of agricultural features, and/or other non-habitation features) or historical sites (which includes farming or ranching features, or simply scatters of historical artifacts). Based on experience with recent data recovery efforts in central and southern Arizona, cultural resources mitigation costs have been estimated.

Formal consultation with the Arizona State Historic Preservation Office (SHPO) has been initiated following identification of the Preferred Alternative. The initial SHPO consultation correspondence is on file with the NRCS. Consultations with SHPO will continue through the design phase as final alignments, borrow materials, and other disturbance areas are further identified. Formal consultations with Indian tribes who have identified the project area as part of their ancestral territory have been initiated following identification of the Preferred Alternative. Consultations with those tribes and any others who may seek to be consulted will continue through the design phase as final alignments, borrow materials, and other disturbance areas are identified.

4.19 STATUS OF OPERATION AND MAINTENANCE

The current *"Operation and Maintenance Agreement" (O&M)* for the Powerline FRS is dated June 20, 1990. The agreement is between the NRCS and the District. The Flood Control District is the local Sponsor. The current operation and maintenance activities include annual inspections, crest surveys, sediment and debris removal activities, repair of erosion features, and weed and rodent control/abatement.

4.20 HAZARD CLASSIFICATION

The FRS is designated as a high hazard structure by ADWR and NRCS. 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" sized structure with a "high-hazard" potential.

4.21 POTENTIAL FAILURE MODES

As noted in the previous section, ADWR and NRCS both classify the Powerline FRS as a high hazard dam with the potential for loss of life if the dam was to suddenly fail. Potential failure modes were identified and qualitatively evaluated in the "*Final Failure Mode and Effects Analysis Report: Cave Buttes Dam, Powerline FRS, Vineyard Road FRS, Rittenhouse FRS, Spook Hill FRS, Signal Butte FRS, and Apache Junction FRS "(KHA, July 2002).* The FMEA identified three Category I and three Category II potential failure modes. The potential failure modes are listed below.

4.21.1 Hydrologic Failure modes

The July 2002 FMEA identified one hydrologic potential failure mode. This is:

- Failure from Overtopping of Powerline FRS (Category I). Hydrologic studies conducted for Powerline, Vineyard, and Rittenhouse FRSs indicated there is a potential for Powerline FRS to be overtopped by the full PMF storm event. The overtopping may be on the order of a maximum of 0.0 to 1.3 feet for a total discharge duration of 2.8 hours. The studies also indicate there may be a discharge from the emergency spillway for the 100-year event. Overtopping of Powerline FRS would occur at the low point on the crest (approximately Station 90+00). Flow would overtop the dam at that point and as flows increased, erosion of the crest and downstream slope would occur and potentially lead to a breach of the dam.

4.21.2 Structure Failure Modes

The July 2002 FMEA identified five structure related potential failure modes. These are:

- Failure from a Potential Earth Fissure(s) through the Dam Embankment in Association with a Significant Flooding Event (Category I). The presence of existing earth fissures in the vicinity and adjacent to Powerline FRS demonstrates the potential for a new earth fissure to manifest itself at the dam embankment. An earth fissure could cause a structural failure of the embankment by opening a crack through the structure. Alternatively, the fissure could potentially undermine the dam embankment by abruptly causing separation of structure at the foundation with the dam bridging the fissure. If the fissure occurred in association with a large flood the structural failure from the fissure would provide a path for a seepage erosion breach. In such a case there would be minimal loss of water. This failure mode was considered by the FMEA team to be the most significant threat to Powerline FRS.
- Failure from Piping through Transverse Crack Causing Breach of Dam in Association with a Major Flooding Event (Category I). Potential for impounded water to infiltrate and flow into a transverse crack(s) existing in embankment prior to the major flooding event or a transverse crack that develops in association with the flooding. The transverse crack allows the entry of great enough flow of water to initiate seepage erosion and breaching failure. Two modes were identified for failure: Mode A – failure through a large (wide) transverse crack that extends across the central filter, and Mode B – failure through entry of flow through multiple upstream transverse cracks, water flows to/through a flaw in the central filter and begins seepage erosion (and loss of central filter material) through a downstream transverse crack.
- Failure from Potential Piping Around/Or from 12-inch Corrugated Metal Pipe Outlet at Station 141+00 (Category II). Infiltration of water into embankment material around pipe and soil is carried away due to seepage erosion along culvert or piping leading to an erosional tunnel, caving or breaching.
- Failure from Potential Erosion of Abutment and/or Emergency Spillway During Spillway Discharges (Category II). The emergency spillway is a limited service earth-lined spillway. Spillway discharges from extreme events could potentially damage the spillway floor and left abutment due to erosion.
- Failure from Potential Embankment Slope Instability (Category II). Potential embankment slope failure due to internal pressure in the central filter.

4.22 CONSEQUENCES OF DAM FAILURE

Dambreak analyses were completed by JE Fuller/Hydrology & Geomorphology, Inc. in June 2007 on behalf of the District and LTM Engineering, Inc. The report titled *"Emergency Action Plan for Powerline, Vineyard Road, & Rittenhouse Flood Retarding Structures" (JEF, 2007)* documented the inundation areas downstream from the three dams for emergency spillway discharges and from dambreaks. Copies of the flood inundation mapping from the Emergency Action Plan for Powerline FRS are included in **Appendix C**.

- The flood wave generated from a dambreach failure at Powerline FRS has the potential to impact major public infrastructure (Loop 202, Williams Gateway Airport) and existing/planned residential areas.
- The flood wave from the auxiliary spillway (discharge of 21,300 cfs) would impact existing and planned residential areas east of the dam. Major public infrastructure is also within the flood hazard area (Ironwood Road and Williams Gateway Airport).

The population-at-risk (PAR) downstream of the Powerline FRS was conservatively estimated in the economics study conducted in support of this Plan/EA. The PAR was estimated and documented in the "Economics Evaluation Technical Memorandum" (Gannett Fleming, January 2013). The PAR is estimated to be 27,000 people. This estimate was worst case based on simultaneous full occupancy of the commercial buildings, schools, residences, etc. The methodology for determining the PAR is provided in the "*Investigation and Analysis Report*" provided in **Appendix D** of this Plan/EA.

4.23 AESTHETICS

A Site Analysis for the project study area extending out one mile around the PVR dams is documented in the report titled "*Powerline, Vineyard Road and Rittenhouse Flood Retarding Structures Rehabilitation or Replacement Project - Site Analysis Report*" (EPG, Inc. February, 2010). The Site Analysis identified site constraints and opportunities for the future development of flood hazard mitigation solutions and for potential multi-use functions within the project study area.

Some of the most visually striking and identifiable landforms within the project boundary are the PVR dams themselves. The PVR dams total 11.6 miles in length and have respective maximum heights of 26.1 feet, 16.5 feet, and 24.1 feet. The structures provide 12,036 acre-feet of flood storage and 100-year flood protection for 147 square miles. Recommendations for the rehabilitation of the flood retarding structures (if a rehabilitation alternative is selected) should consider the functioning of the interconnected system, including its three embankments, three reservoirs, four auxiliary spillways, and one floodway (Powerline Floodway).

Atop the FRS dams, spectacular panoramic views are afforded to additional identifiable and noteworthy landforms such as the Superstition Mountains and Tonto National Forest to the northeast, the Usery and Goldmine Mountains to the northwest, and the San Tan Mountains to the southwest. The remaining prevailing landform comprises large, open flat areas, and jagged edged vee-shaped incised drainages that carve into them. The drainages create finger-like patterns overlaying the flat surface of the ground plane.

During the Site Analysis verification site visit, a significant amount of water was observed in the low flow areas within the reservoirs upstream of the dams from a storm event. The dams and associated reservoirs and low flow channels have altered the historic drainage pattern in a way that

allows pooling to occur immediately upstream of the dams. This altered drainage pattern created an ideal environment for the formation of a unique mesquite bosque ecosystem immediately upstream of the dams. Careful consideration should be given to future development of land and resource goals and objectives, as well as desired recreation and open space functions to preserve this unique ecosystem to the extent feasible as part of a larger regional habitat corridor. The preservation of the mesquite bosque should also be considered for its potential to serve as an open space amenity and attraction. The significant stand of trees should be considered vegetation of high scenic quality.

The upstream portion of the watershed to the east of the PVR dams is primarily alluvial desert. Land use is predominantly undeveloped land with some urban development occurring along the study area fringes north and west of the PVR dams. In these areas, land use includes agriculture, industrial, and low density housing. The landscape on the upstream side of the dams is unusual for its native Sonoran Desert scrubland context due to the lushness provided by the mesquite bosques and pooling in the low flow reservoirs.

The visually dominant dams adjacent to the mesquite bosques constitute another key component of the landscape character. According to the Sponsor's descriptions of methods for providing flood protection for use in scenery and recreation resource assessments of context sensitivity, the structural method employed in this context can be described as a "semi-hard structural method." While the primary objectives of the Sponsor's Policy for Landscape and Aesthetic Treatment of Flood Control Facilities are the preservation of natural landscapes and protection of local community character, flood protection methods vary in their relative ability to complement or enhance the visual character of the landscape setting and achieve context sensitivity.

The panoramic views provided from the tops of the embankments to the surrounding mountains are spectacular. Sponsor's policy is to not allow public access onto the dams. However, where possible, views to the Superstition Mountains and Tonto National Forest to the northeast, views to the Usery and Goldmine Mountains to the northwest, and views to the San Tan and distant mountains to the south should be preserved and focused.

The view sheds as described in this section may be important to traditional (cultural) landscapes. Consultation with appropriate tribes for proposed project input on traditional cultural properties has been initiated.

5.0 ALTERNATIVES

5.1 GENERAL

The Powerline FRS is one of three earthen flood retarding structures (Vineyard Road FRS and Rittenhouse FRS are the other two) located east of the Central Arizona Project (CAP) canal. The three structures were originally designed by the NRCS to operate as an integrated system as the principal spillways at Powerline FRS and Vineyard Road FRS both discharge into a common channel – the Powerline Floodway. The Rittenhouse FRS principal spillway discharges into the Vineyard Road FRS flood pool. The result is that all three principal spillways eventually flow into the Powerline Floodway. The "Powerline, Vineyard Road, and Rittenhouse FRSs Rehabilitation or Replacement Project" (Project) was initiated to formulate alternatives to mitigate identified dam safety deficiencies at the three dams. One of the objectives in the formulation of alternatives for the three dams was to maintain the integrated operational relationship of the three dams (or alternatives) to discharge to the Powerline Floodway. This Supplemental Watershed Plan and Environmental Assessment (Plan/EA) presents the alternatives evaluated and preferred alternative for Powerline FRS. The Powerline FRS is a structural plan element of the Apache Junction-Gilbert Watershed Work Plan. A separate Supplemental Watershed Plan/EA has been prepared for the Vineyard Road FRS and Rittenhouse FRS as these two dams are structural elements of the Williams-Chandler Watershed Work Plan.

This section describes the development and formulation of planning alternatives for the Powerline, Vineyard Road, and Rittenhouse Flood Retarding Structures Rehabilitation or Replacement Project. The formulation of alternatives was developed to meet Sponsor (District) goals and to mitigate or eliminate identified inadequacies associated with the structures.

The primary project goal as defined by the District is to develop an implementable project designed to maintain or improve upon the level of flood protection currently being provided by the PVR FRSs and associated features for the new PVR Project life of 100-years. The Project must meet both District and NRCS requirements for flood protection and must meet District, NRCS and Arizona Department of Water Resources requirements for dam safety.

A secondary project goal is to feasibly minimize the future project "footprint", the overall land area encompassed by the future flood control features and flood conveyance and flood impoundment land areas, and to identify other potential land uses and activities that are compatible with the safe and proper function, operation and maintenance of the future PVR Project and associated features.

5.2 FORMULATION PROCESS PRELIMINARY ALTERNATIVES

The District, NRCS, and Consulting team held three preferred alternatives selection workshops. These workshops were held on December 8, 2010, April 26, 2011, and April 19, 2012. The purpose of the workshops was to discuss and screen the formulated alternatives and measures. The results of the workshop meetings are summarized in the memorandums for those workshops. Several of the alternatives and measures were screened and determined by the workshop attendees (consisting of the District, NRCS, Arizona State Land Department, and other stakeholder representatives) to be unreasonable because the alternatives were not technically feasible, estimated costs were too excessive compared to other alternatives, an alternative was incorporated or combined with another alternative, and/or did not meet the purpose and need for the project. Note

that the alternatives are formulated on a system wide approach (integrated system) such that all three dams were included in an alternative rather than a separate alternative developed for each dam. This system approach was taken to maintain the functional and operational relationship of the three PVR structures. Full descriptions of the alternatives noted below are provided in the "*Level I Final Alternatives Summary Report*" (KHA, February 2011), the "*Level II Final Alternatives Summary Report*" (KHA, June 2012), and the (*Level III Final Alternatives Summary Report* – KHA September 2012). The alternatives eliminated from further detailed study were screened in the alternatives workshops and documented in the workshop notes (see Appendix C in Level II Final Report for workshop notes and ranking matrices).

The " *Level II Final Alternatives Summary Report*" (KHA, June 2012) identified five structural alternatives for plan formulation based on technical analyses and input from the NRCS, the Sponsor, and the Consulting team. These alternatives (alternative numbers are as provided in the Level II report) are listed below for the PVR project:

- Rehabilitation (Alternative 1): Raise and Rehabilitate the Powerline, Vineyard Road, and Rittenhouse FRS structures
- Combination (Alternative 6): Replace Powerline FRS and Northern 1/3 of Vineyard Road FRS with Basins and Channels, Raise and Rehabilitate the Southern 2/3 of Vineyard Road FRS and Rittenhouse FRS
- Combination (Alternative 6A): Replace Powerline FRS and Northern 1/3 of Vineyard Road FRS with Basins and Channels, Raise and Rehabilitate the Southern 2/3 of Vineyard Road FRS and Convert Rittenhouse FRS to a Levee
- Combination (Alternative 8): Replace Powerline and Rittenhouse FRSs with Channels, Raise and Rehabilitate Vineyard Road FRS
- Combination (Alternative 8A): Replace Powerline FRSs with Channels, Raise and Rehabilitate Vineyard Road FRS, and Convert Rittenhouse FRS to a Levee
- No Action Alternative: Also known as No Action Alternative/Future Without Project

Rehabilitation is defined as modification and improvements of the existing dams to meet current State and Federal dam-safety standards. Rehabilitation would include raising the dams to safely pass the inflow design flood (IDF) through the auxiliary spillways, providing new filters to address potential embankment cracking, providing a hardened dam or channel sections within moderate earth fissure risk zones, modification of auxiliary spillways, and replacing the existing principal spillways.

A combination alternative combines structural measures to replace an individual dam or dam segment with a channel or levee with rehabilitation of the remaining dam structures/embankments. A decommissioning alternative (decommissioning of all three dams) was not selected to be evaluated and nor carried further in the Level II report.

The Level III Analysis included analysis of another alternative – Alternative 8B. Alternatives 8A and 8B were carried forward into the Level III analysis (*Level III Final Alternatives Summary Report* – KHA September 2012). The Level III analysis conducted further evaluations of Alternatives 8A and 8B including refined earthwork quantity and construction cost estimates. Both alternatives are identical in the replacement of Powerline FRS with a new 100-year flood channel. The alternatives differ in the treatment of Rittenhouse FRS (Alternative 8A replaces the dam with a

levee, and Alternative 8B rehabilitates the dam) and in the filter treatments for Vineyard Road FRS and Rittenhouse FRS in Alternative 8B. The results of the Level III analysis indicates that Alternative 8A (the 8A option that replaces Powerline FRS with a new channel and hardened channel segments within fissure risk zones; dam rehabilitation for Vineyard Road FRS; and converting Rittenhouse FRS to a levee) was the lowest cost alternative. The Level III report presents and discusses the National Economic Development (NED) alternative as this alternative for the PVR structures. The Level III report also identified the Preferred Alternative as Alternative 8A with the option of hybrid filter for dam rehabilitation of Vineyard Road FRS, replacing Powerline FRS with a 100-year channel, and converting the Rittenhouse FRS to a levee.

5.3 ALTERNATIVES ELIMINATED FROM DETAILED STUDY

Two alternatives (noted above as Alternative 6 and 8) were developed that incorporated different structural treatments for Rittenhouse FRS as noted above in **Section 5.2**. Alternative 6 and Alternative 6A are described below and differ in the approach for the Rittenhouse FRS. Alternative 6 keeps Rittenhouse as a rehabilitated dam and Alternative 6A modifies Rittenhouse FRS to a levee that discharges into Vineyard Road. FRS. Alternative 8 has three different structural measures, again, relating to the treatment of Rittenhouse FRS. Alternative 8 replaces the dam with a 100-year channel, Alternative 8A replaces the dam with a levee, and Alternative 8B rehabilitates the dam. As noted below, Alternatives 6, 6A, and 8 were eliminated from further detailed study.

The alternatives eliminated from further study are described below along with the reason(s) for elimination. These alternatives are:

Rehabilitation of Powerline, Vineyard Road, and Rittenhouse Flood Retarding Structures (Alternative 1)

The concept for Alternative 1 includes rehabilitating and raising Powerline, Vineyard Road and Rittenhouse FRSs to pass the (planning level) probable maximum flood (PMF), while accounting for estimated future subsidence, one foot of freeboard and sediment storage volume. Powerline FRS will be rehabilitated with an upstream filter in low-moderate fissure risk hazard zones. Segments of Powerline FRS in moderate earth fissure risk hazard zones would be replaced with a hardened dam segment (soil cement core). The Powerline Interim Dam Safety Measure (IDSM) alignment will be maintained but replaced with a hardened dam segment and the crest elevation raised to match the proposed raise on Powerline FRS. Vineyard Road FRS and the remaining portion of Powerline FRS will be rehabilitated with an upstream filter for low-moderate fissure risk hazard zones. Rittenhouse FRS is entirely located in low-moderate fissure risk hazard zones and will be raised and rehabilitated with an upstream filter along the entire length of the structure.

The total opinion of probable construction costs for Alternative 1 ranged from $87,000,000 to $120,000,000. The alternative was eliminated from further evaluation in the workshop conducted on April 19, 2012 due to technical uncertainty of building a dam in an earth fissure prone area.

Decommissioning Powerline, Vineyard Road, and Rittenhouse Flood Retarding Structures by Converting the Dams to Basins (Alternative 2)

The concept for Alternative 2 included reducing the existing structures to non-jurisdictional (by ADWR definition) size with auxiliary spillway heights of six feet. The Powerline IDSM alignment will be maintained for the reduced height Powerline structure. Upstream of the reduced structures, detention basins sized for the 100-year event would be constructed outside of the mesquite bosques

to help preserve and protect the bosques. The basins would drain through the bosques and the basin bottom depth will be controlled by the existing principal outlet location. The existing conditions 100-year 24-hour storage volume from the existing conditions 100-year HEC-1 models was used to size each of the basins, in addition to the 100-year sediment volume. No FRS rehabilitation is included.

To evaluate the required excavation volume, the existing flood volume behind the FRS up to the spillway crest height of six feet was used as flood storage and was not included in the volume required for basin excavation. The remaining required storage volume would be provided in the excavated basins where the bottom depth of each basin is controlled by the existing principal outlet location. The basins were sized such that the footprint of each basin was contained within the existing modified easement. The estimated required basin areas and depths without freeboard are 289 acres and ten feet for Powerline, 385 acres and six feet for Vineyard Road, and 538 acres and seven feet for Rittenhouse FRS. The basins will be excavated an additional three feet each in depth to include the 100-year sediment storage.

The opinion of probable cost for converting each FRS to a basin and reducing the dam heights to non-jurisdictional dams (as considered in the Level I analysis) is $190,690,000. This alternative was eliminated from further detailed study in the workshop conducted on April 26, 2011 due to high costs, operational complexity, lower flood protection level (100-year), and handling and storage of excess earthwork spoils.

Decommissioning Powerline, Vineyard Road, and Rittenhouse FRS by Converting all Three Dams to Levees that Drain south to a Basin that Outlets to Queen Creek (Alternative 3).

The concept for Alternative 3 included converting Powerline and Vineyard Road FRSs to levees to meet FEMA and District criteria. Additionally, Rittenhouse FRS would be removed and a levee would be constructed further west and adjacent to the CAP canal. A 100-year detention basin would be constructed at the south end of the project with a gated outlet to Queen Creek Wash.

A new gated at-grade outlet would be constructed at the south end of the 100-year basin to drain the basin to Queen Creek Wash. A new drainage channel would be constructed between the basin outlet and a new CAP overchute near Queen Creek Wash. A gated trash rack would be provided at the new outlet of the basin, and a new basin overflow spillway would be constructed to discharge flow in the same general flowpath as the existing Rittenhouse auxiliary spillway. The Powerline Floodway would not be used under this alternative, but may be utilized as an alternative outlet.

The invert elevation of the CAP overchutes at Queen Creek Wash is approximately 1,566 feet. In comparison, the inverts of the principal spillway outlets at Powerline and Vineyard Road FRSs are 1,563.6 feet and 1,563.8 feet, respectively, lower than the invert elevation of the CAP overchutes at Queen Creek Wash. The low point of the PVR system and the existing CAP overchutes at Queen Creek Wash are separated by approximately 8.5 miles, so even if the overchutes were lowered three feet, the flowpath south to Queen Creek Wash would be effectively flat. The primary constraint of Alternative 3 is achieving positive drainage along the existing structure alignments to drain south to Queen Creek Wash at the new outlet. This is not physically feasible. This alternative was not evaluated further due to the insufficient slope along the existing structures to drain toward the south.

Rehabilitation of Powerline, Vineyard Road, and Rittenhouse Flood Retarding Structures and Excavation of Increased Flood Storage Volume (Alternative 4)

The concept for Alternative 4 includes rehabilitating Powerline, Vineyard Road and Rittenhouse FRSs, and excavating additional storage volume behind the structures sufficient to pass the planning level PMF. Alternative 4 does not include raising the FRSs. The required storage volume excavation will be sufficient to include predicted future subsidence and sediment storage. The Powerline IDSM alignment will be made permanent for Powerline FRS. Powerline and Vineyard Road FRSs would be rehabilitated with an upstream filter for low-moderate fissure risk hazard zones and a hardened soil cement core structure for moderate fissure risk hazard zones. Rittenhouse FRS is entirely located in low-moderate fissure risk hazard zones and would be rehabilitated with an upstream filter along the length of the structure.

The 6-hour planning PMF future conditions HEC-1 models were used to determine the amount of additional flood volume excavation required sufficient for the structure to prevent overtopping. The excavation volume will also include the 100-year sediment volume determined by the District. The stage/storage/discharge curve was updated to reflect the increased volume, and the discharge was adjusted to eliminate overtopping weir flow. The additional storage volume required for Powerline FRS is 7,500 acre-feet. The additional flood storage volumes required for Vineyard Road FRS and Rittenhouse FRS are 11,500 acre-feet and 8,500 acre-feet, respectively. Excavation depths required to achieve these volumes are 28 feet, 20 feet and 20 feet for Powerline, Vineyard Road, and Rittenhouse FRS respectively.

The opinion of probable cost for rehabilitating the FRSs and providing the required flood storage volumes (as considered in the Level I analysis) is $378,203,000. This alternative was eliminated from further detailed study in the workshop conducted on December 8, 2011 due to high costs.

Combination of Decommissioning, New Rittenhouse Structure, and Rehabilitation of Vineyard Road FRS (Alternative 5)

The concept for Alternative 5 includes replacing Powerline FRS and the northern 1/3 of the Vineyard Road FRS with detention basins in low-moderate fissure risk hazard zones and channels in moderate fissure risk hazard zones. The basins and channels would drain to a 100-year basin near the existing shared Powerline FRS and Vineyard Road FRS north auxiliary spillways and outlet to the Powerline Floodway. The southern 2/3 of Vineyard Road FRS would be raised and rehabilitated, and combined with a new Rittenhouse FRS located downstream (west) of the existing Rittenhouse FRS alignment, closer to the CAP canal. The combined structure would be raised to account for predicted future subsidence and sediment storage volume, and share a flood pool with two principal outlets. The Vineyard Road portion of the combined FRS flood pool would drain north to the Powerline Floodway along the existing flow path. The new Rittenhouse portion of the combined FRS flood pool would drain south to Queen Creek Wash. The existing Rittenhouse FRS structure would be removed.

The 6-hour planning PMF future conditions HEC-1 models were used to size the new Rittenhouse/Vineyard Road structure. The 6-hour PMF was updated with the total drainage area for the combined structure. A single HEC-1 model was created combining the full Rittenhouse watershed and the contributing Vineyard Road subbasins. The model was updated with the new PMP and a new stage-storage-discharge curve for the combined structure. The existing 100-year, 24-hour HEC-1 models were used to size the channels and basins for Powerline and the northern 1/3 of Vineyard Road.

There are two primary constraints for Alternative 5. First, the combined Vineyard Road and Rittenhouse FRS would include a new principal spillway that would drain to Queen Creek Wash

via a new constructed channel from the southern end of the combined FRS to Queen Creek Wash. The slope of the channel is limited by the invert elevation of the tie-in with Queen Creek Wash. Second, the alternative is also limited by the existing capacity of Queen Creek. The Sonoqui Detention Dike, owned and operated by the CAP, discharges to the existing CAP overchutes at the CAP canal. The major design consideration for a new overchute at Queen Creek Wash is to not adversely impact the capacity and stability of the existing Queen Creek Wash downstream of the CAP canal.

The opinion of probable cost for replacing Powerline FRS and the northern 1/3 of the Vineyard Road FRS with basins and channels, raising and rehabilitating the southern 2/3 of the Vineyard Road FRS and combining the southern 2/3 of the Vineyard Road FRS with a new Rittenhouse FRS as considered in this Level I analysis is $183,952,000. This alternative was eliminated from further detailed study in the workshop conducted on April 26, 2011 due to high costs.

Combination of Decommissioning and Rehabilitation of Vineyard Road and Rittenhouse FRS (Alternative 6)

The concept for Alternative 6 includes replacing the Powerline FRS, the Powerline IDSM, and the northern 1/3 of the Vineyard Road FRS with detention basins in low-moderate fissure risk hazard zones and channels in moderate fissure risk hazard zones. The basins and channels would drain to a 100-year detention basin near the existing shared Powerline FRS/Vineyard Road FRS north auxiliary spillways and outlet to the Powerline Floodway.

The southern 2/3 of the Vineyard Road FRS would be raised and rehabilitated and outlet north towards the Powerline Floodway. The existing Rittenhouse FRS would be raised and rehabilitated and outlet into the Vineyard Road FRS flood pool (as under existing conditions). The southern 2/3 of the Vineyard Road FRS and Rittenhouse FRS would be raised sufficiently to account for estimated future subsidence and sediment storage.

The interconnected basins and channels for Alternative 6 were preliminarily sized using HEC-1 and approximate basin geometry. The trapezoidal channels serve as in-line connections between the basins and are sized to convey routed discharge from 100-year, 24-hour basins to the large detention basin near the existing shared Powerline and Vineyard Road FRS auxiliary spillways. concentration points were inserted at the basin location to determine the required storage volume and the basins were located on existing topography. Channels were sized sufficiently to route flow between the basins. The basins and channels were then input into the FLO-2D models for the alternative. Initially, the dynamic, two-dimensional routing results indicated that the preliminary basin and channel sizes were not sufficient to pass the 100-year, 24-hour event without overtopping. Storage volume and channel capacity were added by iterative trial to provide enough storage volume and channel capacity without overtopping and provide the required one foot of freeboard (or from equation 6.25 from the *DDMMC* if greater than one foot).

The total opinion of probable construction costs ranged from $185,000,000 to $218,000,000. This alternative was eliminated from further detailed study in the workshop conducted on April 26, 2011 due to high costs.

Combination of Decommissioning and Rehabilitation of Vineyard Road, and Converting Rittenhouse FRS to a Levee (Alternative 6A)

The concept for Alternative 6A includes replacing the Powerline FRS, the Powerline IDSM, and the northern 1/3 of the Vineyard Road FRS with detention basins in low-moderate fissure risk

hazard zones and channels in moderate fissure risk hazard zones. The basins and channels would drain to a 100-year detention basin near the existing shared Powerline FRS/Vineyard Road FRS north auxiliary spillways and outlet to the Powerline Floodway.

The southern 2/3 of the Vineyard Road FRS would be raised and rehabilitated and outlet north towards the Powerline Floodway. The existing Rittenhouse FRS would be converted to a levee and outlet into the Vineyard Road FRS flood pool. The southern 2/3 of the Vineyard Road FRS would be raised sufficient to account for estimated future subsidence and sediment storage.

The levee is designed to convey the 100-year, 24-hour flood with three feet of freeboard per Federal Emergency Management Agency (FEMA) requirements. The crest elevation varies with an overall levee crest slope of 0.0005 ft/ft. The levee has a 3:1 (H:V) upstream slope and a 2:1 (H:V) downstream slope and a top of crest width of 14 feet. The upstream slope would be treated with erosion protection which consists of rock riprap overlaying a geotextile. The converted Rittenhouse levee was evaluated both in HEC-1 and FLO-2D modeling. The required levee height was determined from the maximum water surface elevation against the FRS embankment along the structure. FLO-2D produced the most conservative results and was used to determine the required crest elevations.

The total opinion of probable construction costs for Alternative 6A ranged from $187,000,000 to $208,000,000. This alternative was eliminated from further detailed study in the workshop conducted on April 26, 2011 due to high costs.

Combination of Decommissioning and Rehabilitation of Vineyard Road, and Converting Rittenhouse FRS to a Levee (Alternative 7)

The concept for Alternative 7 includes replacing Powerline FRS with a 100-year channel draining to Vineyard Road FRS. Vineyard Road FRS would be segmented to raise and rehabilitate the northern ½ of the FRS and convert the southern ½ of the FRS to a levee/ floodway that drains south to Rittenhouse FRS. Rittenhouse FRS would be converted to a 100-year basin that drains to Queen Creek.

The 6-hour planning PMF future conditions HEC-1 model was used to determine the flood volume required for the northern ½ of Vineyard Road. The existing Vineyard Road HEC-1 model was modified to exclude basins no longer contributing to the FRS. The HEC-1 model was updated with a new 6-hour PMP calculation based on the new contributing drainage area.

The 100-year, 24-hour storage volume required for the basin located at the southern ½ of Vineyard Road and Rittenhouse was determined from the existing conditions 100-year HEC-1 models. The total excavation volume required for the basin included the volume of the 100-year sediment storage.

The main constraint for Alternative 7 is achieving positive drainage along the existing structure alignments from Vineyard Road into a Rittenhouse basin that drains to Queen Creek Wash (similar constraint to Alternative 3). Physically, the existing alignment and easement boundary south of Vineyard Road FRS does not permit positive drainage into the Rittenhouse basin, which drains to Queen Creek.

The opinion of probable cost for replacing Powerline FRS with a channel, segmenting Vineyard Road FRS into a raised and rehabilitated FRS for the northern ½ and levee floodway for the southern ½, and replacing Rittenhouse FRS with a basin (as considered in the Level I analysis) is

$154,701,000. This alternative was eliminated from further detailed study in the workshop conducted on December 8, 2010 due to high costs.

Combination of Decommissioning Powerline and Rittenhouse FRS and Replacement with Channels and Rehabilitation of Vineyard Road (Alternative 8)

The concept for Alternative 8 includes replacing Powerline FRS and Rittenhouse FRS with 100-year channels to drain to Vineyard Road FRS. Vineyard Road FRS will be raised and rehabilitated sufficient to pass the IDF. Locations where the channel replacing Powerline FRS cross moderate fissure risk hazard zones will require channel defensive mechanisms.

HEC-1 models and the FLO-2D two-dimensional software were used to evaluate the required dam raise elevation. The IDF, future conditions HEC-1 models for the Powerline, Vineyard Road and Rittenhouse watersheds were used to generate hydrographs for inflow points to the FLO-2D model. The IDF was used for Powerline and Rittenhouse channels to account for water in excess of the channel design event that could contribute to Vineyard Road FRS. The FLO-2D model was then used to determine the required dam raise for Vineyard Road FRS to safely pass the IDF.

The proposed Powerline and Rittenhouse channels were sized using existing conditions 100-year, 24-hour peak discharge, as the 24-hour peak discharge was greater than the 6-hour peak discharge. The Powerline watershed features two proposed channels. The first is a collector channel running along the existing FRS alignment to capture inflow that would otherwise reach the structure. The second channel is specifically for Siphon Draw, the largest wash within the watershed.

Channels were initially sized using normal depth routing within HEC-1. The preliminary channel sizes were then input into the alternative FLO-2D model. Where breakouts occurred from channel overtopping, the channel size was increased to provide additional capacity.

The total opinion of probable construction costs for Alternative 8 ranged between $93,000,000, and $118,400,600. This alternative was eliminated from further detailed study in the workshop conducted on December 8, 2010 due to potential impacts to mesquite bosques, lower system performance/flood protection, and relatively higher costs.

Decommissioning by Replacing All Three Structures with In-Line Storage Basins and 100-Year Channel to a 100-Year Basin at Rittenhouse (Alternative 9)

The concept for Alternative 9 includes converting Powerline FRS, Vineyard Road FRS, and Rittenhouse FRS to a stepped 100-year channel with in-line storage basins. The channel will begin in the upper elevations of the modified easement near Powerline FRS and drain south to the low point of the modified easement near Rittenhouse FRS. A new 100-year basin at the southern end of the channel near Rittenhouse FRS would detain the 100-year runoff volume, and drain to Queen Creek Wash through a gated outlet.

A new at-grade principal spillway and a new basin overflow spillway would be constructed at the southern end of the 100-year basin replacing Rittenhouse FRS. The principal spillway would drain south to Queen Creek in a new channel to a new overchute at the CAP canal near the existing outlet of the Sonoqui Detention Dike. An inlet and outlet structure, conduit and trash rack on the inlet would be provided at the new principal spillway. A new basin overflow spillway would be constructed and would drain in the same general flow path as the existing Rittenhouse facility. The Powerline Floodway would not be used under this alternative but could be utilized under a revised alternative scenario.

The upstream invert of the channel is limited by the modified easement boundary in the vicinity of Powerline FRS. The downstream constraint is the elevation of the tie-in with Queen Creek Wash. The upstream and downstream elevation constraints result in an insufficient slope of 0.0006 ft/ft. The combined 100-year, 24-hour discharge for Powerline, Vineyard Road and Rittenhouse is 41,756 cfs, which would require an earthen channel five feet deep with 6:1 side slopes to be over 3,500 feet wide. Given this constraint, further evaluation of this alternative was not considered. This alternative was eliminated from further consideration in the workshop held on December 8, 2010 due to noted technical constraints.

Decommissioning the Powerline, Vineyard Road, and Rittenhouse FRSs with Stabilized Breaches (Alternative 10)

The concept for Alternative 10 calls for decommissioning Powerline, Vineyard Road and Rittenhouse FRSs by constructing stabilized breaches at selected locations at each dam. The structures will be decommissioned by constructing multiple breaches in each structure. The breaches will be designed for the 100-year event and will be located along natural drainage paths in natural washes where existing FEMA 100-year floodplains intersect the structures.

The flow depth and velocities were analyzed at each breach location. Peak flows used in breach analysis were obtained from appropriate combination points in the 100-year, 24-hour existing conditions HEC-1 models. The breaches were analyzed for both concrete and riprap lining. The concrete lining results in high velocities that will require scour protection in the form of riprap or energy dissipaters. Riprap lining results lower-scour exit velocities.

All existing principal spillway and emergency spillway structures would be removed. New 100-year CAP overchutes would be constructed for each breach location. The number of overchute pipes required to pass the 100-year peak discharge over the canal were estimated assuming full flow capacity of the pipes. A pipe diameter of 72-inches was used for overchutes requiring six barrels or less, and concrete rectangular channel overchutes were sized for those requiring more than six barrels.

The opinion of probable cost for decommissioning all three FRSs (as considered in the Level I analysis) is $9,943,000. This alternative was eliminated from further consideration in the workshop held on December 8, 2010 as the alternative did not meet the project purpose and need for continued flood protection.

5.4 ALTERNATIVES DESCRIPTION

Two alternative plans were identified for detailed study and are noted from this point on as Alternative 1 and Alternative 2 for the Powerline FRS. For clarification Alternative 2 is Alternative 8A/8B from the Level II and Level III reports. The difference between 8A and 8B is the treatment of Rittenhouse FRS. Rittenhouse is converted to a levee in 8A and is a rehabilitated dam in 8B. In both 8A and 8B, Powerline FRS is replaced with a 100-year channel to discharge to Vineyard Road FRS as described below. The description of the alternative below is only for Powerline FRS for this Plan/ EA. The two alternative plans for Powerline FRS are:

- Alternative 1 – No Action Plan/Future Without Project: Powerline FRS remains in unsafe condition until Sponsor's eventual Rehabilitation or Replacement of the dam.
- Alternative 2 – Decommissioning: Convert the Powerline FRS into a channel to discharge into the rehabilitated Vineyard Road FRS.

These alternatives are discussed in detail below. Cost estimates for the alternatives are provided in **Appendix E**.

5.4.1 ALTERNATIVE 1 – NO ACTION PLAN/FUTURE WITHOUT PROJECT

The "No Action Alternative" is required under the NRCS National Watershed Manual for a dam rehabilitation planning project. This alternative is also known as the "No Action Alternative/Future Without Project Plan" which is defined as the most likely condition absent the Action Alternatives/Future With Project Plans under current consideration.

Under the "No Action/Future Without Project Alternative" the Sponsor would continue to operate and maintain the Powerline, Vineyard Road, and Rittenhouse Flood Retarding Structures beyond the end of the structures' design lives. The structures would continue to be operated as under existing conditions of the dams with the noted dam safety deficiencies. The structures would continue to have identified safety deficiencies and would not meet current NRCS and ADWR performance standards.

The Sponsor has indicated that without federal financial assistance, sufficient funds are not available to rehabilitate or replace the structures in a timely manner. The Sponsor recognizes, however, that there remains a need to address the existing safety deficiencies. Therefore, the Sponsor would eventually rehabilitate or replace the dams one at a time as non-federal funds become available. The District estimates that rehabilitation/replacement using local funds would occur for the first structure in year 20, the second structure in year 25, and the third structure in year 30 (after the approval date of this Supplemental Watershed Plan).

This alternative is not acceptable to the Sponsor and local community as a viable solution since it does not meet the purpose and need to reduce the risk of loss of life due to catastrophic dam failure. 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. The structures would continue to have safety and performance deficiencies and continue to pose a significant risk of catastrophic failure until eventual rehabilitation or replacement of the structures.

The annual operation and maintenance costs for the No Action alternative are $212,700 (see NRCS Table 4 in **Section 8.0**).

5.4.2 ALTERNATIVE 2 –DECOMMISSIONING: CONVERT THE POWERLINE FRS INTO A CHANNEL TO DISCHARGE INTO THE VINEYARD ROAD FRS

Alternative 2 would decommission the Powerline FRS and Powerline IDSM and replace the dam with a channel (for the purposes of nomenclature this channel is termed the Powerline Channel) designed for the 100-year flood event. The Powerline Channel would collect runoff from the upstream watershed including the Powerline North Diversion Channel, Weekes Wash, and Siphon Draw and would discharge to the Vineyard Road FRS. The Powerline Channel would discharge into Vineyard Road FRS east of the north Vineyard Road auxiliary spillway. There would be no impoundment of floodwaters with the Powerline Channel from the Powerline watershed. The existing dam embankment would be removed or breached and reduced in height to be a non-jurisdictional dam. The FRS would no longer meet the jurisdictional definition of a dam and then be removed from ADWR dam safety jurisdiction. The Powerline Channel would convey the 100-year storm and would provide a 100-year level of flood protection. A conceptual plan layout of Alternative 2 is provided in **Appendix C** as **Figure C-5**.

The FRS is currently under the jurisdictional purview of ADWR. To remove the FRS from jurisdictional status would require decommissioning per Arizona Revised Statutes Section 45-1209. The Arizona Administrative Code Section R12-15-1209 Application to Breach or Remove a High or Significant Hazard Potential Dam outlines the requirements to reduce a high or significant downstream hazard potential dam to non-jurisdictional size. These regulations will need to be considered during final design of this alternative.

The proposed Powerline Channel was sized using existing conditions 100-year, 24-hour peak discharge, as the 24-hour peak discharge was greater than the 6-hour peak discharge. The Powerline watershed features two proposed channels. The first is a collector channel running along the existing FRS alignment to capture inflow that would otherwise reach the structure. The second channel is specifically for Siphon Draw, the largest wash within the watershed.

The Powerline Channel was initially sized using normal depth routing within HEC-1. The preliminary channel sizes were then input into a FLO-2D model for the alternative. The Powerline Channel was sized to convey a peak discharge of 12,500 cfs into Vineyard Road FRS. Where breakouts occurred from channel overtopping, the channel size was increased in width or depth in FLO-2D to provide additional capacity. The Powerline Channel bottom widths and geometries are summarized in **Section 8.2.** A typical section of the Powerline Channel is provided in **Appendix C** as **Figure C-6**.

A construction cost for Alternative 2 is presented in **Section 8**. The cost estimate assumed that the entire embankment for the existing Powerline FRS and Powerline IDSM would be removed for a total of 704,000 cubic yards of material. The material is in the ownership of the Arizona State Land Department. For the purposes of the construction cost the material would be stockpiled on site. Locations of stockpiles would be determined in final design.

The initial hydraulic analyses of the Powerline Channel indicate several locations may require small earthen dikes to provide the 1-foot minimum freeboard required for a 100-year channel. These dikes may be required at the Channel confluence with Siphon Draw and/or at the discharge location into the Vineyard Road FRS. This will be determined in final design. These embankments may be considered levees. If considered as levees, the embankments would be required meet FEMA levee certification requirements. FEMA levee certification requirements are located in Title 44 CFR 65.10. Minimal requirements include but are not limited to: a minimum of three feet of freeboard for the length of the levee above the base flood (100-year) elevation and an additional one foot on either side of structures (bridges, etc.); provisions for embankment erosion protection, embankment and foundation stability, and settlement analysis. The levees will also be required to be designed to meet US Army Corps of Engineers and/or NRCS standards for earthen levees.

Portions of the Powerline Channel would be required to be hardened sections. These channel segments are located within the moderate fissure risk zones. Typical sections of the hardened channel sections are provided in **Appendix C** as **Figure C-7**.

Alternative 2 would not require additional right-of-way or easements for the Powerline Channel. The channel would be located within the existing modified easement.

The construction of the Powerline Channel and removal of the Powerline FRS and IDSM embankment potentially locally impact both environmental and cultural resources. The acres of existing mesquite bosque vegetation that may be directly affected have been quantified (approximately 120 acres).). Mesquite bosque mitigation may include planting tall-pot mesquite

trees (approximately 60 acres) and salvage of some mature mesquite trees and transplanting in designated areas (e.g., along Powerline Channel and potential mitigation area at north end of Vineyard Road FRS). The Sponsor and NRCS will coordinate with ASLD regarding trees along the existing low flow channel along the Powerline FRS. Mitigation plans will be refined during final design. The estimated cost of mesquite bosque mitigation for the PVR project is approximately $1,938,000.

Clearing and excavation of the channel and construction of an O&M road on either side of the channel will disturb or remove existing vegetation. Disturbed areas will be hydroseeded and restored to a native plant community following construction.

An estimation of the potential for impacting cultural resources has been completed for Alternative 2. The area of potential effects (APE) was determined and an estimate of the mitigation for cultural resources prepared. Sites in the APE that will not be subject to project-related impacts will be avoided by project implementation activities. Data recovery studies will be performed to mitigate impacts to all sites likely to suffer project-related impacts. Based on known sites in the vicinity, the majority of the cultural resources present would be either prehistoric sites without evidence of habitation (which might include scatters of artifacts on the surface, or artifacts with remnants of just one or a few roasting pits, agricultural features, and/or other non-habitation features) or historical sites (which might include homesteads, farming or ranching features, or simply scatters of historical artifacts). Most of the remaining sites would be smaller prehistoric habitation sites, with up to two relatively large prehistoric habitation sites within the total APE (for Powerline, Vineyard Road, and Rittenhouse FRSs). Based on experience with recent data recovery efforts in central and southern Arizona, the estimated cost for cultural resources mitigation for the PVR project is $3,010,000.

The total installation cost for Alternative 2 (from NRCS Table 2 in **Section 8.0**) is $23,893,600. Total project costs include a contingency of 25%, additional permitting, engineering and construction management percentages. The Sponsor's O&M costs are estimated at $212,700.

6.0 ENVIRONMENTAL CONSEQUENCES

6.1 EFFECTS OF ALTERNATIVE PLANS

This section describes potential effects of the alternatives from **Section 5.4** within each resource category noted as relevant to the proposed action in **Table 3-1**.

6.1.1 GEOLOGY

The site geology and soils for the FRS embankment are subject to land subsidence leading to the potential for the development of earth fissures. Earth fissure risk zone mapping has been previously developed for the PVR project.

Alternative 1 – No Action. This alternative would continue to operate the dam as under existing conditions with the modifications implemented with the Powerline IDSM. The IDSM has a 15 year design life. The site geology and soils would be a major consideration in Alternative 1 since the dam and IDSM would continue to be at risk to potential earth fissure development.

Alternative 2 – Decommissioning. This alternative replaces the Powerline FRS with a channel. The existing dam embankment would be removed or lowered in height to make the remaining structure a non-jurisdictional dam. The Powerline Channel would direct flows from the Powerline watershed into the Vineyard Road FRS. The channel would be a hardened channel within the fissure risk zone and an earth-lined channel outside the fissure risk zone. Alternative 2 would have a short-term effect on soils by soil disturbance/grading activities. The site geology and soils would be a minor consideration for Alternative 2 as no floodwaters would be impounded.

6.1.2 PRIME AND UNIQUE FARMLAND

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

Alternative 2 – Decommissioning. This alternative replaces the Powerline FRS with a channel and therefore there is no impoundment. The flows from the channel would be directed to the raised and rehabilitated Vineyard Road FRS. This alternative provides flood protection for downstream important agricultural lands. The risk of catastrophic flooding from a dambreak is removed.

6.1.3 SURFACE WATER QUANTITY

Alternative 1 – No Action. This alternative would continue to operate the dam as under existing conditions with the modifications implemented with the Powerline IDSM. Alternative 1 does not safely pass the inflow design flood through the auxiliary spillway with the required freeboard.

Alternative 2 – Decommissioning. This alternative would not impound water and therefore have no direct effect on impounded waters. Instead the channel would direct flows to the Vineyard Road FRS. The channel would be designed for the 100-year flood. The PMF is not required for Alternative 2.

6.1.4 REGIONAL WATER MANAGEMENT PLANS

Alternative 1 – No Action. Alternative 1 would provide continued flood protection up to the 100-year event for downstream canals particularly the Central Arizona Project (CAP) canal, a large

water supply from the Colorado River to central Arizona. The canal would continue to be vulnerable to breach failure the FRS or overtopping of the structure for storm events approaching the PMF.

Alternative 2 - Decommissioning. Alternative 2 would direct storm flows to the Vineyard Road FRS and thus provide continued flood protection up to the 100-year event. The CAP canal would be vulnerable flood events greater than the 100-year. The PMF is not required for Alternative 2.

6.1.5 FLOODPLAIN MANAGEMENT

Alternative 1 – No Action. This alternative would have a long-term adverse direct effect by potentially exposing the downstream floodplain to flooding risks from overtopping flood events or discharges through the auxiliary spillways above the 100-year event. However, Alternative 1 would provide continued flood protection up to the 100-year event for the downstream floodplain. The Federal Emergency Management Agency (FEMA) floodzone Zone A designations could be removed from the floodplain maps.

Alternative 2 - Decommissioning. Alternative 2 would direct storm flows to the Vineyard Road FRS and thus provide continued flood protection up to the 100-year event for downstream floodplain. The Federal Emergency Management Agency (FEMA) floodzone Zone A designations could be removed from the floodplain maps.

6.1.6 THREATENED AND ENDANGERED SPECIES

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

Alternative 2 – Decommissioning. A qualified biologist determined that federally threatened and endangered species or critical habitat would not be potentially impacted by this alternative since suitable habitat for these species is not present in the project area.

Suitable habitat is present for the Tucson shovel-nosed snake (*Chionactis occipitalis klauberi*) and dispersal habitat is present for the Sonoran desert tortoise *(Gopherus agassizii).* These are candidate species for the U.S. Fish and Wildlife Service (USFWS) and may become listed in the future and warrant additional assessment.

Survey protocol for the Tucson shovel-nosed snake has not been published by the USFWS. Prior to construction the status of the Tucson shovel-nosed snake on the USFWS threatened, endangered, proposed, and candidate list will be re-verified (i.e. status changed from candidate to threatened) and coordination with the USFWS will be undertaken to determine if a survey protocol has been established and/or if a survey is required. If this species is observed construction will cease until measures can be taken to ensure the preservation of the snake and/or its habitat.

Desert tortoise has the potential to occur within the project area. Prior to start of construction, the project area will be canvassed for tortoises and, if any tortoises are discovered, Arizona Game and Fish Department (AGFD) Guidelines for Handling Sonoran Desert Tortoises Encountered on Development Projects (Revised October 23, 2007) will be followed.

Additionally, the project contains suitable habitat for the western burrowing owl (*Athene cunicularia hypugaea*) which is protected under the Migratory Bird Treaty Act. Prior to start of construction, a survey for burrowing owls will be required in the disturbance area following the AGFD protocol (January 2009).

As a result of the actions described above, there will be no effect on federally threatened and endangered species or their critical habitat due to implementation of this alternative. The above-mentioned mitigation measures will be utilized to minimize impacts to special status species.

6.1.7 VEGETATIVE COMMUNITIES

The biotic community within the study area is identified as the Arizona Lower Colorado River Valley, Sonoran Desert Scrub community. Vegetation is found throughout the FRSs and study area and consists primarily of woody shrubs and herbaceous growth.

Alternative 1 – No Action. This alternative has no effect on vegetation communities and allows the continued presence of the mesquite bosque upstream of the dam.

Alternative 2 – Decommissioning. The acres of existing mesquite bosque vegetation that may be directly affected by construction activities have been quantified (approximately 120 acres). The mitigation may include planting tall-pot mesquite trees (approximately 60 acres) and salvage of some mature mesquite trees and transplanting in designated areas (e.g., along Powerline Channel and potential mitigation area at north end of Vineyard Road FRS). The Sponsor and NRCS will coordinate with ASLD regarding trees along the existing low flow channel along the Powerline FRS. The costs of mesquite bosque mitigation have been included in the alternative cost estimate.

Clearing and excavation of the channel includes an access O&M road on either side of the channel. Disturbed areas will be hydroseeded following construction. Removal of the existing dam embankment and stabilization of the dam site will impact the existing mesquite bosque. Mitigation measures would be implemented to reduce short term and long term impacts. The Alternative 2 channel would have a short-term direct effect on the vegetation community by removal of the pre-dominant vegetation type – desert brush.

6.1.8 FISH AND WILDLIFE

The arroyos upstream of the dam is normally dry except during heavy rainfall events and do not support fish populations. This local desert environment is home to several species of birds, reptiles, and mammals that use scrub desert habitat.

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

Alternative 2 – Decommissioning. Wildlife species present in the study area could have a short-term direct effect by Alternative 2. Vegetation would be removed from areas along and adjacent to the new channel.Wildlife would also be disturbed by construction activities and would likely move away from the construction area. This wildlife 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 short-term temporary loss of habitat as disturbed areas will be hydroseeded following construction.

Implementation of this alternative will impact the existing mesquite bosque. Mitigation measures, as described above, would be implemented to reduce short term and long term impacts.

The Arizona Game and Fish Department (AZGFD) recently published their "*Pinal County Wildlife Connectivity Assessment: Report on Stakeholder Input*" (April 2013). This report summarizes their wildlife connectivity assessment in Pinal County and diffuse movement areas identified in the

project vicinity. Consultation with the AZGFD and the report will be conducted during the design phase of this alternative.

6.1.9 Migratory Birds/Bald and Golden Eagles

Alternative 1 – No Action. This alternative has no effect on migratory birds/bald and golden eagles.

Alternative 2 – Decommissioning. The project area contains suitable habitat for the western burrowing owl (*Athene cunicularia hypugaea*) which is protected under the Migratory Bird Treaty Act. Prior to start of construction, a survey for burrowing owls will be required in the disturbance area following the AGFD protocol (January 2009). Mitigation measures will be completed as part of final design.

6.1.10 Aesthetics

Alternative 1 – No Action. This alternative would have no effects on aesthetics. The project area would remain as it is currently with existing conditions.

Alternative 2 – Decommissioning. The construction activities for this alternative would construct a channel upstream of the existing dam and IDSM. It was assumed for this alternative that the embankments for the Powerline FRS and IDSM would be removed. The decommissioning (dam removal) of the Powerline FRS and IDSM would have a beneficial effect on the landscape by the removal of a man-made structure. The excess spoils materials would be stockpiled within the Sponsor's easement. This material may be used for the dam raise and rehabilitation of another FRS – Vineyard Road FRS. The removal of the embankments (or partial removal) will alter the local viewshed and allow the footprint to be restored to near natural conditions prior to the dam being constructed.

6.1.11 Flood Damages

Alternative 1 – No Action. This alternative would have a long-term adverse direct effect by allowing the continued risk of flood damages to homes, businesses, and infrastructure from a catastrophic flood event.

Alternative 2 – Decommissioning. This alternative would have a long-term beneficial direct effect by reducing the risk of flood damages to homes, businesses, and infrastructure from a catastrophic flood event by eliminating impoundments and providing effective flood control up to the 100-year event.

6.1.12 Historic Properties/Cultural Resources

Alternative 1 – No Action. This alternative would have no effect on historic properties/cultural resources.

Alternative 2 – Decommissioning. The Sponsor's Class III cultural resources survey and research in the area of potential effects (APE) has noted archaeological sites located within the APE. Sites in the APE that will not be subject to project-related impacts will be avoided by project implementation activities. Data recovery studies will be performed to mitigate impacts to the sites likely to suffer project-related impacts. Based on the known sites in the APE, the majority of the cultural resources present are either prehistoric sites without evidence of habitation (which includes scatters of artifacts on the surface, or artifacts with remnants of agricultural features, and/or other

non-habitation features) or historical sites (which includes farming or ranching features, or simply scatters of historical artifacts). Based on experience with recent data recovery efforts in central and southern Arizona, cultural resources mitigation costs have been estimated.

6.1.13 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.

Alternative 2 – Decommissioning. There would be no impoundments with Alternative 2 and mitigate flooding up to the 100-year event, thus posing a significantly lower risk to minority or disadvantaged populations. The construction project could generate short-term jobs for local workers.

6.1.14 Public Health and Safety

Alternative 1 – No Action. This alternative would have a long-term adverse direct effect by allowing the continued risk to human health, safety, and loss of life from a catastrophic flood event.

Alternative 2 – Decommissioning. This alternative would have a long-term beneficial direct effect by reducing 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.

6.1.15 Cumulative Impacts

The cumulative impacts of the proposed project were considered during planning. The planning team considered proposed actions as outlined in the adjacent William-Chandler Watershed for the Vineyard Road FRS and Rittenhouse FRS as well as other known and foreseeable proposed actions by other state or federal agencies. The team determined that the cumulative impacts of the proposed actions in this watershed and the William-Chandler Watershed will have an overall beneficial impact for the people and resources of the area. The team determined that there are no other proposed actions in the project area that will have potential adverse impacts. The Arizona Department of Transportation (ADOT) is currently planning potential freeway alignments which may impact the project area. The project sponsor will continue to coordinate with ADOT to minimize any adverse impacts as planning proceeds.

6.2 Comparison of Alternative Plans

This section describes the extent to which each alternative meets the project purpose of flood prevention and the Sponsor's formulation goal to provide for continued flood protection for the downstream benefitted area while meeting all of the standards set by ADWR and the NRCS for safety and reliability of the project. Also presented are risks and uncertainty associated with the alternatives.

Alternative 1 – No Action: In this alternative the Powerline FRS and IDSM would remain in place and would continue to provide flood protection up to the 100-year event, given assumed future conditions on the upstream watershed to be the same as existing conditions, until year 2017 (end of design life). The Powerline FRS would not meet all of the standards set by ADWR and the NRCS for public safety and reliability. The previously described inadequacies in dam foundation, central filter, auxiliary spillway capacity, and embankment cracking would remain. At the end of the design life period, the Sponsors would continue to operate and maintain the dam until such time

that available construction funding becomes available to replace the dam. Therefore, Alternative 1 is not acceptable to the Sponsor and local community as a viable solution since it does not meet the purpose and need to reduce the risk of loss of life due to catastrophic dam failure. The structures would continue to have safety and performance deficiencies and continue to pose a significant risk of catastrophic failure until eventual rehabilitation or replacement of the structures.

Alternative 2 – Decommissioning: The alternative eliminates impoundment by the Powerline FRS so that it will no longer need to conform to dam safety criteria or performance standards. Alternative 2 provides a new channel that replaces the Powerline FRS. The channel will convey floods up to the 100-year event to the Vineyard Road FRS. Therefore, Alternative 2 meets the project purpose and the Sponsor's formulation goals.

6.2.1 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. These uncertainties described below will be addressed during the design phase of the project.

Under Alternative 1 – No Action, the Sponsor (District) would continue to operate and maintain the dam in its present condition and in accordance with the current Emergency Action Plan.

Geohazard Investigations and Monitoring

The Powerline IDSM is an interim measure (design life of 15 years) to mitigate the potential for an earth fissure near or under the Powerline FRS. The alignment/location of the IDSM is based on current investigations and analyses for projected future earth fissure risk zones. The District will continue the on-going monitoring program at Powerline FRS for indications of further subsidence and potential of earth fissure development.

Hydrology and Hydraulics

The dam would continue to have structural inadequacies in auxiliary spillway capacity. As a result, there is a risk of dam break until the FRS is decommissioned.

Current hydrologic analytical results indicates the FRS and auxiliary spillway is not capable of passing the planning 6-hr PMF (for both existing and future land use conditions), which overtops the dam by 0.6 foot. The dam experiences no flow in the auxiliary spillway for any of the existing conditions multi-frequency (2-year through 500-year) events. The future conditions land use for Powerline FRS results in auxiliary spillway flow only during the 500-year, 24-hour storm event at a depth of 0.5 ft.

The erosion analysis using the SITES model indicates that the auxiliary spillway erodes during the stability design hydrograph and breaches during the existing and future conditions freeboard design hydrographs. As a result there remains a risk of breach of the auxiliary spillway.

Under Alternative 2 – Decommissioning, the Powerline FRS would be replaced by a 100-year channel. This alternative is subject to uncertainty because of missing or approximate information utilized during the planning study. Uncertainties and the effects of these uncertainties, and suggestions for future studies are listed below.

Geohazard Investigations and Analyses

The proposed Powerline Channel includes channel segments that provide mitigation measures within the earth fissure risk zones. The location of the "hardened" channel segments are based on delineation of these zones conducted with current data at the time of this Plan/EA and projected in a linearwise fashion for planning purposes. The limits of the channel hardening (if required) will be determined in final design. The future projection of the delineation of the risk zones and level of risk zone may change during the design life (100-years) of the proposed project. Continued monitoring of land subsidence and geohazard investigations are recommended for the design life of the project.

Construction Sequence

The construction of the Powerline Channel needs to occur after the dam rehabilitation is completed for the Vineyard Road FRS (the rehabilitation of the Vineyard Road FRS is described in the separate document "*Final Supplemental Watershed Plan and Environmental Assessment for the Vineyard Road and Rittenhouse FRS*" by Kimley-Horn, April 2013). The dam rehabilitation improvements for Vineyard Road FRS include/provide for flood storage capacity from the Powerline watershed for the 100-year flood event.

Powerline FRS and IDSM Embankment

The construction cost estimate assumed that the embankment for the Powerline FRS and IDSM would be removed, the sites graded out, and no special handling of the excess spoils were considered. The embankment soils are owned by the Arizona State Land Department. The embankment for the Powerline FRS may be opted by the District to be breached in one or more locations instead of being removed. This will be determined in final design with considerations from ASLD and ADWR.

Hydrology and Hydraulics

The SITES modeling for the principal spillway hydrograph (PSH), stability design hydrograph (SDH), and integrity or freeboard hydrograph (FBH) was completed for the existing dam conditions as part of this planning study. SITES modeling was completed for the alternatives (8A and 8B) to ascertain the volume and peak discharge contributing from the Powerline watershed to the Vineyard Road FRS watershed via the Powerline Channel. PMF modeling was conducted using HEC-1 and FLO-2D to estimate the contribution from the Powerline watershed to the Vineyard Road FRS from the Powerline Channel. However, SITES hydrologic and spillway erosion modeling was not completed for the alternatives for the SDH or the FBH. These need to be completed as part of final design to determine the final Vineyard Road FRS flood volume storage and assist with design of the auxiliary spillways for Vineyard Road FRS.

This study developed a 'planning PMP' which is a reduced precipitation depth over the Hydrometerological Report 49 (HMR-49) derived precipitation depths. The report titled "*Powerline, Vineyard Road and Rittenhouse Flood Retarding Structures Rehabilitation or Replacement Project – Final PMP Technical Memorandum*" (Kimley-Horn, July 2010) recommended a ten percent (10%) reduction of the HMR-49 derived 6-hr PMP as the planning PMP for analysis of the operational response of the existing dams and for the proposed alternatives. The recommendation was based on a site-specific PMP study conducted for the Magma FRS (another flood retarding structure located south of the Rittenhouse FRS).

The Arizona Department of Water Resources is currently developing updated PMP maps for the State of Arizona. These maps should be used as part of final design to conduct a site-specific PMP

study for the PVR watersheds to confirm the planning PMP reduction and/or determined if a further reduction may be warranted. The new site-specific PMP values should be used to update the IDF hydrology and hydraulics for the PVR watershed and structures.

FEMA Floodplains

The Powerline Channel will be designed for the 100-year storm event and will discharge into the Vineyard Road FRS. The channel will be designed to meet or exceed FEMA, District, and NRCS design requirements for flood control channels. The existing FEMA floodplain mapping indicates several washes with Zone A floodplains (Weekes Wash and Siphon Draw). The Powerline Channel will intercept these washes and remove the Zone A floodplain downstream of the channel. For the channel to be recognized as providing 100-year flood protection a FEMA CLOMR/LOMR should be prepared as part of final design or shortly after completion of construction.

Cultural Resources

Sites in the APE that will not be subject to project-related impacts will be avoided by project implementation activities. The Sponsor's Class III cultural resources survey and research in the area of potential effects (APE) has noted archaeological sites located within the APE. Sites in the APE that will not be subject to project-related impacts will be avoided by project implementation activities. Data recovery studies will be performed to mitigate impacts to the sites likely to suffer project-related impacts. Based on the known sites in the APE, the majority of the cultural resources present are either prehistoric sites without evidence of habitation (which includes scatters of artifacts on the surface, or artifacts with remnants of agricultural features, and/or other non-habitation features) or historical sites (which includes farming or ranching features, or simply scatters of historical artifacts). Based on experience with recent data recovery efforts in central and southern Arizona, cultural resources mitigation costs have been estimated.

6.2.2 NED, EQ, AND OSE ACCOUNTS

The requirements under "Economic and Environmental Principles and Guidelines ("P&G") for Water and Related Land Resources Implementation Studies" (WRC 1983) have been applied to the current study and have been used in planning this action. Principles and Guidelines specify 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).

Principles and Guidelines 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. The RED is not a requirement under P&G and was not considered in this study.

The effects of the alternative plan in terms of the NED account are summarized in **Table 6-1**. 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, if required.

Table 6-1 Summary and Comparison of Candidate Plans – NED Account

	Alternative 1 No Action	Alternative 2 Decommissioning/NED
Project Investment	$212,700 (O&M)	$23,893,800
National Economic Development Account (NED)		
Beneficial Annual[1/]	$0	$0
Adverse Annual (Project costs and maintenance)	$212,700	$1,006,700
Net Beneficial	($212,700)	($1,006,700)

[1/] The proposed project will provide an estimated $14,779,300 in average annual equivalent damage reduction benefits. However, as the "no action" or future without project alternative also provides this same benefit stream, the project does not have a positive incremental benefit. The benefits of the project are tied to reducing the risk of catastrophic failure of the existing structures and thus reducing the risk to life and property, as described in the plan.

Benefits for the project were based upon the reduction of flood damages. Flood damages under both a With Dams and Without Dams scenario were estimated. The difference in flood damages between the two scenarios can be considered a benefit of retaining flood protection. Because both of the alternatives, including the No Federal Action/Future Without Project, continue to provide flood protection throughout the project life, the benefits are same for each alternative.

The adverse annual costs include the investment cost amortized at a discount rate of 3.75% over a period of 103-years plus the annual maintenance costs. The net beneficial amounts are computed as the annual benefits, less the adverse annual costs.

The above economic evaluation is documented in the report titled "Powerline, Vineyard Road and Rittenhouse Flood Retarding Structures Supplemental Watershed Plan/Environmental Assessment Economics Evaluation Technical Memorandum" (Gannett Fleming Inc. April, 2013). The economics evaluation memorandum is summarized in the "*Investigations and Analysis Report*" in **Appendix D**.

Under Alternative 1 (No Action Plan) the existing Powerline FRS and IDSM would remain in place and would continue to provide flood protection benefits up to the 100-year event until the end of the Powerline structure design life (year 2017). Flows in excess of the 500-year event would be conveyed by the auxiliary spillway and would impact the CAP canal and downstream residential areas west of the dam. The dam would most likely remain designated as an "unsafe non-emergency elevated risk" structure. The Sponsors have stated that a constructed breach the dam is not an acceptable alternative.

Alternative 2 would provide flood protection for greater than the 100-year event. Consistent with P&G, the alternative that has the highest positive net benefits would be identified as the NED Plan. However, per Section 502.2 of the NRCS National Watershed Program Manual, "In cases where

human life is at risk in the event of catastrophic failure of an existing dam that does not meet current safety and performance standards, an overriding reason for an exception to the NED plan requirement exists. To avoid seeking individual exceptions in such cases, the NED plan is defined as the federally assisted alternative with the greatest net economic benefits."

The effects of the alternative plans in terms of the EQ and OSE accounts are summarized in **Table 6-2** and **Table 6-3**, respectively below.

Table 6-2 Summary and Comparison of Candidate Plans – EQ Account

	Alternative 1 **No Federal Action**	**Alternative 2** **Decommissioning/NED**
SOILS		
Geology	IDSM design life 15 years	Hardened channel segments within earth fissure risk zones
Prime and Unique Farmland	No effect	No effect
WATER		
Surface Water Quantity	No effect	Discharge to Vineyard Road FRS
Floodplain Management	Potential exposure the downstream floodplain to flooding risks from overtopping flood events or discharges through the auxiliary spillways above the 100-year event.	Powerline flows directed to the Vineyard Road FRS and thus provide continued flood protection up to the 100-year event for downstream floodplain
PLANTS		
Threatened and Endangered Species	No effect	No effect
Vegetative Communities	No effect	Removal of existing vegetation within project footprint. Effect minimized due to post-construction hydro-seeding and other mitigation measures.
ANIMALS		
Fish and Wildlife Habitat	No effect	Short-term minor adverse effect during construction

Table 6–2 Summary and Comparison of Candidate Plans – EQ Account (continued)

	Alternative 1 No Federal Action	Alternative 2 Decommissioning/NED
ANIMALS		
Threatened and Endangered Species	No effect	No effect
Migratory Birds/Bald and Golden Eagles	No effect	Mitigation for burrowing owl
HUMANS		
Aesthetics	No effect	Moderate effects during construction, no long-term effect; provides opportunity for multi-use
Flood Damages	Downstream properties, residences, business at risk from inundation from dam failure or dam overtopping	Powerline channel discharge to Vineyard Road FRS. Reduced risk of downstream flood damages.
Cost, Sponsor	Continued O&M costs	Action will require significant expenditure of funds.
Cost, NED	No effect	Action will require significant expenditure of funds.
Historic Properties/Cultural Resources	No effect	Sites in the APE that will not be subject to project-related impacts will be avoided by project implementation activities. Data recovery studies will be performed to mitigate impacts to all sites likely to suffer project-related impacts.

Table 6-3 Summary and Comparison of Candidate Plans – OSE Account

	Alternative 1 No Federal Action	Alternative 2 Decommissioning/NED
Sediment Damage	No effect	Discharge to Vineyard Road FRS. Powerline sediment carried to Vineyard Road FRS.
Human Health and Safety	Continued risk of loss-of-life due to dam failure from embankment cracking and/or overtopping.	Un-safe dam removed. No impoundment of water for Powerline Channel.

Table 6 – 3 Summary and Comparison of Candidate Plans – OSE Account (continued)

	Alternative 1 No Federal Action	Alternative 2 Decommissioning/NED
Land Rights and Relocations	No effect	No effect
Land Use	Breach of dam could limit downstream development	Flood protection provided for the 100-year event
Environmental Justice	Potential to inundate residential structures from dambreak	Flood protection provided for residential structures
Municipal and Irrigation Water	CAP canal subject to inundation in a dam break flood	No effect
Transportation	Continued risk of transportation infrastructure due to dam failure from embankment cracking or overtopping	Flood protection provided for public infrastructure

The effects of the alternatives on resources of national recognition are summarized in **Table 6-4.**

Table 6-4 Effects of the Alternatives on Resources of National Recognition

Types of Resources	Principal Sources of National Recognition	Measurement of Effects	
		Alternative 1 No Federal Action	Alternative 2 Decommissioning/NED
Air Quality	Clean Air Act, as amended (42 USC 7401 et seq.)	No effect	Short-term minor adverse effect during construction.
Coastal Zone	Coastal Zone Management Act of 1972, as amended (16 USC 1451 et seq.)	No effect	No effect
Endangered & Threatened Species Critical Habitat	Endangered Species Act of 1973, as amended (16 USC 1531 et seq.)	No effect	No effect
Fish and Wildlife Habitat	Fish and Wildlife Coordination Act (16 USC 661 et seq.)	No effect	Short-term minor adverse effect during construction.

Table 6 – 4 Effects of the Alternatives on Resources of National Recognition (continued)

Types of Resources	Principal Sources of National Recognition	Measurement of Effects	
		Alternative 1 No Federal Action	Alternative 2 Decommissioning/NED
Floodplains	Executive Order 11988, Flood plain Management	No effect	Establish floodplain associated with channel.
Historic and Cultural Properties	National Historic Preservation Act of 1966, as amended (16 USC 470 et seq)	No effect	Sites in the APE that will not be subject to project-related impacts will be avoided by project implementation activities. Data recovery studies will be performed to mitigate impacts to all sites likely to suffer project-related impacts
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	No effect
Water Quality	Clean Water Act of 1977, as amended (33 USC 1251 et seq.)	No effect	No effect
Wetlands/Waters of the U.S.	Executive Order 11990, Protection of Wetlands; Clean Water Act, Food Security Act of 1985	No effect	No effect
Wild and Scenic Rivers	Wild and Scenic Rivers Act, as amended (16 USC 1271 et seq.)	No effect	No effect

7.0 CONSULTATION AND PUBLIC PARTICIPATION

As noted in **Section 3.0** – Scope of the Supplemental Watershed Plan and Environmental Assessment, an initial public scoping meeting to solicit input on the planning process for the Powerline, Vineyard Road, and Rittenhouse Flood Retarding Structures Rehabilitation or Replacement Project FRS was held on November 4, 2010 in Mesa, Arizona (Williams Gateway Airport). Meeting notices/announcements were published in local newspapers, mailed to approximately 11 Federal and State agencies and newsletters sent to approximately several thousand local residents (including disadvantaged and minority publics) and stakeholders, and electronic copies sent to Pinal County. The Sponsor provided a program overview at the meeting. Kimley-Horn and Associates, Inc. provided an overview of the study and the scheduled activities. Several local residents attended the scoping meeting. Since no public comments were received at the scoping meeting no relevant concerns were identified during this public scoping process.

On February 1, 2011, the District and Kimley-Horn conducted a second public presentation in Mesa, Arizona (Williams Gateway Airport). The purpose of the presentation was to present the draft alternatives for the rehabilitation or replacement project. The objective of the presentation was to gain public input and comments on the draft alternatives. Several comments were received from the public in attendance providing input on the draft alternatives.

On February 12, 2013, the District and Kimley-Horn conducted a third public presentation in Mesa, Arizona (Williams Gateway Airport). The third public meeting was held during the review of the draft Plan/EA. The purpose of the public meeting is to present the Preferred Alternative and summarize the alternatives studied for the PVR project. No public comments were received at the meeting.

Stakeholder meetings and workshops have been conducted with invited public agencies, conservation groups, and land planning group to obtain comments, feedback, and evaluations of tentative alternatives for the PVR dams. A series of seven (7) meetings and workshops were conducted during the period from August 2010 to April 2012. Presentation materials consisting of descriptions and exhibits of proposed alternatives, cost estimates, environmental considerations, land footprints, and multi-use opportunities were discussed and used in the workshops to evaluate, screen, and rank the alternatives. The alternatives were ranked by the stakeholders using a weighted matrix scoring system.

In compliance with Section 106 of the National Historic Preservation Act, NRCS conducted consultations with the Arizona State Historic Preservation Office (SHPO) and with all tribes whose ancestral claims areas overlap the project area. Tribes include the Gila River Indian Community, the Hopi Tribe, the Pascua Yaqui Tribe, the Salt River Pima-Maricopa Indian Community, the San Carlos Apache Nation, the White Mountain Apache Tribe, and the Yavapai-Apache Nation. In November 2012, NRCS and project sponsor representatives met with a representative of the SHPO to initiate the Section 106 process. In January 2013, correspondence was sent to the SHPO and affected tribes describing the purpose and need of the project, the preferred alternative, the area of potential effects for the project, known archaeological sites within the project area, and the need for mitigation of sites that will be adversely affected by project implementation. NRCS invited the SHPO and affected tribes to collaborate in the Section 106 process for the project. Specifically, the SHPO and tribes were requested to identify any previously unrecorded cultural resources, provide any concerns relative to historic properties that may be affected by the project, and provide any

information that will assist NRCS with project planning and appropriate treatment of cultural resources.

The Sponsor and Kimley-Horn have conducted several consultations with the U.S. Army Corps of Engineers, Regulatory Branch – Phoenix office in regards to jurisdictional determinations of Waters of the U.S. in the project area. Kimley-Horn prepared on behalf of the Sponsor application of Approved Jurisdictional Determination (AJD) and a Significant Nexus Analysis (SNA). These documents have been submitted to the Corps of Engineers. The Corps has received and reviewed the AJD and the SNA, and per requirements, has forwarded the AJD and SNA to the U.S Environmental Protection Agency (EPA). Concurrence of no waters of the U.S. on the project site has been received by the Corps in their letter dated February 11, 2013. Further discussion of the SNA is provided in the "*Investigation and Analysis Report*" in **Appendix D.**

In addition to the public, the following agencies and groups were invited to participate during the planning process:

7.1 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
- U.S. Department of Homeland Security, Federal Emergency Management Agency
- Bureau of Land Management
- Natural Resources Conservation Service

7.2 STATE AND LOCAL GOVERNMENT

- Office of the Governor
- Arizona State Parks Board, State Historic Preservation Office
- Arizona Department of Agriculture
- Arizona Department of Water Resources
- Arizona Department of Transportation
- Arizona Division of Emergency Management
- Arizona Department of Environmental Quality
- Arizona Game and Fish Department
- Arizona State Land Department
- Maricopa County
- Pinal County
- City of Apache Junction
- City of Mesa
- Town of Queen Creek
- Town of Gilbert

7.3 TRIBAL CONTACTS

- Gila River Indian Community
- Hopi Tribe

- Pascua Yaqui Tribe
- Salt River Pima-Maricopa Indian Community
- San Carlos Apache Nation
- White Mountain Apache Tribe
- Yavapai-Apache Nation

8.0 THE PREFERRED ALTERNATIVE

8.1 RATIONALE FOR ALTERNATIVE PREFERENCE

The Preferred Alternative is Alternative 2 – Decommissioning. The decommissioning will be accomplished by replacing the Powerline FRS and Powerline IDSM with a 100-year channel to discharge to the Vineyard Road FRS. The decommissioning alternative will meet the plan purpose of flood prevention and the Sponsor's formulation goal of providing continued flood protection and eliminating the existing safety deficiencies associated with the Powerline FRS. The existing FRS would no longer be defined as a jurisdictional dam by ADWR. A plan schematic/exhibit for Alternative 2 is included in **Appendix C**.

The NRCS has identified in their memorandum with the subject of "*NED Alternative and Preferred Alternative for the PVR FRS Rehabilitation Project*" (NRCS, Jan. 2013) that the NED alternative (least-cost technically-feasible) is identified as consisting of the following major components and filter options for the Powerline FRS, Vineyard Road FRS and Rittenhouse FRS:

- Replace Powerline FRS with 100-year channels with hardened segments;
- Raise and rehabilitate Vineyard Road FRS with the 'hybrid" filter option;
- Convert Rittenhouse FRS to a levee.

The approximate total project cost for this NED alternative/filter options is $83M as noted in the Level III report and is reported as the least cost alternative. This alternative describes Alternative 2 and is the NED Plan for the Powerline FRS.

Consistent with P&G, the alternative that has the highest positive net benefits would be identified as the NED Plan. However, per Section 502.2 of the NRCS National Watershed Program Manual, "In cases where human life is at risk in the event of catastrophic failure of an existing dam that does not meet current safety and performance standards, an overriding reason for an exception to the NED plan requirement exists. To avoid seeking individual exceptions in such cases, the NED plan is defined as the federally assisted alternative with the greatest net economic benefits."

Section 5.2 presented a discussion of Alternatives 8B and 8A in relation to the Preferred Alternative and the NED Plan. As noted Alternatives 8A and 8B were carried forward into a Level III analysis (*Level III Final Alternatives Summary Report* – KHA January 2013). The Level III analysis conducted further evaluations of Alternatives 8A and 8B. Both alternatives are identical in the replacement of Powerline FRS with a new 100-year flood channel. The alternatives differ in the treatment of Rittenhouse FRS and in the filter treatments for Vineyard Road FRS and Rittenhouse FRS in Alternative 8B. The Level III report identified the Preferred Alternative as Alternative 8A with the option of a 'hybrid' filter for the dam rehabilitation of Vineyard Road FRS, converting the Rittenhouse FRS to a levee, and replacing Powerline FRS with a 100-year channel.

The Preferred Alternative and the NED Plan for the Powerline Channel is one in the same for this Plan/EA. The Preferred Alternative and NED Plan for the Vineyard Road FRS and Rittenhouse FRS are provided in the "*Final Supplemental Watershed Plan and Environmental Assessment for the Vineyard Road FRS and Rittenhouse FRS*" (Kimley-Horn April 2013).

8.2 MEASURES TO BE INSTALLED

The features of the Preferred Alternative are summarized below which are based on the results of the technical investigations and analyses, and in accordance with the Sponsor and NRCS requirements.

8.2.1 POWERLINE CHANNEL

The concept for the Preferred Alternative includes constructing a new 100-year channel upstream of Powerline FRS and removing both the existing FRS and IDSM embankments. The proposed Powerline channel was sized using the existing conditions 100-year discharge. Typical cross sections are provided in **Appendix C** as **Figure C-6**. The Powerline channel is comprised of two channels. The first is a collector channel running along the existing FRS alignment to capture inflow that would otherwise reach the structure. The second channel is specifically for Siphon Draw, the largest wash within the watershed. The two channels combine before discharging into the Vineyard Road FRS flood pool.

The channels were initially sized using normal depth routing within HEC-1. The preliminary channel sizes were then input into the FLO-2D model. Where breakouts occurred from potential channel overtopping, the channel sizes were increased to provide additional capacity. The resulting bottom widths and geometries of the two proposed channels are summarized in **Table 8-1**.

Table 8-1 Summary of Powerline Channel Geometry and Results.

Powerline Channel									
				Design Parameters			Analysis Results		
Hydrologic Segment	**Start Station**	**End Station**	**Lining**	**Channel Bottom Width [ft]**	**Total Depth[1] [ft]**	**Side Slopes [ft:ft] [H:1]**	**Peak Discharge[2] [cfs]**	**Depth of Flow[3] [ft]**	**Velocity[3] [ft/s]**
CP25	10+00	27+50	Earthen	60	5.1	6	984	4.0	2.9
CP25 Hardened	27+50	46+50	Hardened	60	3.0	2	939	2.0	7.2
CP9	46+50	61+50	Earthen	150	6.2	6	3,153	4.9	3.6
CP5R Hardened	61+50	77+50	Hardened	150	5.8	2	7,746	4.2	11.7
CP5R	77+50	Vineyard Flood Pool	Earthen	500	5.6	6	8,129	4.4	3.5
CP4 (Siphon Draw)			Earthen	1000	4.1	6	13,444	3.1	4.2

[1] Total depth including freeboard
[2] Peak discharge reported from FLO-2D results
[3] Depth of flow and velocity reported from FlowMaster normal depth calculations

Segments of the proposed collector channel will be hardened with concrete as shown in the typical section in **Appendix C**. The available earth fissure risk hazard mapping at this level of analysis does not fully cover the proposed channel limits so existing mapping zones were projected upstream. A map of Fissure Risk Hazard Zones (FRZs) is provided in **Appendix C**. The segments of the channel crossing a yellow moderate FRZs will be hardened structures (concrete lined) with upstream and downstream permeable backfill trenches wrapped in geotextile. Channel segments in

green FRZs will be earth-lined channels. The Powerline channel drains into the Vineyard Road FRS flood pool upstream of the north auxiliary spillway. The excess spoil material from the channel excavation is anticipated to be stockpiled within the Sponsor's easement at locations to be determined with the land owner – Arizona State Land Department.

8.2.2 POWERLINE NORTH DIVERSION CHANNEL

The section of the Powerline North Diversion Channel between Highway 60 and Baseline Road has several local washes entering the channel from the east. The confluence of the washes with the channel is experiencing erosion and local headcutting up into the washes. Stabilization of the channel banks and confluences with the local washes has been conceptually developed and an exhibit is provided in **Appendix C**. Construction cost estimates to stabilize the channel cross section have also been developed.

The existing channel at Baseline Road is headcutting into the right-of-way of Baseline Road and into the Baseline Road embankment fill on the south side of the road. Stabilization of the channel at this location consists of rock-filled gabion baskets for grade control and rock riprap for scour protection. Exhibits showing the locations of the channel improvements are included in **Appendix C** as **Figure C-8**. The 48-in culverts under Baseline Road will be replaced with two 10-ft wide by 6-ft high box culverts similar to the crossing under US 60.

8.2.3 POWERLINE FRS EMBANKMENT REMOVAL

The Preferred Alternative includes construction costs to remove the embankment for the Powerline FRS and the Powerline IDSM. The removal of the embankments would occur after construction of the new Powerline Channel. The location of the embankments would be graded, stabilized, and hydroseeded with native plant mix. The excess spoil material from the embankment removal is anticipated to be stockpiled within the Sponsor's easement at locations to be determined with the land owner – Arizona State Land Department.

8.3 MITIGATION FEATURES

Clearing and excavation of a new Powerline 100-year channel, improvements to the North Diversion Channel, and FRS and IDSM removal and construction of an O&M road on either side of the channel will temporarily disturb existing vegetation including portions of the existing mesquite bosque. Disturbed areas due to construction activities will be hydro-seeded with native plant mix. An estimated 120 acres of mesquite bosque will be directly impacted by construction of the project. Mesquite bosque mitigation may include planting new tall-pot mesquite trees (approximately 60 acres) and salvage of some mature mesquite trees and transplanting in designated areas (e.g., along Powerline Channel, and potential mitigation area at north end of Vineyard Road FRS). The Sponsor and NRCS will coordinate with ASLD regarding trees along the existing low flow channel along the Powerline FRS. Mitigation plans will be refined during final design in consultation with the Arizona Game and Fish Department.

The proposed undertaking will have an adverse effect on cultural resources in the construction zones and possibly on other cultural resources within the project's area of potential effects (APE). All cultural resources in the APE have been identified by performing a records review and an intensive cultural resources field survey. In consultation with the State Historic Preservation Officer (SHPO), Indian tribes who have identified the project area as part of their ancestral territory, land owners, and cooperating entities, cultural resources in the APE that will not be subject to project-related impacts will be avoided by project implementation activities, and cultural

resources that are determined to be historic properties will be subjected to data recovery studies to mitigate impacts. The data recovery mitigation may be conducted in a phased approach in consultation with the SHPO, tribes, land owners, and cooperators.

Weed prevention methods will be implemented during construction activities. These methods will be determined in final design but may include: use of certified weed free seed, sterilized straw mulch with a tackifier so the straw mulch holds onto the ground, washing vehicles off before they enter the site, and managing adjacent weed populations to the extent possible (to prevent seed drift). Also, the use of pre-emergent herbicide could be considered for any non-planted areas that will be plated with Decomposed Granite or Rip Rap. A further measure would be to not allow weeds to colonize any soil stockpile areas before the re-use of the stored soil on site.

Erosion control measures, both temporary during construction and permanent measures will be installed. Erosion control will be specified in the NRCS contract specifications. **Section 8.4** below states the Sponsors are responsible for a 402 National Pollutant Discharge Elimination System Permit (NPDES) for Stormwater from Construction Sites which includes the preparation of a Stormwater Pollution Prevention Plan (SWPPP).

The installation activities will be required to conform with local and county dust control regulations and measures. Dust control will be specified in the NRCS contract specifications.

8.4 PERMITS AND COMPLIANCE

The Sponsors are responsible for all permits, including a 402 National Pollutant Discharge Elimination System Permit (NPDES) for Stormwater from Construction Sites from the Arizona Department of Environmental Quality, and submittal Form SCS-ADS- 78 (Real Property Assurances).

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.

If during the installation cultural resources are discovered, all work activities associated with the installation activity will stop and procedures detailing cultural resources discovered during implementation will be implemented per NRCS contract specifications. All work will comply with Arizona State Level Agreement, NRCS General Manual 420 Part 401, the National Cultural Resources Procedures Handbook [H 190 Part 601], and A.R.S. § 41-841 *et seq*. Cultural resources investigations on State-owned or State-controlled lands will be conducted under a permit issued by the Arizona State Museum pursuant to the Arizona Antiquities Act (A.R.S. § 41-841 et seq.).

An encroachment permit may be required from the CAP for construction within the CAP canal right-of-way.

8.5 COSTS

The estimated total installation cost for the Preferred Alternative is $23,893,800. This estimated total installation cost includes the cost of construction plus NRCS engineering and project administration costs, as well as the Sponsor's engineering, and project administration costs. The

Sponsor's planning costs for the project were estimated at $716,860 which was not included in above figure.

NRCS **Tables 1** through **6** are included in this section of this Plan-EA and presents information about the Preferred Alternative. The costs shown in **Tables 1** and **2** for the planned decommissioning work were estimated using a 2012 price level. Annual costs were based on a 2012 discount rate of 3.75% over a project life of 103-years. **Table 3** summarizes important physical characteristics of the existing dam. **Tables 4**, **5**, and **6** highlight the amortized or annual average dollar costs and benefits for the planned decommissioning work. An outline of the table contents follows:

- Table 1. Estimated Installation Cost: This table documents the federal and non-federal funding sources respectively. The table shows federal expenditures under the Watershed Protection and Flood Prevention Act (PL 83-566).
- 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 3b. Structure Data-Channel Work: This table shows important physical characteristics and geometry for the proposed channel improvements (Powerline Channel, North Diversion Channel).
- Table 4. Estimated Average Annual National Economic Development (NED) Cost: This table shows the anticipated installation costs of the Preferred Alternative discounted over the evaluation period of 103 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 NED Benefits and Costs: This table summarizes the benefits and costs of the Preferred Alternative and documents the overall benefit-to-cost ratio of the proposed project.

8.6 INSTALLATION AND FINANCING

8.6.1 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.

8.6.2 PLANNED SEQUENCE OF INSTALLATION

The major construction elements in the Preferred Alternative can be divided into the Powerline Channel, the North Diversion Channel, and removal/breach of the existing dam embankment.

The new Powerline Channel, North Diversion Channel, and removal of the existing dam embankment should not occur until the work on the rehabilitated Vineyard Road FRS is completed (under the *Vineyard Road and Rittenhouse FRS Supplemental Watershed Plan and Environmental Assessment Project*). However, the order of construction sequence for the Preferred Alternative is to construct the Powerline Channel first beginning with the confluence of the channel into the Vineyard Road FRS. The channel should be constructed from downstream to upstream and include

the major side/confluences with Siphon Draw and Weekes Wash. The North Diversion Channel improvements could be constructed next. Once construction of the channels are completed, the existing Powerline FRS and IDSM embankments may be removed and the footprints stabilized. Erosion protection measures may be placed when grading is completed for the specific elements.

8.6.3 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.

The NRCS will provide technical assistance to the Sponsors with the design and construction of the decommissioning project. NRCS will:

- Provide contract administration technical assistance
- Provide construction management technical assistance
- Provide financial assistance equal to 65% of project costs, not to exceed 100% of actual construction costs
- Execute a cooperative agreement with 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.

The Sponsors will:

- Secure all needed permits, easements (if required), and rights for installation, operation, and maintenance of the new channels.
- It is anticipated that some utilities will require relocation and/or protection (including a waterline located along the existing Powerline FRS auxiliary spillway which is owned by others). Utilities need to be researched as part of the design phase of the project. Utility relocations are the responsibility of the utility owner.
- 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. 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 the channels.
- Execute an updated Operation and Maintenance agreement with NRCS for the Powerline Channel and North Diversion Channel.
- Execute a cooperative agreement with NRCS 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.
- Provide nonfederal funds for cost-sharing of the project at a rate equal to, or greater than, 35% of project costs.
- Provide local administrative and construction management services necessary for installation of the project.
- Comply with all applicable Federal, State, and local floodplain management laws, ordinances and regulations.

- Be responsible for enforcing all associated project easements and rights-of-way.

The Flood Control District of Maricopa County will provide technical leadership for the installation, operation, and maintenance of the structural measures installed under the Supplemental Watershed Plan and Environmental Assessment. The NRCS will work closely with the Sponsor in the development of an operation and maintenance plan and will participate in annual inspections jointly with the Sponsor and the State Office of Dam Safety.

Contracts to implement the Preferred Alternative measures will be between the District and the selected construction firm. The NRCS will facilitate the request for funding from appropriations for the dam rehabilitation program. The NRCS will provide the financial assistance to the District by means of a cooperative agreement.

All works of improvement will be installed in accordance with NRCS standards and specifications and meet all applicable local, state, and Federal regulations.

8.6.4 Real Property and Relocations

Implementation of the Preferred Alternative will not require procurement of real property rights by the Sponsors.

- Additional temporary work easements for over excavation, loading, and unloading may be required in the vicinity of the CAP canal for removal of the existing dam embankment. Areas for construction staging and stockpiling can be located within 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.

8.6.5 Other Agencies

- The decommissioning plan will require review and concurrence from the ADWR Dam Safety Division.
- Hauling on local roadways will likely require a haul-road permit that will be the responsibility of the construction contractor.

8.6.6 Financing

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

8.6.7 Operation, Maintenance, and Replacement

The Flood Control District of Maricopa County will operate and maintain the Powerline Channel. The operation, maintenance, and replacement program is carried out as prescribed in the Operation and Maintenance Agreement. A new O&M agreement between the Sponsors and NRCS will be written and executed prior to the beginning of construction. The agreement is developed in accordance with the NRCS National Operation and 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 channel.
- Rodent control.
- 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 channel; 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 Preferred Alternative is $212,700 (see NRCS **Table 4** in Section 8.7).

8.7 NRCS NATIONAL WATERSHED MANUAL TABLES

NRCS Table 1 - Estimated Installation Cost

Powerline FRS

Apache Junction-Gilbert Watershed, Maricopa and Pinal Counties, AZ

(Dollars) [1/]

Installation Cost Item	Unit	Number	Estimated Cost[1/2/3]		
			Federal Funds	Other Funds	Total
Replacement of Powerline FRS	No.	1	$15,942,200	$7,951,600	$23,893,800
Total Project			$15,942,200	$7,951,600	$23,893,800

January 2013

1/ 2012 Prices.
2/ Federal Funds include NRCS Engineering Services and Project Administration ($650,000), which are not included when calculating eligible federal cost share. Permit costs ($434,300) are also not included.
3/ The Sponsor's planning costs ($716,900) are not included in this table. However, these costs are included when calculating eligible federal cost share.

NRCS Table 2 - Estimated Cost Distribution - Structural and Non-Structural Measures

Powerline FRS

Apache Junction-Gilbert Watershed, Maricopa and Pinal Counties, AZ
(Dollars) [1/]

Works of Improvement	Installation Cost ----------Federal Funds[2/]---------				Installation Costs ----------Other Funds----------						Total Installation Cost
	Construction	Engineering Services	Project Admin.	Total Federal Funds	Construction	Engineering Services	Real Property Rights	Required Permits	Project Admin.	Total Other Funds	
Replacement of Powerline FRS	$15,292,200	$600,000	$50,000	$15,942,200	$6,855,800	$651,500	$0	$434,300	$10,000	$7,951,600	$23,893,800
Grand Total	$15,292,200	$600,000	$50,000	$15,942,200	$6,855,800	$651,500	$0	$434,300	$10,000	$7,951,600	$23,893,800

January 2013

1/ Price Base: 2012
2/ Federal Engineering Services and Project Administration costs, as well as permit costs, are not included when calculating eligible federal cost share.
3/ The Sponsor's planning costs are not included in this table. However, these costs are included when calculating eligible federal cost share.

NRCS Table 3b - Structural Data – Channel Work, **Powerline FRS** Apache Junction-Gilbert Watershed, Maricopa and Pinal Counties, AZ

						Channel Dimensions				n-Value		Velocities (ft/s)					
Channel Name (Reach)	**Station**	**Drain Area (mi^2)**	**100 Year Freq Design Discharge (ft^3/s)**	**Water Surface Elevation Feet (msl)**	**Hydraulic Gradient (ft/ft)**	**Gradient (ft/ft)**	**Bottom Width (ft)**	**Elevation (ft/msl)**	**Side Slope**	**Aged**	**As-Built**	**Aged**	**As-Built**	**Excavation Volume (yd^3)**	**Type of Work 1/**	**Existing Channel Type 2/**	**Present Flow Condition 3/**
CP25	10+00 to 27+50	2.1	984	1602.0 1597.1	0.0017	0.0017	60	1598.0 1595.1	6	0.045	-	2.9	-	13,900	I	O	E
CP25 Hardened	27+50 to 46+50	2.1	939	1597.1 1593.8	0.0017	0.0017	60	1595.1 1591.8	2	0.013	-	7.0	-	13,800	I	O	E
CP9	46+50 to 61+50	12.5	3,153	1593.8 1594.1	0.0017	0.0017	150	1591.8 1589.2	6	0.045	-	3.4	-	30,600	I	O	E
CP5R Hardened	61+50 to 77+50	21.5	7,746	1594.1 1590.7	0.0017	0.0017	150	1589.2 1586.5	2	0.013	-	11.0	-	48,700	I	O	E
CP5R	77+50 to Vineyard Road Flood Pool	21.5	8,129	1590.7 1580.4	0.0017	0.0017	500	1586.5 1576.0	6	0.045	-	3.3	-	911,900	I	O	E
CP4 (Siphon Draw)		25.2	13,444	1599.0 1579.1	0.0037	0.0037	1000	1595.9 1576.0	6	0.045	-	4.1	-	455,500	I	O	E

1/ I-Establishment of new channel including necessary stabilization measures

January 2013

II-Enlargement or realignment of existing channel or stream

III-Cleaning out natural or manmade channel (including bar removal and major clearing and snagging operations)

IV-Clearing and removal of loose debris within channel section

V-Stabilization as primary purpose (by continuous treatment or localized problem areas-present capacity adequate)

2/ N-An unmodified, well-defined natural channel or stream

M-Manmade ditch or previously modified channel or stream (show approximate date of original construction in parenthesis)

O-None or practically no defined channel

3/ Pr: Perennial - Flows at all times except during extreme drought

I: Intermittent - Continuous flow through some seasons of the year

E: Ephemeral - Flows only during periods of surface runoff, otherwise dry

S: Ponded water with no noticeable flow-caused by lack of outlet or high groundwater table

NRCS Table 4 - Estimated Average Annual National Economic Development (NED) Costs

Powerline FRS

Apache Junction-Gilbert Watershed, Maricopa and Pinal Counties, AZ
(Dollars) [1/]

Works of Improvement	----------Project Outlays----------		Total
	Amortization of Rehabilitation Cost[2/]	Operation, Maintenance and Replacement Cost	
Powerline FRS	$794,000	$212,700	$1,006,700
TOTAL	$794,000	$212,700	$1,006,700

January 2013

1/ Price Base 2012.

2/ Amortized for 102 years at 3.750 percent.

NRCS Table 5 - Estimated Average Annual Flood Damage Reduction Benefits
Powerline FRS
Apache Junction-Gilbert Watershed, Maricopa and Pinal Counties, AZ
(Dollars) [1/]

Item	Future With Project		Future Without Project		Total Damage Reduction Benefits	Benefits of All Alternatives (Average Annual Equivalent Value[2])
	Ag. Related	Non-Ag. Related	Ag. Related	Non-Ag. Related		
Floodwater						
Residential		$13,113,100		$13,113,100	$0	$0
Commercial/Industrial		$80,700		$80,700	$0	$0
Institutional		$32,500		$32,500	$0	$0
Agriculture	$677,300		$677,300		$0	$0
Infrastructure						
Roadways		$8,100		$8,100	$0	$0
Irrigation Canal	$100		$100		$0	$0
Insurance Administration Costs		$309,000		$309,000	$0	$0
TOTAL	**$677,400**	**$13,543,400**	**$677,400**	**$13,543,400**	**$0**	**$0**

January 2013

1/ Price Base 2012. Amortized for 103 years at 3.75 percent.

2/ Calculated as follows: calculate present value of damage reduction in each year, sum the present values, and then calculate the amortized annual amount ("average equivalent value") that would yield the present value sum. Present value and amortization use the discount rate of 3.75%. The benefits of the project are tied to reducing the risk of catastrophic failure of the existing structures and thus reducing the risk to life and property, as described in the plan.

NRCS Table 6 - Comparison of NED Benefits and Costs

Powerline FRS

Apache Junction-Gilbert Watershed, Maricopa and Pinal Counties, AZ

(Dollars) [1/]

Works of Improvement	Average Annual Benefits (Ag-Related)	Average Annual Benefits (Non Ag-Related)	Average Annual Costs[2/]	Benefit/ Cost Ratio[3/]
Powerline FRS	$0	$0	$1,006,700	0.0 to 1.0

January 2013

1/ Price Base 2012.
2/ From Table 4.

3/ The proposed project will provide an estimated $14,779,300 in average annual equivalent damage reduction benefits. However, as the "no action" or future without project alternative also provides this same benefit stream, the project does not have a positive incremental NED benefit. The benefits of the project are tied to reducing the risk of catastrophic failure of the existing structures and thus reducing the risk to life and property, as described in the plan.

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10.0 LIST OF PREPARERS

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

Table 10-1 List of Preparers

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Appendix A Comments and Responses

Summary of Comments and Responses

1. One letter of comment was received from the Arizona Game and Fish Department during interagency review of the Draft Plan/EA. This letter and the associated response letter are included in this appendix.

2. One email message and two additional letters of comment were also received. These comments and associated responses are summarized below:

    - Comment from Arizona Department of Environmental Quality: 'After reviewing the Draft Environmental Assessments, ADEQ has no comments related to water quality that were not already addressed.'

    - Response: No response required.

    - Comment from Flood Control District of Maricopa County: 'The levee criteria should state more of the 44 CFR 65.10 freeboard criteria: a minimum of 3.5 feet at the upstream end tapering to 3 feet at the downstream and 4 feet near structures (drop structures or future bridges, etc.).'

    - Response: We will incorporate your comments into the Plan/EA with the goal of attaining the minimum freeboard requirement, per FEMA 44CFR 65.1 0, during final design of this structure.

    - Comment from U.S. Bureau of Land Management: 'We have determined the project's planned improvements and associated effects do not influence BLM-administered lands.'

    - Response: No response required.

3. Additional Correspondence included:

    - Department of the Army, Los Angeles District Corps of Engineers Arizona-Nevada Office. "Approved Jurisdictional Determination Regarding Presence/Absence of Geographic Jurisdiction". (SPL-2012-00406-MWL). February 11, 2013.

THE STATE OF ARIZONA
GAME AND FISH DEPARTMENT
5000 W. CAREFREE HIGHWAY
PHOENIX, AZ 85086-5000
(602) 942-3000 • WWW.AZGFD.GOV
REGION VI, 7200 E. UNIVERSITY DRIVE, MESA, AZ 85207

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DIRECTOR
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DEPUTY DIRECTORS
GARY R. HOVATTER
BOB BROSCHEID

March 29, 2013

Felicia Terry, P.E., CFM
District Project Manager
Flood Control District of Maricopa County
Phoenix, Arizona

Re: Comments the Draft Supplemental Watershed Plans and Environmental Assessments for the Vineyard Road, Rittenhouse and Powerline Flood Retarding Structures

Dear Ms. Terry,

The Arizona Game and Fish Department (Department) appreciates the opportunity to provide review and comment on the above titled documents located in northwest Pinal County, south of Apache Junction and parallel to the Central Arizona Project (CAP) canal between Baseline and Ocotillo Roads. We recently met with you regarding the project and appreciate the opportunity for continued coordination throughout the process. We offer the following additional comments for consideration in the documentation.

We appreciate the opportunity to work with you to identify where areas of connectivity and habitat would be most important to protect. The Department is currently finalizing the Pinal County Wildlife Connectivity Assessment: Report on Stakeholder Input that identifies wildlife linkages within the project area: riparian, landscape and diffuse movement areas as we discussed in our recent meeting. This includes the CAP identified as a landscape movement as well as a barrier area, as there is opportunity for wildlife to move along and across the canal. In addition, riparian and diffuse movement areas have been identified within the project vicinity and could be identified within the document. Those areas as discussed in our recent meeting include the riparian stringers coming into the project area along with the mesquite bosques.

The Department recognizes efforts put forth through mitigation for minimizing and/or avoiding removal and/or modification of the mesquite bosque habitat within the project area and will continue to work with you on the associated planning. The creosote flat habitat within the area adjacent to the structures is of value to the wildlife in its current natural pattern and has documented utilization by a diversity of species. We recommend avoiding, minimizing and/or mitigating for any compaction of soil and degradation of vegetation in the flat areas to the greatest extent possible. This would also benefit the future planned development areas as aesthetically, it would provide for more a natural visual character within the largely creosote flat and natural drainage patterns occurring on the landscape. In addition, we recommend use of soft structural modifications as opposed to the hardening, channelization and landscape scraping in

order to meet wildlife needs and we recognize those efforts made in the preferred alternative to minimize those hardened structures to only where necessary.

As you know, the project area contains several species of wildlife including burrowing owl, kit fox, desert tortoise, coyote, badger, quail, dove, mule deer and javelina, documented along these structures from bedding down in the mesquite bosque habitat, to tracks along the drainages connecting to the FRS structures (please see attached extensive list from HabiMap™, Species of Greatest Conservation Need). Species of economic importance in this area includes: javelina, deer, quail and doves. We recommend additional survey work in your project area to further assess Tucson shovel-nosed snake and desert tortoise presence at the specific areas of concern. The most recent published report 2012 (attached) for the snake indicated presence north of Florence on and north of the Florence Military Reservation and indicates adjacent habitats, to include the project area, also as suitable for the gartersnake. In addition, a cluster of records just to the west of the project area has also been documented. Construction activity should avoid Mid March thru May to account for breeding times (burrowing owl, gambels quail) and potentially extended through June for the snake (http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=C06D). Surveys should be conducted immediately prior to, or during, construction in order to reduce the possibility of impacting key species, species of concern and species of greatest conservation need. Michael Ingraldi from the Wildlife Contracts Branch (928)532-5625 would be able to assist you with cost estimates for these kinds of surveys. If encountered during any phase of construction, we recommend contacting Department personnel for appropriate measures to be taken to move these animals out of the footprint with little or no impact to construction timelines. Use of heavy equipment should be kept to the project footprint as much as feasible. Traffic into and out of the construction area should be kept to a minimum to limit the potential for an extended footprint and additional habitat loss.

The Department appreciates the mitigation measures put forward for the vegetation reseeding and mesquite plantings, along with those identified for the Tucson shovel-nosed snake, desert tortoise and burrowing owls. We understand these mitigation measures would be further defined in the final design of the project and we look forward to the further coordination on the design plan.

Again, we appreciate the opportunity to continue to provide comments on the proposed project and work collaboratively through the final design planning process. Please contact me @ kwolff-krauter@azgfd.gov , if you have any questions regarding this letter.

Sincerely,

Kelly Wolff-Krauter

Kelly Wolff-Krauter
Region VI Habitat Program Manager

cc: Rod Lucas, Regional Supervisor, Region VI
Tim Holt, Field Supervisor, Region VI
Laura Canaca, Project Evaluation Program Supervisor

M13-02155023

Flood Control District
of Maricopa County

Board of Directors
Denny Barney, District 1
Steve Chucri, District 2
Andrew Kunasek, District 3
Max W. Wilson, District 4
Mary Rose Wilcox, District 5

www.fcd.maricopa.gov

2801 West Durango Street
Phoenix, Arizona 85009
Phone: 602-506-1501
Fax: 602-506-4601
TT: 602-505-5897

April 15, 2013

Ms. Kelly Wolff-Krauter
Region VI Habitat Program Manager
Arizona Game and Fish Department
7200 E. University Drive
Mesa, Arizona 85207

Dear Ms. Wolff-Krauter:

Thank you for your letter dated March 29, 2013 regarding the Draft Supplemental Watershed Plans and Environmental Assessments (Plans/EAs) for the Powerline, Vineyard Road and Rittenhouse Flood Retarding Structures Rehabilitation or Replacement Project. We also appreciate the recent meeting among Arizona Game and Fish Department (AGFD), Natural Resources Conservation Service (NRCS), and Flood Control District of Maricopa County (FCDMC) personnel to discuss wildlife and habitat needs and concerns in the project vicinity. We are pleased to provide the following specific responses to your comments:

Comment: We appreciate the opportunity to work with you to identify where areas of connectivity and habitat would be most important to protect…In addition, riparian and diffuse movement areas have been identified within the project vicinity and could be identified within the document.

Response: We agree and will continue to work with the AGFD to identify and maintain or improve wildlife linkages within the project area. As discussed, we will reference the "Pinal County Wildlife Connectivity Assessment: Report on Stakeholder Input" in the Final Plans/EAs. We will incorporate the information contained in this report, along with any additional input provided by AGFD, during the design phase of the project.

Comment: The Department recognizes efforts put forth through mitigation for minimizing and/or avoiding removal and/or modification of the mesquite bosque habitat within the project area and will continue to work with you on the associated planning.

Response: We will continue to work with AGFD during project implementation on the mutual goal of avoiding and minimizing impacts to the mesquite bosque. Further, we will consult with AGFD as plans and designs are prepared for mitigation of impacted areas.

Comment: The creosote flat habitat within the area adjacent to the structures is of value to the wildlife in its current natural pattern and has documented utilization by a diversity of species. We recommend avoiding, minimizing and/or mitigating for any compaction of soil and degradation of vegetation in the flat areas to the greatest extent possible.

Response: We commit to minimizing the footprint of construction areas, borrow areas, and other disturbance areas to the extent possible during project implementation. As outlined in the Plans/EAs, all disturbed areas will be hydro-seeded with a native plant mix.

Comment: In addition, we recommend use of soft structural modifications as opposed to the hardening, channelization and landscape scraping in order to meet wildlife needs and we recognize those efforts made in the preferred alternative to minimize those hardened structures to only where necessary.

Response: As discussed in the Plans/EAs, the location and extent of channel hardening (if required) will be limited to fissure risk zones as further defined during final design.

Comment: We recommend additional survey work in your project area to further assess Tucson shovel-nosed snake and desert tortoise presence at the specific areas of concern…Surveys should be conducted immediately prior to, or during, construction in order to reduce the possibility of impacting key species, species of concern and species of greatest conservation need…If encountered during any phase of construction, we recommend contacting Department personnel for appropriate measures to be taken to move these animals out of the footprint with little or no impact to construction timelines.

Response: As discussed in the Plans/EAs, and per NRCS and FCDMC policy, surveys for these species will be performed prior to project construction. During construction, in the event any special status species are encountered, AGFD will be contacted and proper handling procedures will be followed.

Comment: Construction activity should avoid Mid March thru May to account for breeding times (burrowing owl, gambels quail) and potentially extended through June for the snake.

Response: The construction of the project will be performed in construction phases, details pending final design and project funding. However, in general a construction phase for this large regional flood control project can be anticipated to take from a minimum of a full year of continuous construction activities up to a maximum of about 2 years of the same. The District's current practice in such situations is to use our on-call biological services consultants to do nesting bird surveys 2-3 times per week during breeding bird season if clearing and grubbing activities for any project phase will take place during that time. Additionally, prior to the start of disturbance in a given project area, where there is appropriate habitat, we have our biological

consultants survey for the presence of burrowing owls and desert tortoises. We will be asking for guidance from AZGFD on the best approach for surveying for the Tucson Shovel-nosed Snake which we understand might possibly be present in the area. We are of course willing to discuss any further guidance or procedures AGFD may recommend in this regard.

Comment: Use of heavy equipment should be kept to the project footprint as much as feasible. Traffic into and out of the construction area should be kept to a minimum to limit the potential for an extended footprint and additional habitat loss.

Response: To the extent practical, equipment use and vehicle traffic will be kept to the project footprint and designated routes. As noted above, any disturbed areas will be hydro-seeded.

Comment: Again, we appreciate the opportunity to continue to provide comments on the proposed project and work collaboratively through the final design planning process.

Response: We commit to continuing to work with AGFD during the implementation of this project to ensure impacts to wildlife and habitat are avoided, minimized, and mitigated where necessary using the best available technical guidance and procedures.

In closing, thank you again for your helpful comments and we look forward to further cooperation on this important project as we move proceed into the implementation phase.

Sincerely,

Felicia Terry

Felicia Terry, P.E., CFM
Project Manager

DEPARTMENT OF THE ARMY
LOS ANGELES DISTRICT CORPS OF ENGINEERS
ARIZONA-NEVADA OFFICE
3636 NORTH CENTRAL AVENUE, SUITE 900
PHOENIX, AZ 85012-1939

February 11, 2013

REPLY TO
ATTENTION OF

Office of the Chief
Regulatory Division

Jennifer Tremayne
Kimley-Horn and Associates, Inc.
7740 North 16th Street, Suite 300
Phoenix, Arizona 85020

SUBJECT: Approved Jurisdictional Determination Regarding Presence/Absence of Geographic Jurisdiction

Dear Ms. Tremayne:

I am referring to your request (File No. SPL-2012-00406-MWL) dated June 6, 2012, for an approved Department of the Army jurisdictional determination (JD) for the Powerline, Vineyard Road, & Rittenhouse Flood Retarding Structures Rehabilitation or Replacement Project site located within/near the City of Apache Junction, Pinal, Arizona.

As you may know, the Corps' evaluation process for determining whether or not a Department of the Army permit is needed involves two tests. If both tests are met, then a permit is required. The first test determines whether or not the proposed project is located in a water of the United States (i.e., it is within the Corps' geographic jurisdiction). The second test determines whether or not the proposed project is a regulated activity under Section 10 of the River and Harbor Act or Section 404 of the Clean Water Act. As part of the evaluation process, pertaining to the first test only, we have made the jurisdictional determination below.

Based on available information, we have determined are no waters of the United States on the project site in the locations depicted on the enclosed drawings. The basis for our determination can be found in the enclosed JD form(s).

This letter contains an approved jurisdictional determination for the Powerline, Vineyard Road, & Rittenhouse Flood Retarding Structures Rehabilitation or Replacement Project site. If you object to this decision, you may request an administrative appeal under Corps regulations at 33 CFR Part 331. Enclosed you will find a Notification of Appeal Process (NAP) fact sheet (Appendix A) and Request for Appeal (RFA) form. If you request to appeal this decision you must submit a completed RFA form to the Corps South Pacific Division Office at the following address:

Tom Cavanaugh
Administrative Appeal Review Officer,
U.S. Army Corps of Engineers
South Pacific Division, CESPD-PDS-O, 2042B
1455 Market Street, San Francisco, California 94103-1399

In order for an RFA to be accepted by the Corps, the Corps must determine that it is complete, that it meets the criteria for appeal under 33 C.F.R. Part 331.5, and that it has been received by the Division Office within 60 days of the date on the NAP. Should you decide to submit an RFA form, it must be received at the above address by April 12, 2013. It is not necessary to submit an RFA form to the Division office if you do not object to the decision in this letter.

This verification is valid for five years from the date of this letter, unless new information warrants revision of the determination before the expiration date. If you wish to submit new information regarding the approved jurisdictional determination for this site, please submit this information to Michael Langley at the letterhead address by April 12, 2013. The Corps will consider any new information so submitted and respond within 60 days by either revising the prior determination, if appropriate, or reissuing the prior determination. A revised or reissued jurisdictional determination can be appealed as described above.

This determination has been conducted to identify the extent of the Corps' Clean Water Act jurisdiction on the particular project site identified in your request. This determination may not be valid for the wetland conservation provisions of the Food Security Act of 1985. If you or your tenant are USDA program participants, or anticipate participation in USDA programs, you should request a certified wetland determination from the local office of the Natural Resources Conservation Service, prior to starting work.

If you have any questions, please contact Michael Langley of my staff at 602-230-6953 or via e-mail at Michael.W.Langley@usace.army.mil.

Please be advised that you can now comment on your experience with Regulatory Division by accessing the Corps web-based customer survey form at: http://per2.nwp.usace.army.mil/survey.html.

"Building Strong and Taking Care of People!"

Sincerely,

Sallie McGuire

Sallie D. McGuire
Chief, Arizona Branch
Regulatory Division

Enclosures

Appendix B Project Map

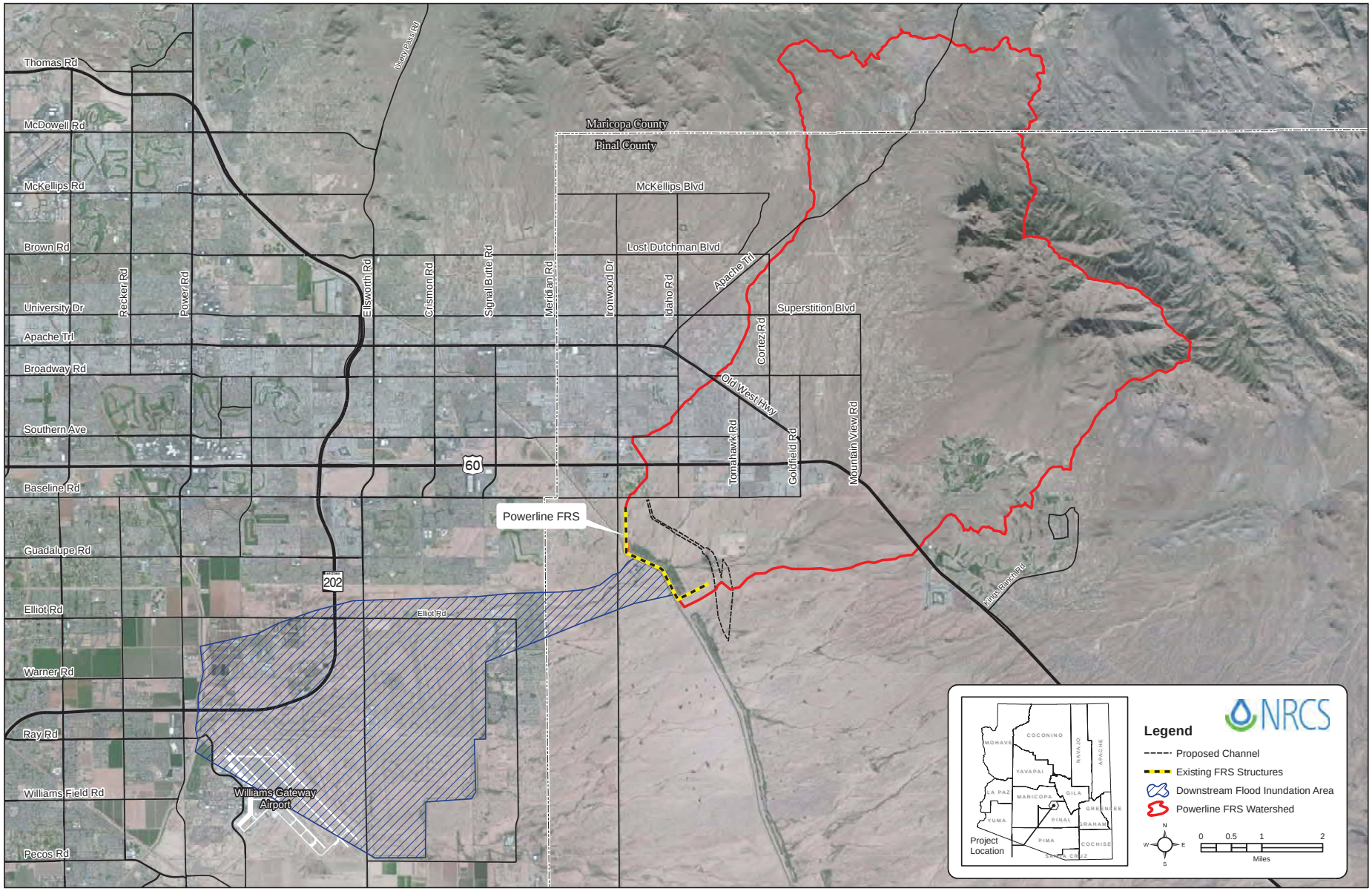


Figure B-1: Powerline FRS Project Location Map

Kimley-Horn and Associates, Inc.
2012 KIMLEY-HORN AND ASSOCIATES, INC.
Engineering, Planning and Environmental Consultants
7740 North 16th Street, Suite 300
Phoenix, Arizona 85020 (602) 944-5500

SCALE(H): 1"= 6000'
SCALE(V): N/A
DESIGNED BY: TDD
DRAWN BY: JAG
CHECKED BY: RAE
DATE: SEPT. 2012

NO	REVISION	BY	DATE	APPR.

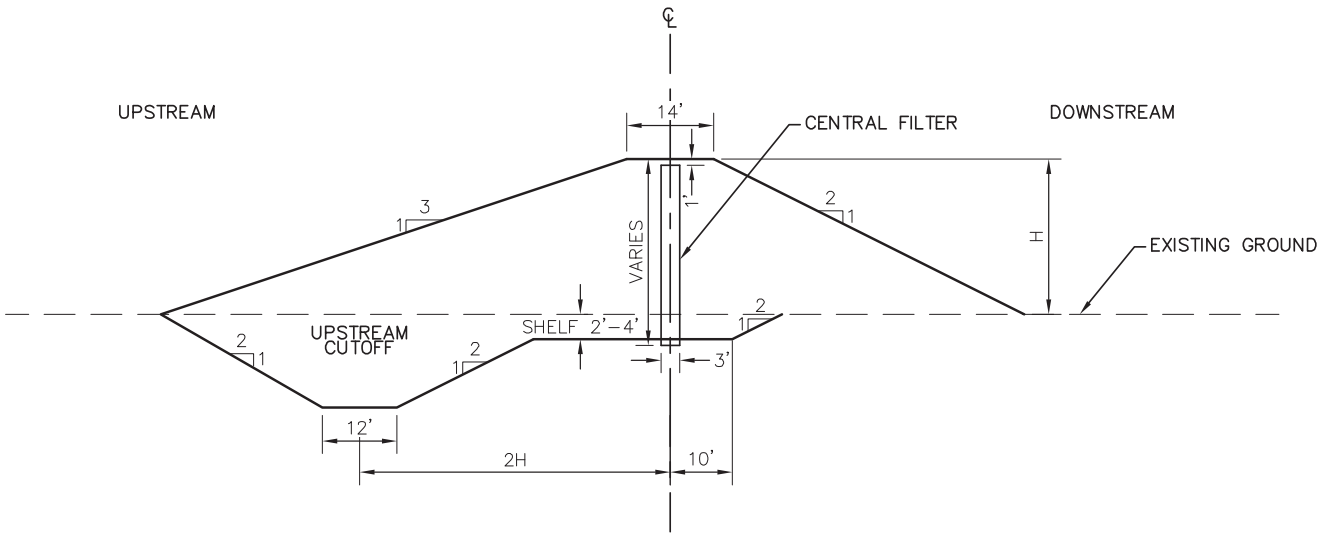
PROJECT NO. 91131019

DRAWING NAME POWERLINE_PROJECT_MAP.MXD

Appendix C Support Maps

Figure C-1. Powerline FRS Existing Embankment - Typical Section
Figure C-2. Powerline FRS Principal Spillway
Figure C-3. Powerline FRS Auxiliary Spillway
Figure C-4. Earth Fissure Risk Zones
Figure C-5. Plan View Preferred Alternative
Figure C-6. Proposed Powerline Channel – Typical Section
Figure C-7. Proposed Powerline Channel – Hardened Typical Section
Figure C-8. Plan View of Proposed North Diversion Channel
Figure C-9. Proposed North Diversion Channel - Typical Section
Figure C-10. Emergency Spillway Inundation Areas – Powerline FRS
Figure C-11. Dam Failure Inundation Areas – Powerline FRS
Figure C-12. 100-year Floodplain Mapping with Dams In-Place
Figure C-13. 100-year Floodplain Mapping without Dams In-Place

POWERLINE FRS



NOTE: THE CENTRAL FILTER EXTENDS FROM STATIONS 17+83 TO 150+70. THE FILTER AVERAGES 18 FEET IN DEPTH AND HAS A MAXIMUM DEPTH OF 42 FEET BELOW THE DAM CREST. THE FILTER WAS DESIGNED TO EXTEND INTO NATIVE SOILS FOR ITS ENTIRE LENGTH. THERE ARE NO FINGER DRAINS CONNECTING THE CENTRAL FILTER TO THE DOWNSTREAM TOE OF THE EMBANKMENT.

GRAPHIC SCALE
10 0 5 10 20
(IN FEET)

Kimley-Horn and Associates, Inc.

Figure C-1: Powerline FRS Existing Embankment - Typical Section

K:\1PDC_Water\Resources\P131019\CADD\Alternative\Level_II_RiskDam.dwg Mar 09, 2011 anthony.doucette
REVPK

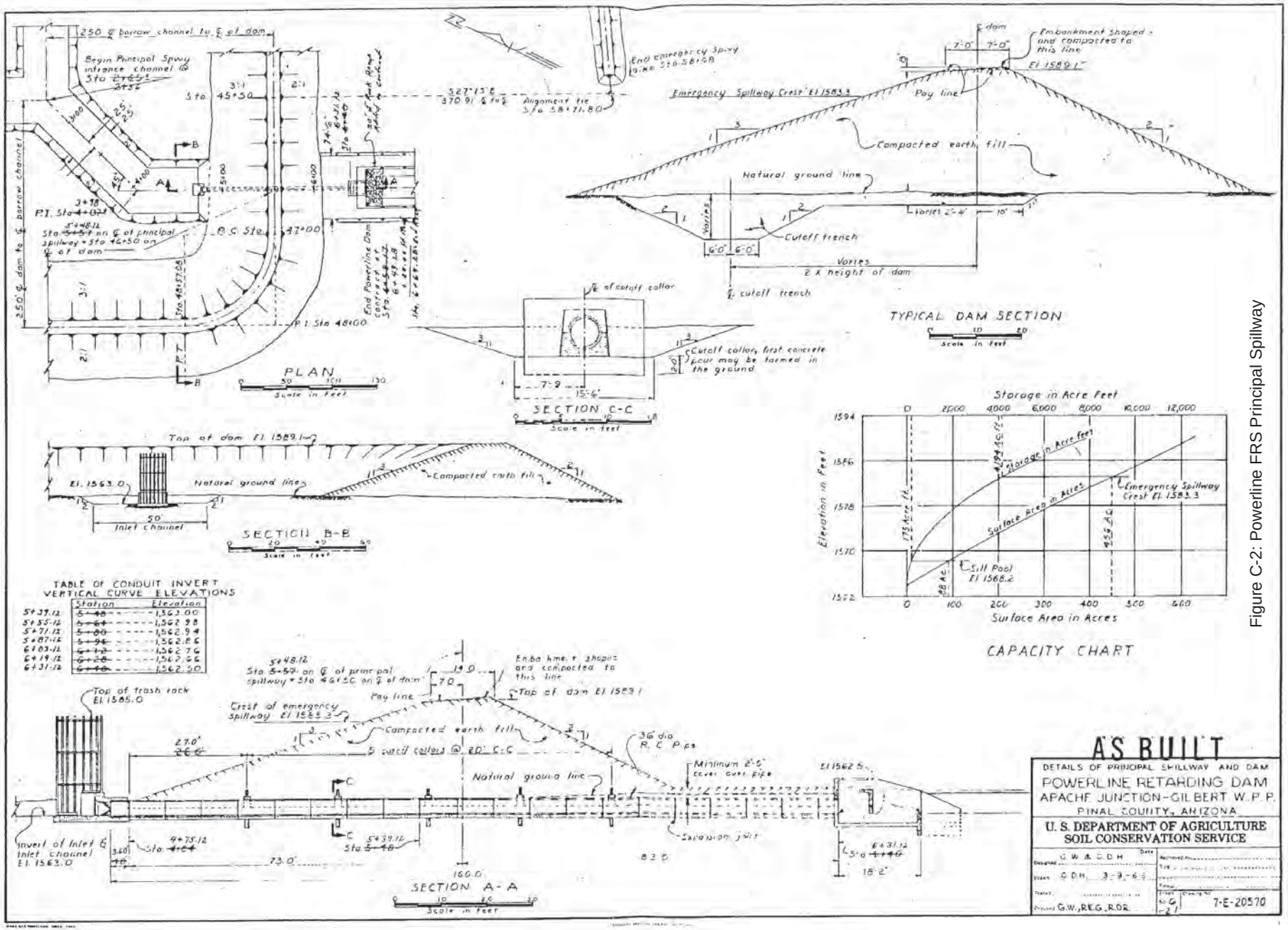


Figure C-2: Powerline FRS Principal Spillway

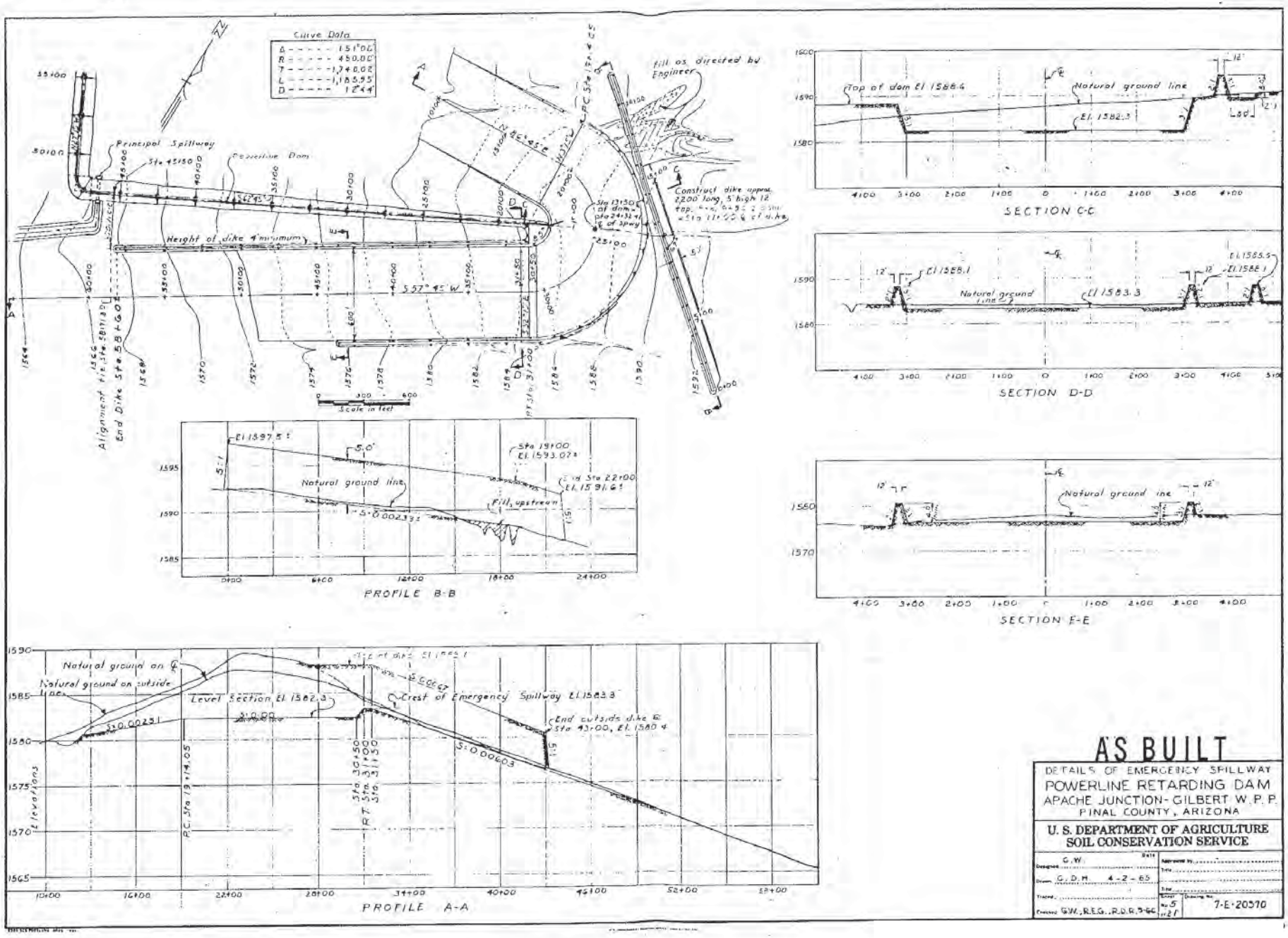
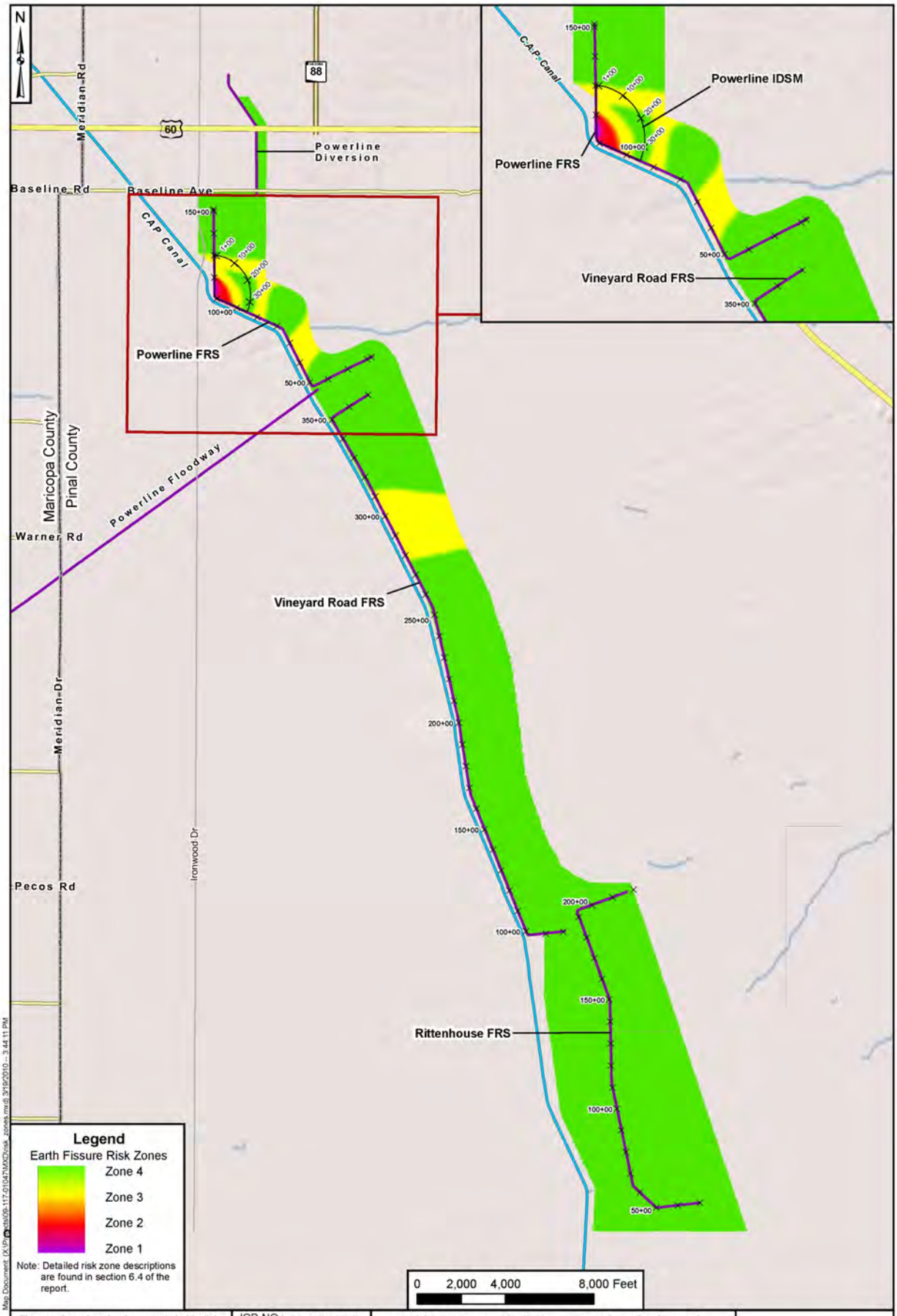


Figure C- : Powerline FRS u iliary Spillway



The map shown here has been created with all due and reasonable care and is strictly for use with AMEC Project Number: 09-117-01047. This map has not been certified by a licensed land surveyor, and any third party use of this map comes without warranties of any kind. AMEC assumes no liability, direct or indirect, whatsoever for any such third party or unintended use.

JOB NO.:	09-117-01047
DESIGN	KCF
DRAWN:	AMEC GIS
DATE:	08/2010
SCALE:	1" = 4,000'

Initial Subsidence and Earth Fissure Report Powerline, Vineyard Road, and Rittenhouse Flood Retarding Structures Rehabilitation or Replacement Project
Contract FCD2008C041, Work Assignment No. 2

Earth Fissure Risk Zones

FIGURE C-4

amec

Map Document: (X:\Projects\09-117-01047\MXD\risk_zones.mxd) 3/19/2010 -- 3:44:11 PM

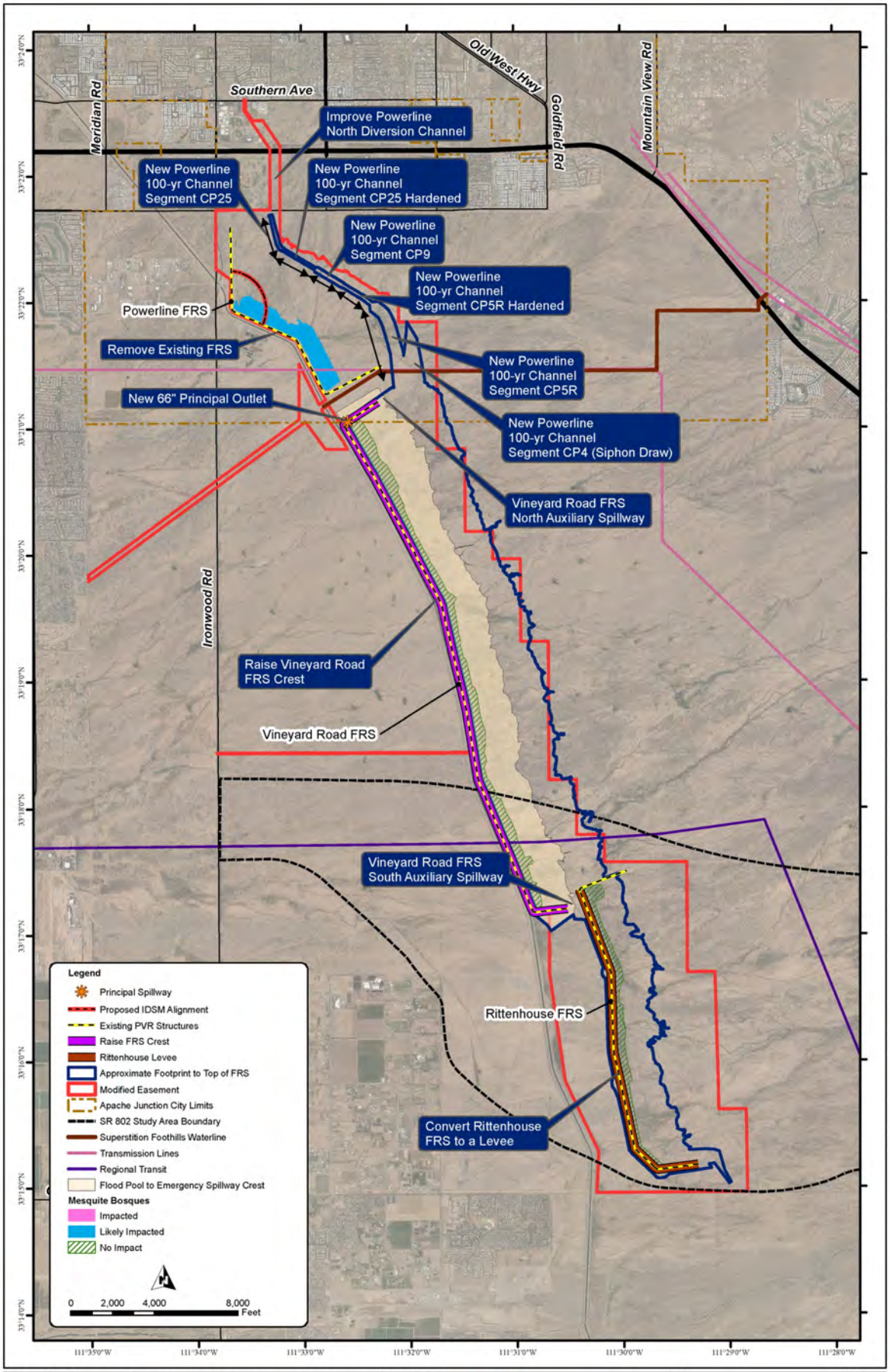
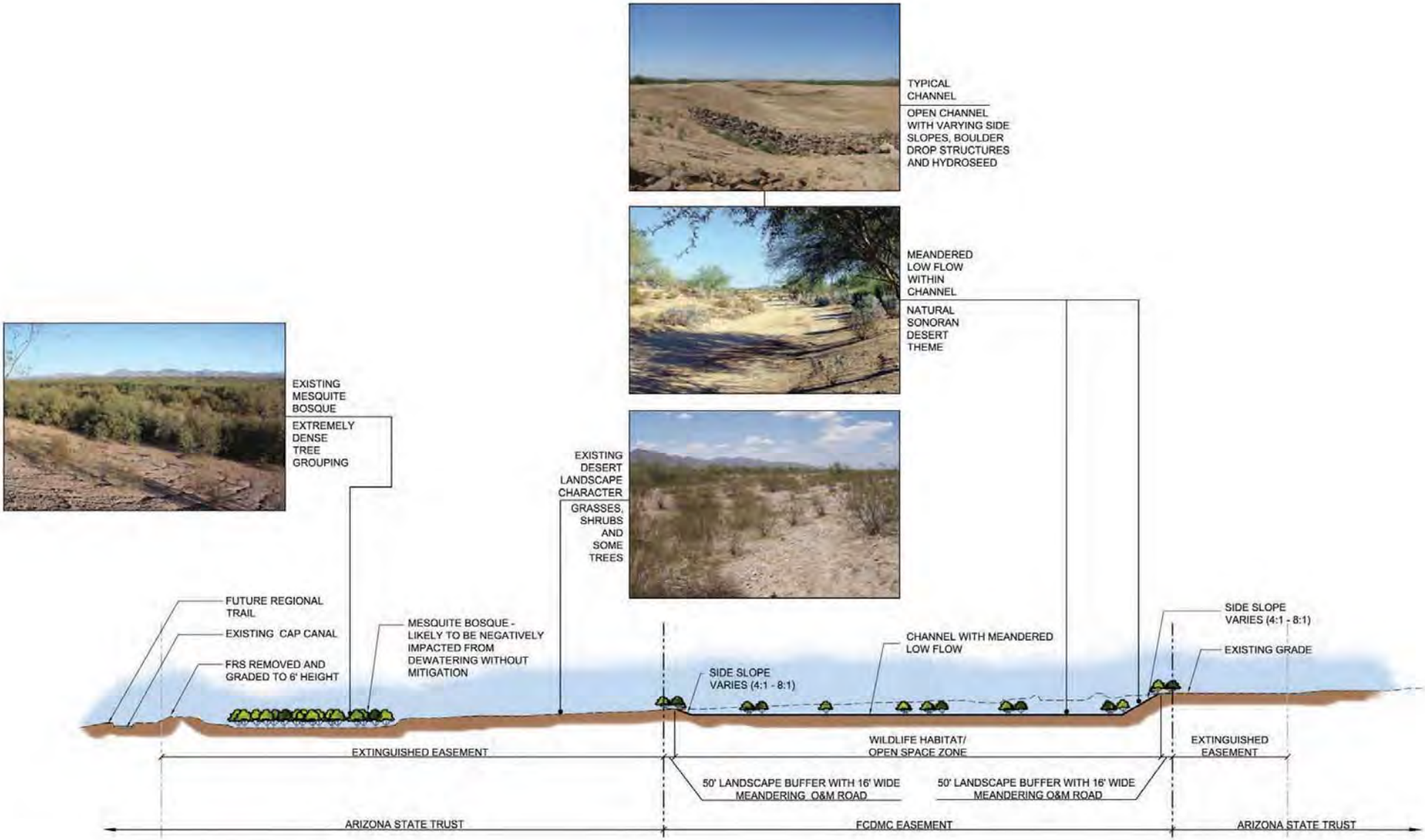


Figure C-5: Plan View Preferred Alternative

SCALE(H): AS SHOWN
SCALE(V): N/A
DESIGNED BY: TDD
DRAWN BY: TDD
CHECKED BY: RAE
DATE: APRIL 2012

Kimley-Horn and Associates, Inc.
Engineering, Planning and Environmental Consultants
7878 North 16th Street, Suite 300
Phoenix, Arizona 85020 (602) 944-5500

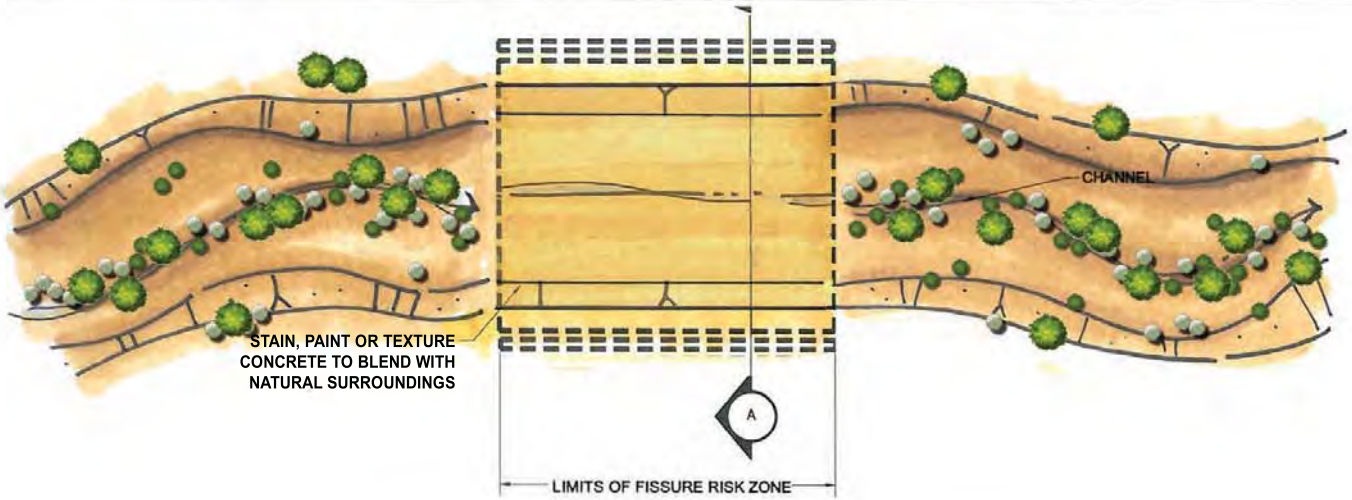
NO | REVISION | BY | DATE | APPR.



TYPICAL CHANNEL SECTION

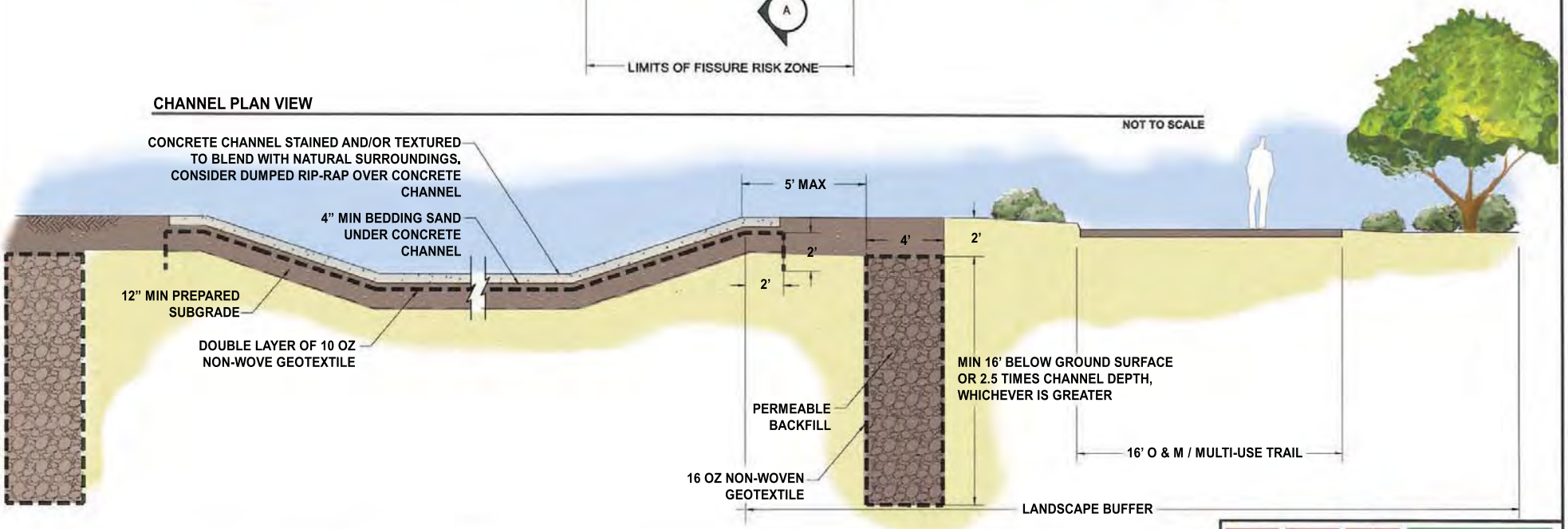
SCALE: 1" = 400' 1H:5V 0 200 400 800

FIGURE C-6: PROPOSED POWERLINE CHANNEL - TYPICAL SECTION



CHANNEL PLAN VIEW

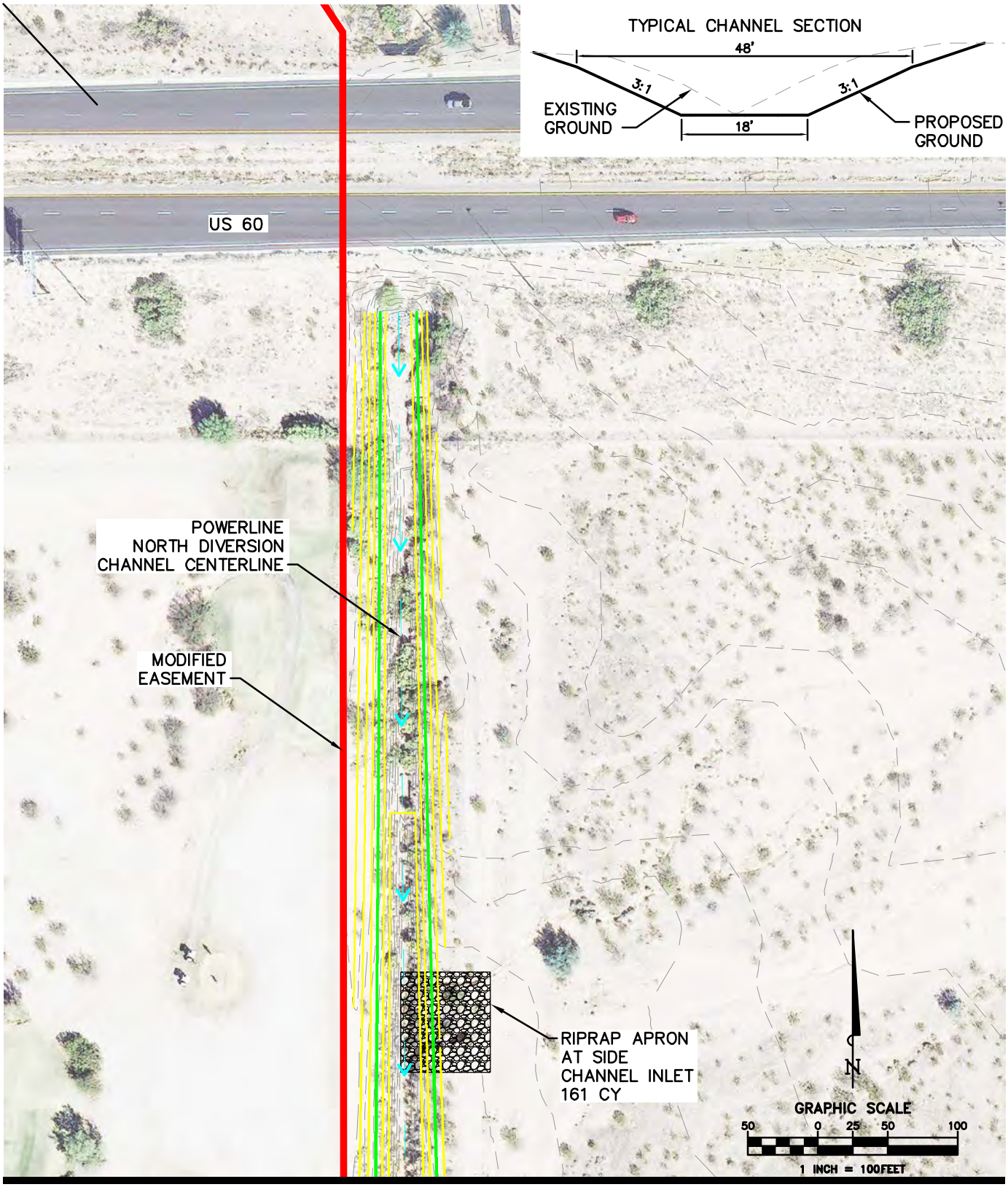
NOT TO SCALE



CROSS-SECTION A: CHANNEL

NOT TO SCALE

FIGURE C-7: PROPOSED POWERLINE CHANNEL - HARDENED TYPICAL SECTION



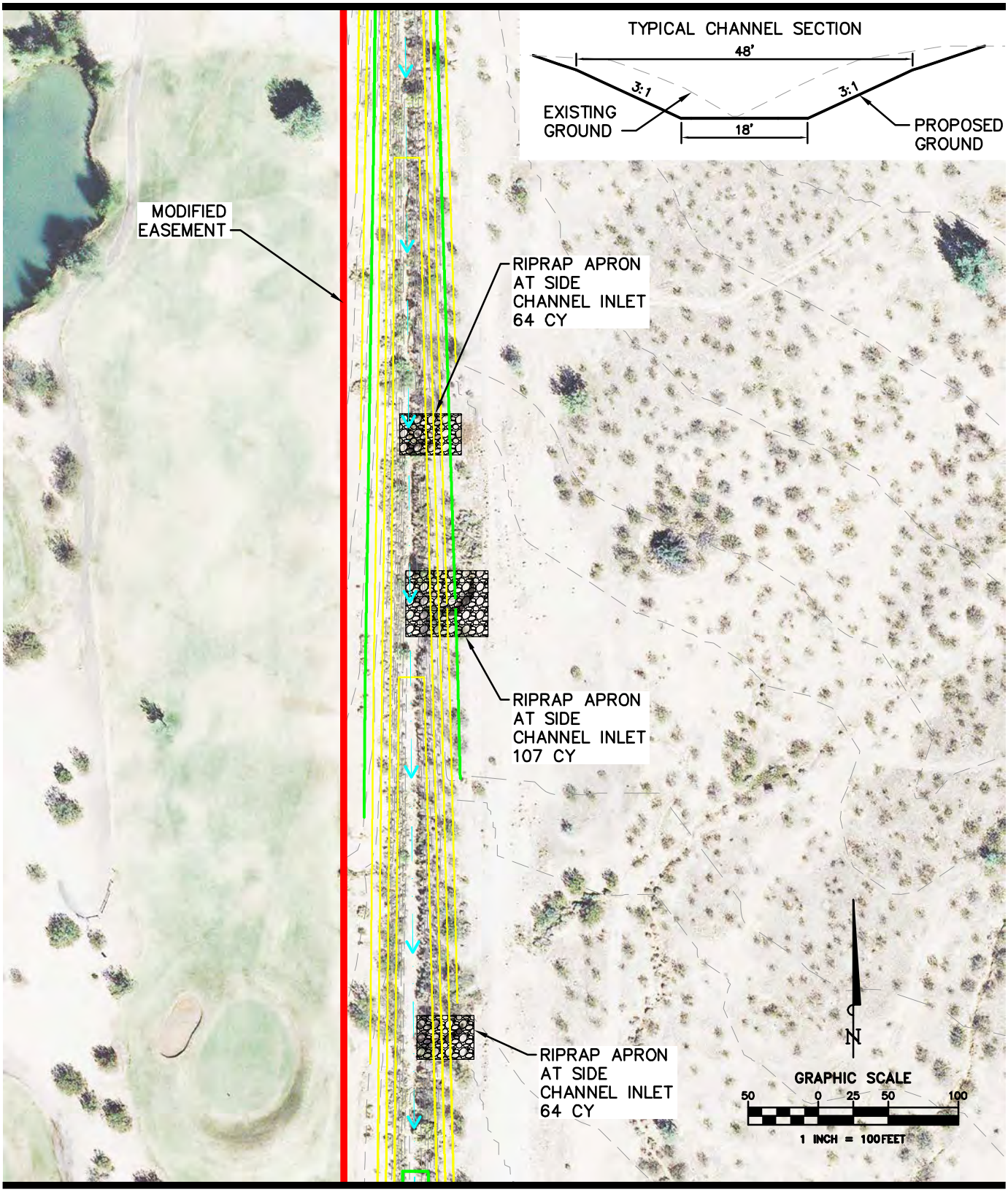
MATCHLINE – SEE SHEET 2

FIGURE C-8
POWERLINE NORTH DIVERSION CHANNEL IMPROVEMENTS
(SHEET 1 OF 4)

Kimley-Horn and Associates, Inc.

K:\PHX_WaterResources\91131019\CADD\Alternatives\Level_III\PowerlineNorthDiversionChannel_Improvements.dwg Sep 06, 2012 tony.doucette
XREFS: CombinedTopofromJEF

MATCHLINE – SEE SHEET 1



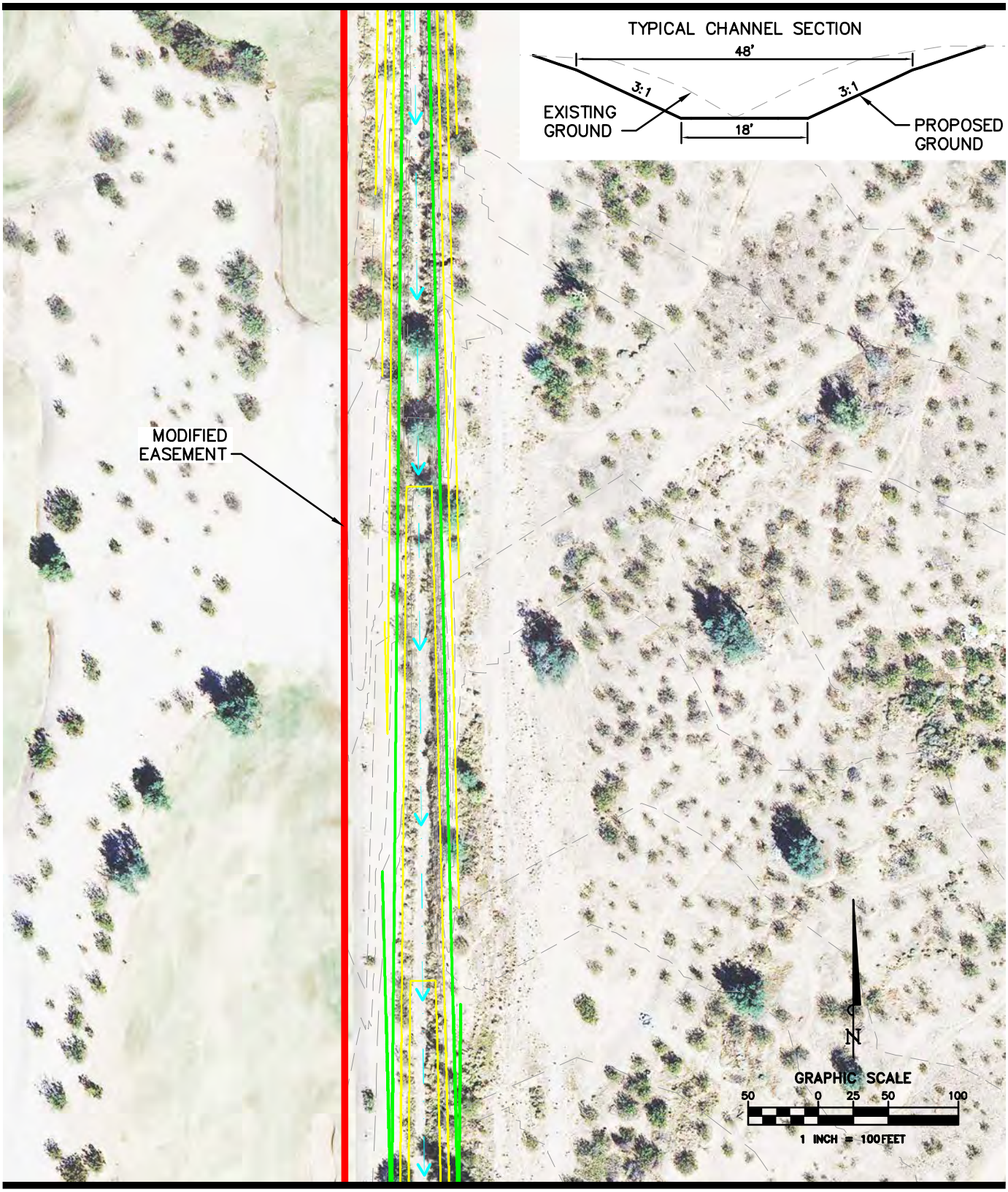
MATCHLINE – SEE SHEET 3

FIGURE C-8
POWERLINE NORTH DIVERSION CHANNEL IMPROVEMENTS
(SHEET 2 OF 4)

Kimley-Horn and Associates, Inc.

K:\PHX_WaterResources\91131019\CADD\Alternatives\Level_III\PowerlineNorthDiversionChannel_Improvements.dwg Sep 06, 2012 tony.doucette
XREFS: CombinedTopofromJEF

MATCHLINE – SEE SHEET 2



MATCHLINE – SEE SHEET 4

FIGURE C-8
POWERLINE NORTH DIVERSION CHANNEL IMPROVEMENTS
(SHEET 3 OF 4)

K:\PHX_WaterResources\91131019\CADD\Alternatives\Level_III\PowerlineNorthDiversionChannel_Improvements.dwg Sep 06, 2012 tony.doucette
XREFS: CombinedTopofromJEF

Kimley-Horn and Associates, Inc.

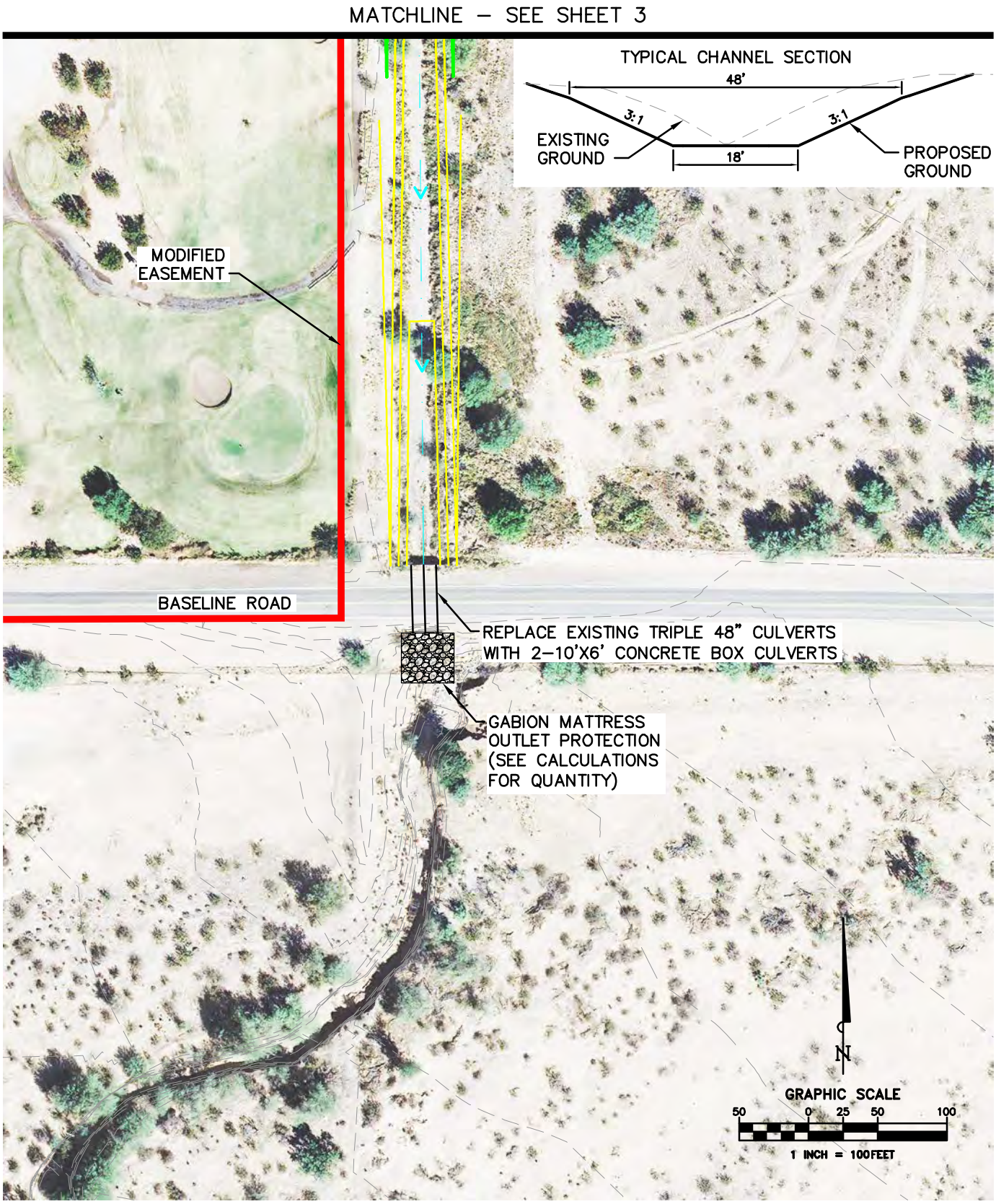


FIGURE C-8
POWERLINE NORTH DIVERSION CHANNEL IMPROVEMENTS
(SHEET 4 OF 4)

Kimley-Horn and Associates, Inc.

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XREFS: CombinedTopofromJEF

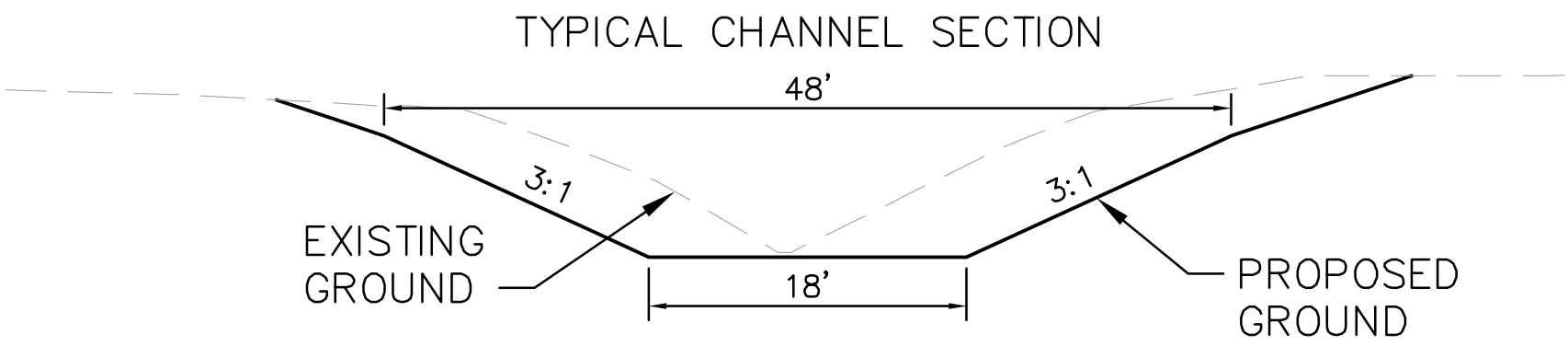


FIGURE C-9
PROPOSED NORTH DIVERSION CHANNEL - TYPICAL SECTION

Kimley-Horn and Associates, Inc.

Figure C-10: Emergency Spillway Inundation Areas - Powerline FRS

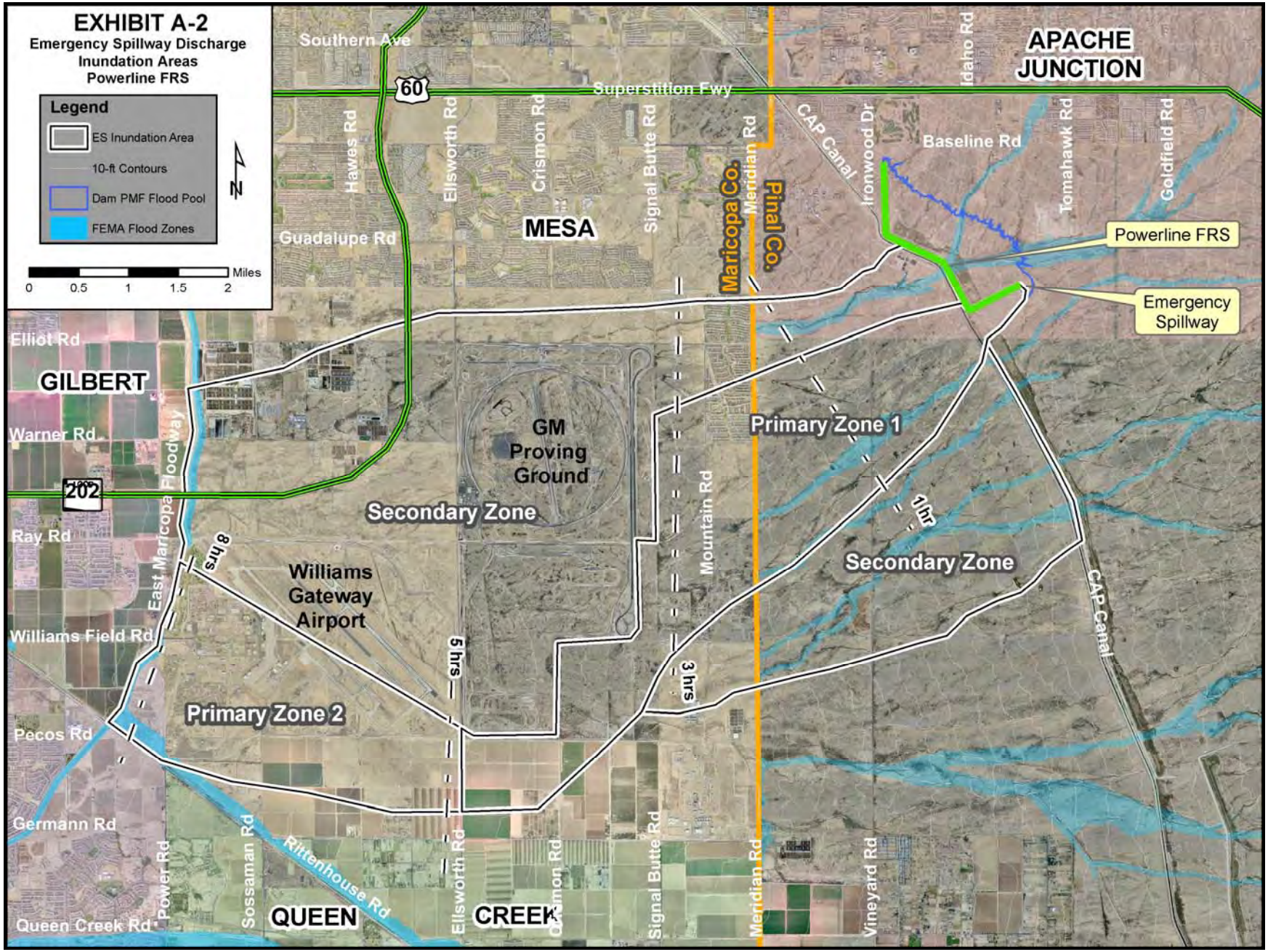
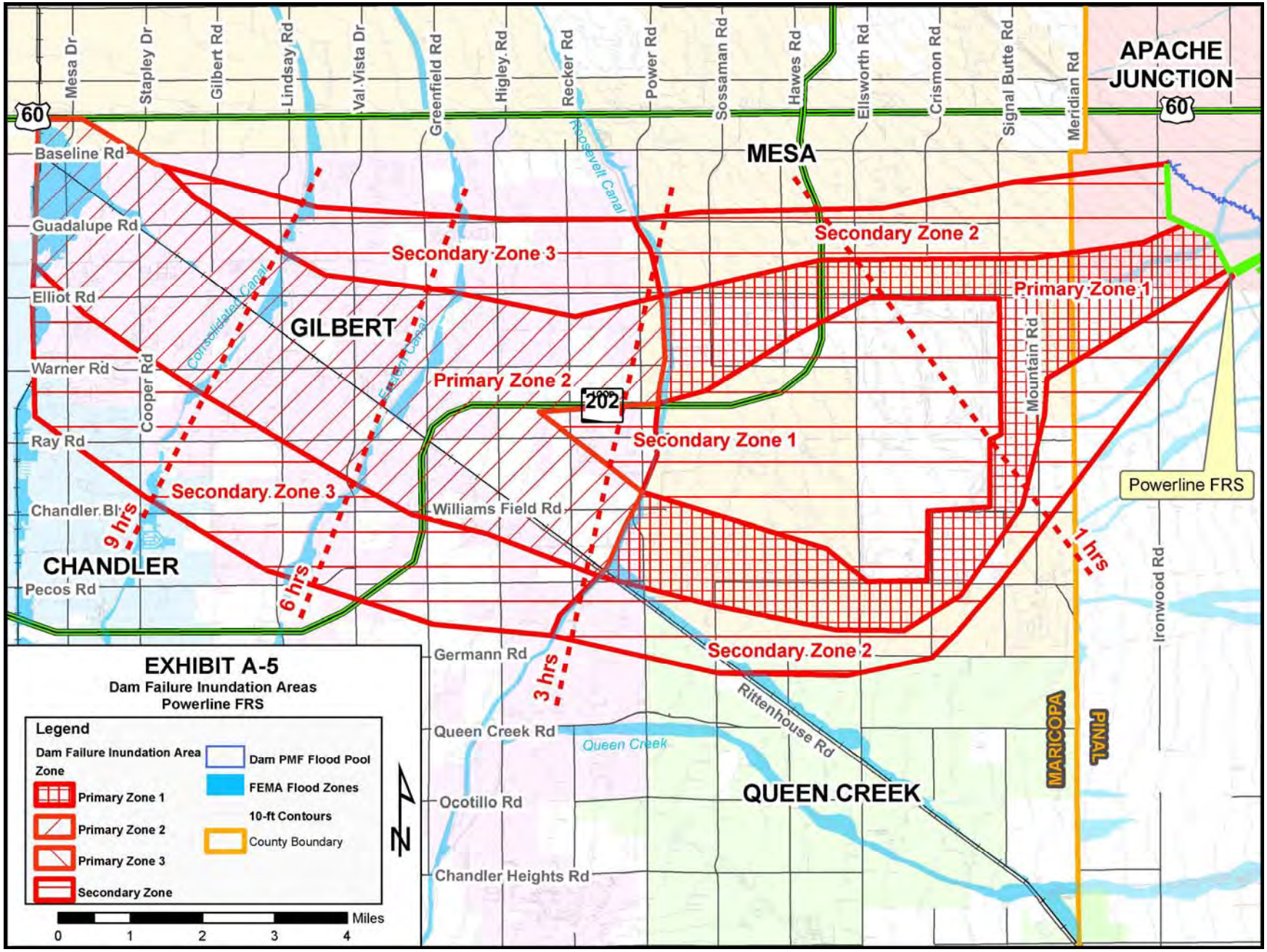


Figure C-11: Dam Failure Inundation Areas - Powerline FRS



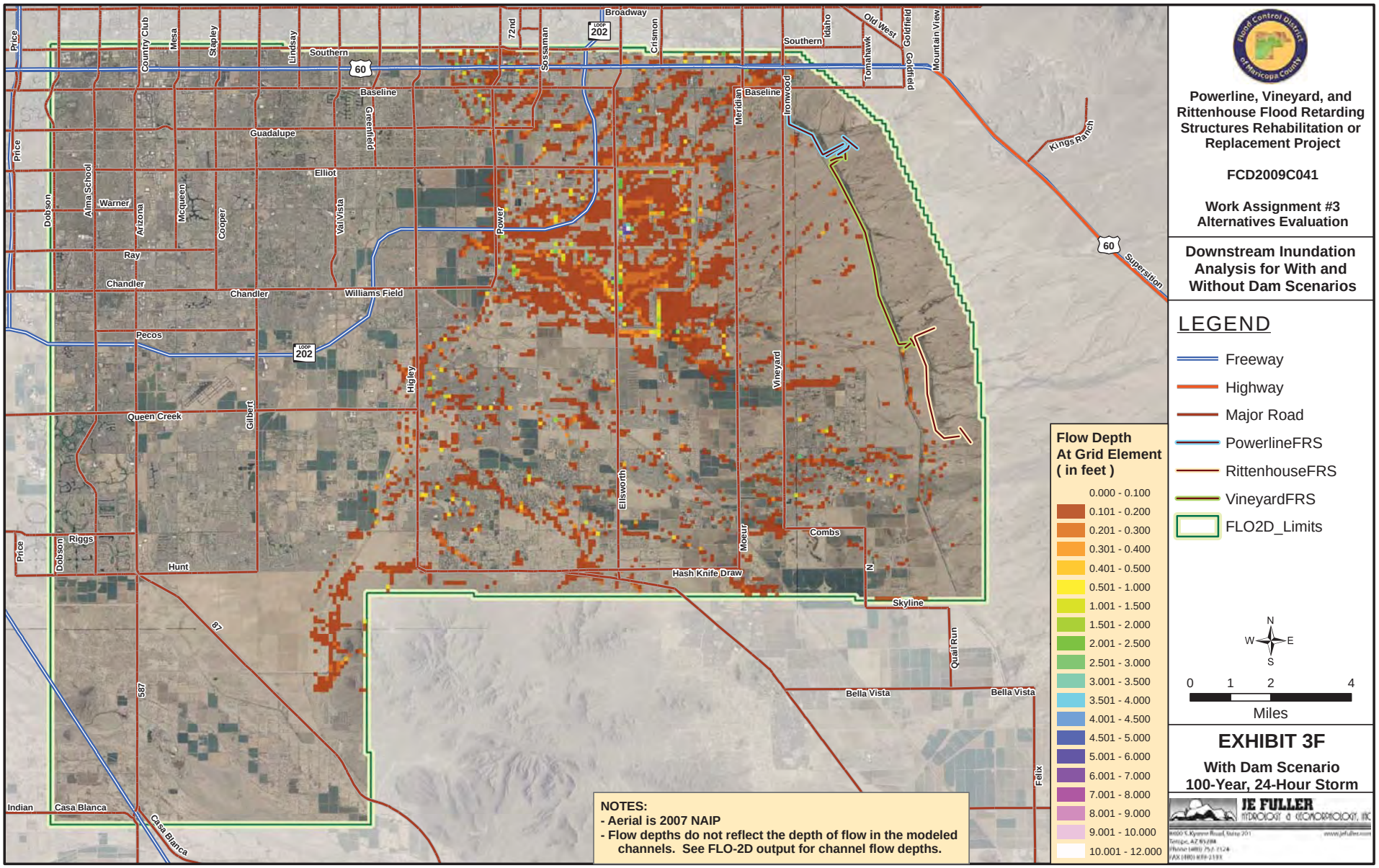


Figure C-12: 100-year Floodplain Mapping With Dams In-Place

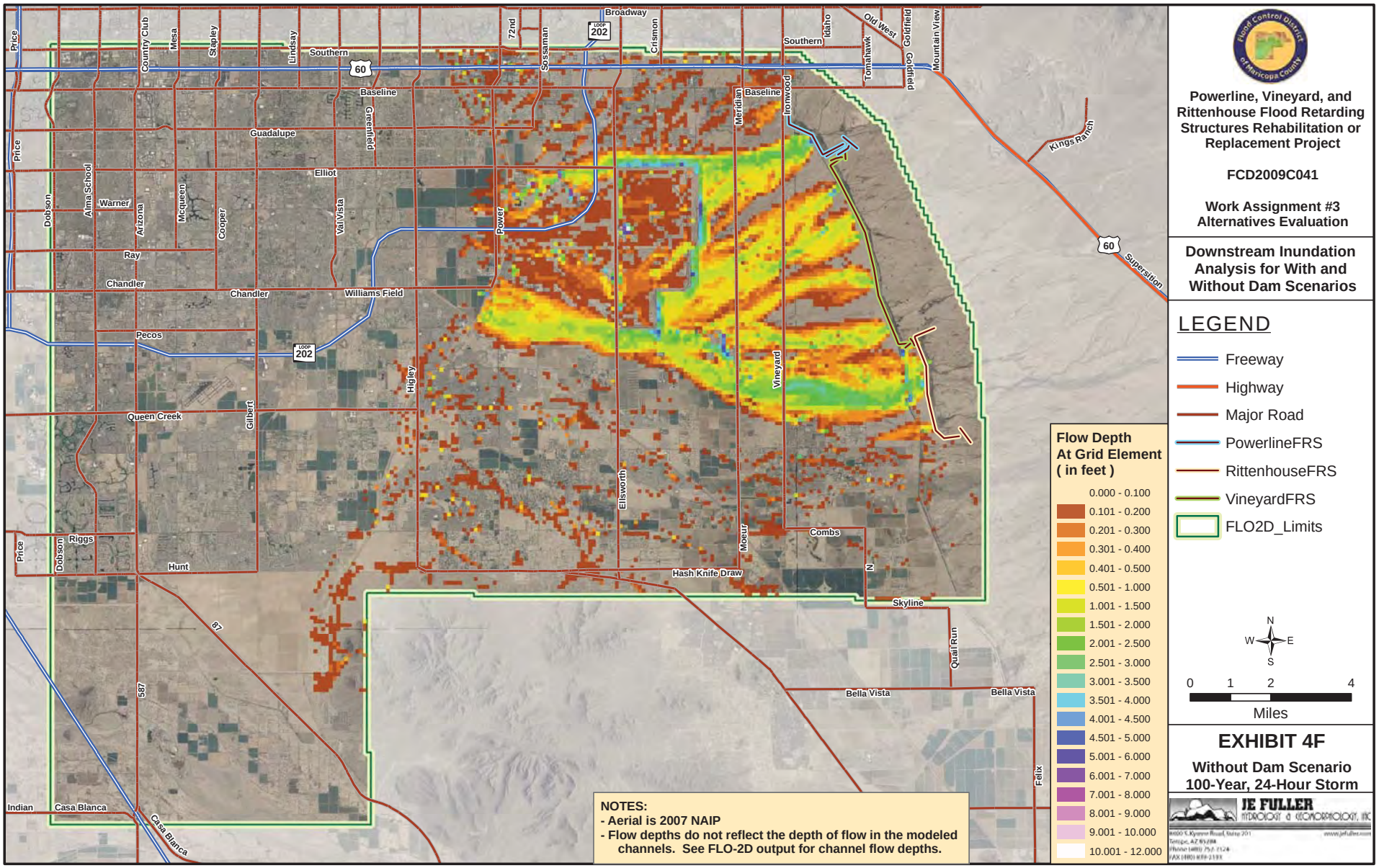


Figure C-13: 100-year Floodplain Mapping Without Dams In-Place

Appendix D Investigation and Analyses Report

APPENDIX D

INVESTIGATIONS AND ANALYSES REPORT

POWERLINE FLOOD RETARDING STRUCTURE

SUPPLEMENTAL WATERSHED PLAN AND

ENVIRONMENTAL ASSESSMENT

Prepared by:
Kimley-Horn and Associates, Inc.

For the:
Flood Control District of Maricopa County
FCD2008C042

In cooperation with:
Natural Resources Conservation Service
US Department of Agriculture

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1. INTRODUCTION

The Powerline Flood Retarding Structure (FRS) was designed and constructed by the United States Department of Agriculture – Natural Resources Conservation Service (NRCS) (formerly the Soil Conservation Service – SCS) in 1968 under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566) as amended. The FRS was constructed as part of the Apache Junction-Gilbert Watershed Protection and Flood Prevention Project. The FRS is operated and maintained by the Flood Control District of Maricopa County (District). The 2.5 mile long, 21 foot high earth dam provides flood protection to downstream residents, structures, and infrastructure from flood flows originating from the 47 square mile watershed that lies east of the dam.

The FRS has developed safety deficiencies and is approaching the original 50-year project lifetime. In May 2007, an earth fissure was identified in close proximity to the downstream toe of the dam. In light of the proximity of this earth fissure to the Powerline embankment, and the presence of other documented earth fissures in the general vicinity of the dam, the Arizona Department of Water Resources (ADWR) classifies Powerline FRS as being in an "unsafe, non-emergency, elevated risk" condition. As such, the Powerline FRS is one of ADWR's highest priority unsafe dams in the state. The District is currently constructing the Powerline Interim Dam Safety Measure (IDSM). The IDSM consists of a new alignment for a portion of the Powerline FRS based on the results of past investigations indicating a high probability of an earth fissure beneath the existing embankment. In 2009, the District requested Federal planning and implementation assistance for long-term solutions to the identified dam safety deficiencies. This Supplemental Watershed Plan and Environmental Assessment (Plan/EA) determines the feasibility of decommissioning the FRS and replacing the FRS with a constructed channel to provide for continued flood protection while meeting current applicable local, State, and Federal regulations.

The Powerline FRS is one of three dams (the other two are Vineyard Road FRS and Rittenhouse FRS) that were designed and constructed by the NRCS located along the Central Arizona Project canal in Pinal County. The structures were designed to operate as an integrated passive system. Each FRS has a principal spillway consisting of reinforced concrete pipe and each FRS has an earthen, open-channel auxiliary spillway, with the exception of Vineyard Road FRS, which has two auxiliary spillways. The principal spillways for both the Powerline and Vineyard Road FRS discharge into a common channel called the Powerline Floodway. Rittenhouse FRS functions as a cascading reservoir during principal spillway operation by discharging into the flood pool reservoir behind Vineyard Road FRS, which outfalls to the Powerline Floodway. The result is that all three principal spillways eventually flow into the Powerline Floodway. However, the auxiliary spillways of the FRSs do not cascade and do not outfall to the Powerline Floodway.

The above information is presented as the investigations, studies, and reports for the Powerline, Vineyard Road and Rittenhouse Flood Retarding Structures Rehabilitation or Replacement Project was conducted on a joint approach rather than on the individual dams and watersheds. The following sections below are summaries of those studies and reports for the PVR project.

2. HYDROLOGY AND HYDRAULICS

This section of the "Investigations and Analyses Report" provides a summary of the hydrologic and hydraulics analysis in previous investigations as well as studies conducted by Kimley-Horn for the PVR project.

2.1. Previous Studies

Previous existing conditions of the PVR FRS watersheds have been studied as part of the following investigations:

- "Desert Drive Area Study Existing Conditions Hydrology" (DDA Existing Conditions Hydrology) by the Arizona State Land Department (ASLD, 2007)
    - The Arizona State Land Department conducted an existing conditions hydrology study for an area of State Lands known as Desert Drive Area (DDA). The Desert Drive Area study includes the PVR structures and their contributing watersheds. The purpose of the hydrology study was to determine the rainfall runoff response for the Desert Drive Area under existing conditions.
    - HEC- 1 models were developed for the l00-year, 200-year, 500-year, and PMF storm events. The 100-year, 200-year and 500-year storm events were analyzed for 6-hour and 24-hour storm durations. The PMF storms were analyzed for the 6-hour and 72-hour storms. For the Desert Drive Area downstream of the PVR structures, only the 100-year, 6-hour and 24-hour models were developed.
- "Desert Drive Area Study Existing Conditions Inundation and Sedimentation Analysis for PVR Structures (DDA Inundation and Sedimentation) by the Arizona State Land Department (ASLD 2008).

  This is Volume II of the Desert Drive Area study. This study utilized FLO-2D software to create a two dimensional model of the discharges entering the PVR structures. The FLO-2D model was completed in order to evaluate the interconnected character of the PVR Structures and to determine the existing condition inundation limits of the structures for the 100-year, 24-hour storm and the 6-hour and 72-hour PMF events (full and half). The results of the analysis provide overtopping depths and durations for each of the storms evaluated.

2.2. Hydrologic Design Criteria

The rehabilitation or replacement of the PVR structures must meet the most critical design criteria between NRCS, ADWR and District hydrologic design criteria. The project must meet both District and NRCS requirements for flood protection and District, NRCS and ADWR requirements for dam safety. NRCS design criteria, flood protection, and dam safety requirements are documented in "Earth Dams and Reservoirs," Technical Release No. 60, dated July 2005. ADWR design criteria and dam safety requirements are documented in the "Arizona Administrative Code Title 12, Chapter 15, Article 12 – Dam Safety Procedures" dated June 12, 2000.

Per NRCS criteria for High Hazard Dams, the principal spillway design flood is the 100-year and 10-day storm, and the principal spillway must have: a) the capacity to prevent the auxiliary spillway from functioning more frequently than the 100 year event. ADWR requires that the

principal spillway has capacity to evacuate 90% of the storage capacity in 30 days, excluding reservoir inflows.

The NRCS auxiliary spillway design flood is based on the stability design hydrograph and freeboard hydrograph. The stability design hydrograph is based on the 100-year 6-hour event and the 6-hour PMP. The freeboard hydrograph is the hydrograph resulting from the critical PMP. The auxiliary spillway must have the capacity to pass the stability design hydrograph at safe velocity and pass the freeboard hydrograph with a water surface at or below the top of the dam (no freeboard). The ADWR auxiliary spillway design flood and inflow design flood (IDF) will range from 0.5 to the full PMF, with size increasing based on the persons at risk and the potential for downstream damage. The auxiliary spillway capacity must be sufficient to pass the IDF plus freeboard requirements, which (for new or unsafe dams) require the largest of: a) the sum of the IDF maximum water depth above the spillway crest plus wave run up; b) the sum of the IDF maximum water depth of the spillway crest plus 3 feet; or c) a minimum of 5 feet from the auxiliary spillway crest to the dam crest.

NRCS stability design requirements include that the auxiliary spillway maximum stress limitations must not be exceeded for the stability design hydrograph. The integrity of the spillway must also be evaluated to ensure the spillway will not breach (headcut will not advance beyond the upstream edge of the level part of the inlet channel) during passage of the freeboard hydrograph.

2.3. Probable Maximum Precipitation/Probable Maximum Flood

Kimley-Horn prepared the "Final PMP Technical Memorandum" (Kimley-Horn, 2010) to provide a planning level recommendation of the anticipated percent reduction in probable maximum precipitation (PMP) rainfall depths when using a site-specific approach compared to traditional HMR-49 methods. Kimley-Horn calculated the HMR-49 PMP values for each individual structure watershed rather than as a whole for all three structures. Based on the available results and findings of the Magma FRS site specific studies and the relatively close proximity of the dam to the PVR structures, Kimley-Horn recommended a percent reduction of 10%, 30% and 25% for the 6-, 24-, and 72-hour storms, respectively.

The recommended planning level PMP was input into PVR FRSs HEC-1 models to develop the planning level PMF for each structure. The controlling storm for the PVR structures, based on this analysis, is the 6-hr PMP local storm.

2.4. Existing and Future Conditions Hydrology and Hydraulics Update

Kimley-Horn prepared the "Existing and Future Conditions Hydrology and Hydraulics Update Technical Report" (Kimley-Horn, 2010) to document hydrologic and hydraulic updates for existing and future land use conditions associated with each FRS. The results of the hydrology and hydraulics study provide baseline conditions for the three structures.

Multi-frequency inflow hydrographs were developed for the existing and future conditions 100-year, 6-hour and the 2-, 5-, 10-, 25-, 50-, 100- and 500-year, 24-hour storms, and the 6-hour, 24-hour and 72-hour probable maximum flood (PMF).

2.5. Level Pool Analysis Results

Powerline FRS experiences no flow in the auxiliary spillway for any of the existing conditions multi-frequency (2 yr through 500 yr) events. The future conditions land use for Powerline FRS

results in auxiliary spillway flow only during the 500-year, 24-hour storm event at a depth of 0.5 ft.

Vineyard Road FRS experiences flow in the auxiliary spillway for the 500-year, 24-hour existing conditions storm event at a depth of 0.5 ft in the south spillway. The 500-year, 24-hour event is the only existing conditions auxiliary flow for Vineyard Road FRS. The future conditions land use 100-year, 24-hour event for Vineyard Road results in a flow depth of 0.6 ft in the south auxiliary spillway. The future conditions land use 500-year, 24-hour event results in a flow depth of 1.8 ft in the south auxiliary spillway and 1.2 ft in the north auxiliary spillway.

Rittenhouse FRS experiences flow in the auxiliary spillway for the 500-year, 24-hour existing conditions storm event at a depth of 1.0 ft. The 500-year, 24-hour event is the only existing conditions auxiliary flow for Rittenhouse FRS. The future conditions land use 100-year, 24-hour event for Rittenhouse FRS results in a flow depth of 0.6 ft in the auxiliary spillway. The future conditions 500-year, 24-hour event results in a flow depth of 1.9 ft in the auxiliary spillway. The future conditions land use “with retention” results in no flow for the 100-year 6-hour or 100-year 24-hour events.

For all three FRSs, the future conditions multi-frequency peak flow rates, peak storage volumes and peak stages increase relative to existing conditions. The percent increase is highest during more frequent return intervals (i.e. the 2-year storm event) and lowest during less frequent return intervals (i.e. the 500-year event). Both the 100-year 6-hour and 100-year 24-hour future conditions with retention models for all three FRSs result in a decrease in peak storage volume and peak stage and no outflow in the auxiliary spillways.

The 6-hour reduced PMP overtops the Powerline FRS crest by 0.6 ft in both the existing and future conditions. The structure is not overtopped in the existing or future conditions 24- and 72-hour reduced PMP events.

The existing conditions 6- and 72-hour reduced PMP events overtop the Vineyard Road FRS crest by 1.2 and 0.8 ft, respectively. The future conditions 6-, 24- and 72-hour reduced PMP events all overtop the Vineyard Road FRS crest by 1.3, 0.4 and 0.7 ft, respectively. Vineyard Road FRS is not overtopped in the 24-hour existing conditions reduced PMP event.

Rittenhouse FRS is overtopped in all existing and future conditions reduced PMP events. The existing conditions 6-, 24- and 72-hour reduced PMP events overtop the Rittenhouse FRS crest by 1.0, 0.1 and 0.3 ft, respectively. The future conditions 6-, 24- and 72-hour reduced PMP events overtop the Rittenhouse FRS crest by 1.0, 0.1 and 0.2 ft, respectively.

2.6. Dynamic Reservoir Routing Results

HEC-1 existing conditions inflow hydrographs developed for the 100-year, 6-hour and 100-year, 24-hour storms and the 6-, 24- and 72-hour reduced PMP storms were used to update the dynamic reservoir routing FLO-2D models prepared as part of the “DDA Inundation and Sedimentation” (ASLD, 2007). The FLO-2D models were used to generate auxiliary spillway outflow hydrographs and freeboard estimates for each FRS.

2.7. Principal Spillway Hydrograph, Stability Design Hydrograph and Freeboard Hydrograph

Kimley-Horn prepared the "Principal Spillway Hydrograph, Stability Design Hydrograph and Freeboard Hydrograph Technical Memorandum" (PSH, SDH and FBH Technical Memorandum, Kimley-Horn 2010) to document the future land use conditions principal spillway hydrograph (PSH) analysis and the existing and future conditions stability and integrity analysis for the existing PVR auxiliary spillways.

Kimley-Horn used the PVR FRSs Existing Conditions PSH Analysis single basin models as the basis for the future land use PSH analysis. The NRCS SITES Analysis Computer Program was used to complete the analysis. Future conditions land use was taken from the "Existing and Future Hydrology and Hydraulics Update" (Kimley-Horn, 2010). The time for PSH drawdown increased for Powerline and Vineyard Road FRSs during future conditions. The PSH drawdown did not change for Rittenhouse FRS because the composite CN value did not change for future land use conditions. None of the FRSs experience auxiliary spillway flows during the 100-year, 10-day event for existing or future land use conditions.

An existing and future conditions stability and integrity analysis for the existing PVR auxiliary spillways was completed. The 6-hour reduced PMP storm event was determined to be the critical storm duration for each FRS in the "Final PMP Tech Memo" (Kimley-Horn, 2010) and was used to develop the SDH and FHB.

Precipitation depths used for the FBH and SDH equation were taken from the "Existing and Future Conditions Hydrology and Hydraulics Update Technical Report" (Kimley-Horn, 2010). The reduced PMP value was used for the SDH and FBH. SDH and FHB were calculated using the 6-hour HMR-49 distribution.

Precipitation depths were input in HEC-1 models from the "Existing and Future Conditions Hydrology and Hydraulics Update Technical Report" (Kimley-Horn, 2010h) to determine the flood hydrographs at each structure. HEC-1 inflow hydrographs were imported into FLO-2D and dynamically routed through the reservoir to obtain the spillway hydrographs. The hydrographs were then input into SITES to evaluate the stability and integrity of each auxiliary spillway.

The allowable stress for each spillway was calculated using a spreadsheet developed by the NRCS that follows Agricultural Handbook (AH) 667 and TR-60 methodology. The soil effective stress was obtained from the SITES output file for each spillway and compared to the calculated allowable stress. The soil is stable for Vineyard Road and Rittenhouse auxiliary spillways under existing conditions with the SITES soil effective stress being less than the calculated allowable stress. The soil is erodible for Powerline auxiliary spillway under existing conditions where the effective stress is greater than the calculated allowable stress. Under future conditions, the soil is stable for the Vineyard Road north and Rittenhouse auxiliary spillways. The soil is erodible for the Powerline and Vineyard Road south auxiliary spillways.

An integrity analysis was completed for each auxiliary spillway using the SITES model. There are four spillways, one at Powerline, two at Vineyard Road, and one at Rittenhouse. Soil borings were taken at each spillway and documented in detail in the "Final Geotechnical Summary and Analysis Report" (AMEC, 2010).

Representative soil parameters were selected from the available laboratory results for each SITES material. Spillway profiles used in the analyses are a composite of the as-built spillway profiles and the existing topography spillway profiles prepared by AMEC (AMEC, 2010). The profiles were simplified to include a 50-ft long control crest section followed by a constructed exit channel at a constant slope. A non-constructed spillway section was extended beyond the constructed spillway section to the valley floor in each spillway profile. All four auxiliary spillways breach under both existing and future conditions. The time to breach ranges from 7.0 to 8.5 hours for the PVR FRSs.

2.8. Downstream Inundation Analysis

The "Downstream Inundation Hydrology and Mapping Technical Memorandum" (JEF, 2010) provides inundation data downstream of the PVR structures to support the economic analysis for subsequent alternatives evaluation and selection.

Both the "with dams" and "without dams" 2-, 5-, 10-, 25-, 50-, 100-year 24-hour, and 100-year 6-hour storm events were dynamically routed using FLO-2D through the watershed downstream of the PVR FRSs. Inflow hydrographs at the PVR FRSs used in the FLO-2D model were obtained from the multi-frequency analysis conducted as part of the "Existing and Future Conditions Hydrology and Hydraulics Update" (Kimley-Horn, 2010). A single, areal reduced point precipitation depth was applied to the downstream watershed to generate runoff within FLO-2D. The results show substantially shallower and moderate flooding across the downstream watershed for the "without dams" scenario than the "with dams" scenario.

2.9. Sediment Yield Analysis Update

The Flood Control District conducted an updated projected sediment yield analyses for the existing PVR structures for the purposes of the PVR FRS Rehabilitation or Replacement project (Flood Control District December, 2010) for future hydrologic land use conditions.

The methodology used by the District to estimate the sediment yield can be found in the District's River Mechanics Manual for the Drainage Design Management System for Windows (DDMSW version 4.6.0). The District used the DDMWS version 4.6.0 (with river mechanics) to determine total sediment yield. The total sediment yield consists of wash load and total bed material load. The *wash load* is calculated with the MUSLE method, and the *total bed material load* is calculated with the Zeller-Fullerton equation (Zeller and Fullerton, 1983), which is based on the assumption that the reach is at an equilibrium condition.

The District's results are summarized in the following table.

Summary of Sediment Yield Analysis Update

FRS	Sediment Yield [ac-ft/mi^2/yr]	Contributing Area[1] [mi^2]	25-Year Sediment Volume [ac-ft]	100-Year Sediment Volume [ac-ft]
Powerline	0.238	34	203	810
Vineyard Road	0.272	53	361	1442
Rittenhouse	0.151	42	160	641

The NRCS criteria for sediment storage for dams may be found in *Technical Release 60, Earth Dams and Reservoirs* (*TR-60*). TR-60 refers to the NRCS publication *National Engineering Handbook (NEH) No 3 – Sedimentation (NEH-3)* for criteria and general guidelines for estimating sediment yield. The NRCS *National Watershed Program Manual (NWM)* (Dec, 2009) provides guidelines for the rehabilitation of existing dams and sediment storage volume requirements. On page 78, Section 505.35, B, paragraph iii states that for the rehabilitation of an existing dam: "Sediment storage life will be for the longest reasonable period practical (100 years maximum) but in no case will the evaluation life be less than 50 years".

2.10. Freeboard

Freeboard was estimated as the sum of wave runup plus wave setup in accordance with procedures described in Freeboard Criteria and Guidelines for Computing Freeboard Allowances for Storage Dams, ACER Technical Memorandum No. 2 by the United States Bureau of Reclamation (USBR), revised in 1981 (ACER-TM2). Wave runup is the movement of water up a structure on the breaking of a wave and the amount of runup is the vertical height above still water level. Wave setup is the vertical rise in the still water on the leeward side of a body of water caused by the wind stresses on the surface of the water. The two are summed for wave action.

The existing embankments for the PVR structures have been in place since 1968-1969 and are assumed fully settled. For the purposes of this planning level study, it is assumed that additional freeboard to compensate for future settlement is not required. Freeboard also accounts for anticipated future land subsidence at each structure.

2.11. Level II Hydrology and Hydraulics Technical Memorandum

The purpose of this Hydrology and Hydraulics Technical Memorandum was to document the hydrologic and hydraulic approach, methodology and results for evaluation of the Level II planning alternatives for the PVR project. This hydrologic and hydraulic study was used to conduct preliminary evaluations of the identified alternatives.

The scope of this study was to conduct updated hydrologic/hydraulic analyses to evaluate future project alternative conditions for the PVR Level II analysis planning alternatives. Previous hydrologic and hydraulics studies conducted by Kimley-Horn for existing PVR conditions are used as a baseline and updated for project alternatives. The tasks performed in developing this memorandum are listed below.

- Update previously prepared HEC-1 hydrologic models for five planning alternatives.
- Conduct FLO-2D modeling for the five planning alternatives. Model alternatives including dam rehabilitation for the inflow design flood and alternatives including basins and channels for the 100-year, 24-hour storm.

2.12. Final Level III Alternatives Summary Report

This report documents the evaluation of Level III alternatives for the PVR structures and presents the results of the analysis of those alternatives. The analysis includes hydrology and hydraulics for each of the Level III alternatives, geotechnical and geohazard evaluation, identification of existing and planned utility corridors and transportation infrastructure,

development of conceptual landscape themes and recreational opportunities, and development of preliminary construction cost estimates.

The hydrology and hydraulics evaluations of two planning alternatives were conducted as part of the Level III study. Updated rating curves for the auxiliary spillways and for Vineyard Road and Rittenhouse FRSs were prepared and documented in Appendix C of the report. These updated rating curves were input into FLO-2D models to evaluate the operational response of the alternatives.

3. ECONOMICS

This section provides an abbreviated summary of the economic evaluation conducted in support of the Supplemental Watershed Plan and Environmental Assessment for the PVR project. The reader is referred to the full economic evaluation technical memorandum for further details and information.

The PVR economic evaluation is documented in the following report:

- Powerline, Vineyard Road and Rittenhouse Flood Retarding Structures Supplemental Watershed Plan/Environmental Assessment Economics Evaluation Technical Memorandum. (Gannett Fleming Inc. January, 2013)

3.1. Economics Evaluation Technical Memorandum Summary

The economics evaluation was prepared in support of the Powerline, Vineyard Road and Rittenhouse Flood Retarding Structure Supplemental Watershed Plan and Environmental Assessments (Plan/EAs). The memorandum describes the methodology and summarizes the results of the benefit-cost analysis. The analysis was conducted on the following two alternatives:

- Alternative 8A: Replace Powerline FRS, Rehabilitate Vineyard Road FRS, and convert Rittenhouse FRS to a levee,
- No Federal Action Alternative (Future Without Project)

The benefit-cost analysis follows the procedures outlined in the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G)*, the *Natural Resource Economics Handbook Part 611 – Water Resources* and the *National Watershed Manual* (Dec 2009). All values in the analysis are in 2012 prices and all annual values have been discounted using the FY2012 federal discount rate for water resources projects of 3.750 percent. Economic values were derived based on each of the three dams as a single analysis unit.

The study area for the economics evaluation encompasses approximately 54.5 square miles immediately downstream of the Powerline, Vineyard and Rittenhouse dams in Maricopa and Pinal Counties, AZ. The study area for the project was defined as the limits of the 100-year floodplain downstream of the three dams without the dams in place. This area encompassed the farthest extent of flooding for the combination of alternatives and storm events examined within the scope of the project. Study area land uses include agriculture, residential, commercial, industrial, institutional, and infrastructure.

3.1.1. Study Area Inventory

To identify study area land uses, GIS tax parcel data was obtained from the Maricopa and Pinal Counties Tax Assessor's Offices. A database of tax parcels within the study area limits was created using ArcGIS. The parcels were then divided using the Assessor's Use Code descriptions into the following categories:

- Residential – existing residential properties
- Residential(new) – residential properties under construction, or imminently to be constructed

- Commercial/Industrial – existing commercial and industrial businesses, Phoenix-Mesa Gateway Airport
- Institutional – K-12 schools, churches, college campuses, federal, county and municipal properties
- Agricultural – active agricultural land
- Agricultural(structures) – parcels including both active agricultural land and agricultural buildings
- Infrastructure – roads, irrigation districts, utilities' right-of-way
- Vacant – vacant land (regardless of zoning designation)

The accuracy of the parcels database and Use Codes was verified through a fieldview and examination of aerial photography.

Population-at-Risk (PAR)

The population benefiting from the dams consists of the population that would be inundated by an uncontrolled breach of the dam. Dambreak scenarios for each FRS were previously modeled for the "Powerline, Vineyard and Rittenhouse Flood Retarding Structures Emergency Action Plan" (FCD 2006).

The estimated population within the dambreak floodplain limits, based on the structures inventory, were estimated and provided in the memorandum. Where the dambreak floodplain limits fell outside of the study area, the estimated number of residential structures was extrapolated based on a percent increase or decrease in the study area population (i.e., the Rittenhouse FRS dambreak limits were 14% larger than the overall study area, so the population of the study area was multiplied by 1.14 to estimate the dambreak population). This extrapolation was verified with aerial mapping denoting approximate population density. Household size was estimated using 2010 U.S. Census Bureau demographic data on average household size for Maricopa and Pinal Counties. The estimate (2.73 persons) is an average of the two counties (2.67 and 2.78 persons, respectively).

For commercial/industrial and institutional structures, population estimates were based on daytime occupancy. Commercial/industrial and institutional structures estimates were based on the structures inventory. The Phoenix-Mesa Gateway Airport falls within the dambreak floodplain for all three dams, and so was included in each population at risk estimate. The average occupancy at the airport was estimated using data from the Phoenix-Mesa Gateway Airport Authority's report, *Economic Benefit Analysis, FY 2010*. Average occupancy at Arizona State University Polytechnic Campus was estimated to be approximately 1/2 of the annual enrollment of 9,700 students. Average occupancy at Mesa Community College, a commuter campus, was estimated to be approximately 1/4 of the annual enrollment of 27,000 students.

For the portion of the dambreak area outside the project study area, 2010 U.S. Geological Survey GIS data was used to identify additional schools. It was outside the scope of the analysis to identify additional commercial/industrial and other institutional structures individually for the portion of the dambreak area outside the project study area. Instead, the number of these structures was extrapolated based on study area totals.

The PAR estimated in the technical memorandum represents a conservative approach and estimate.

3.2. Hydraulic Model

Hydraulic modeling of the downstream inundation area with and without the PVR structures was prepared using the FLO-2D flood routing model, version 2009.06. A 500-foot by 500-foot grid was developed for the computational domain area and ground elevations were obtained from the District's 10-foot topography with supplemental 2-foot contour data sets from the District.

Further details regarding the hydrologic and hydraulic modeling conducted for the project can be found in the following references:

- "PVR Existing and Future Conditions Hydrology and Hydraulics Update Technical Report", Kimley-Horn and Associates, Inc., November 2010.
- "PVR Downstream Inundation Study", JE Fuller, Inc., November 2010.

Appendix A of the technical memorandum for floodplain delineation mapping shows the inundation limits for the 2-year, 5-year, 10-year, 25-year, 50-year, and 100-year storm events for each scenario.

3.3. Benefits: Preferred Alternative and No Federal Action Alternative

Benefits were estimated for the following two alternatives:

- Alternative 8A: Replace Powerline FRS, Rehabilitate Vineyard Road FRS, and convert Rittenhouse FRS to a levee (Preferred Alternative)
- No Federal Action Alternative (Future Without Project)

The No Federal Action/Future Without Project represents the sponsor's most likely course of action in the absence of federal funding. For this study, the "No Federal Action/Future Without Project Alternative" was defined as the following:

> The District would continue to operate and maintain the Powerline, Vineyard Road, and Rittenhouse Flood Retarding Structures under existing conditions until the end of the structures' design lives. The structures would continue to have identified safety deficiencies and would not meet current NRCS and ADWR performance standards. Under this alternative, the structures would continue to provide flood protection until and if there is a sudden breach event. This condition is unacceptable to the District and NRCS.
>
> The District has indicated that without federal financial assistance, sufficient funds are not available to rehabilitate or replace the structures in a timely manner. The District recognizes, however, that there remains a need to address the existing safety deficiencies. Therefore, the District would eventually rehabilitate or replace the dams one at a time as non-federal funds become available. The District estimates that rehabilitation/replacement using local funds would occur (after approval of the Supplemental Watershed Plan) for the first structure in year 20, the second structure in year 25, and the third structure in year 30.
>
> This alternative is not acceptable to the Sponsors and local community as a viable solution, since the structures would continue to have safety and performance deficiencies

and continue to pose a significant risk of catastrophic failure until such time of the structures' eventual rehabilitation, replacement or removal from service.

Because both of the alternatives, including the No Federal Action/Future Without Project, continue to provide flood protection throughout the project life, the benefits are same for each alternative.

Benefits for the project were based upon the reduction of flood damages. Flood damages under both a With Dams and Without Dams scenario were estimated. The difference in flood damages between the two scenarios can be considered a benefit of retaining flood protection.

To analyze each dam as a single analysis unit, the downstream study area was reviewed by project hydrologists to provide an approximate demarcation of flooding impacts attributable to each dam. The study area was divided into four regions: one region for the floodplain of each dam, and a fourth region where Vineyard FRS and Rittenhouse FRS have overlapping floodplains (see Figure 1). Benefits for the overlapping floodplain were allocated by each FRS's percent control, measured by a comparison of total acre feet retained behind each structure. It was determined that the storage capacity behind the two dams was nearly identical and benefits were allocated accordingly at 50% for each dam.

3.4. Costs: Preferred Alternative and No Federal Action Alternative

Cost estimates for each alternative were developed by project engineers in conjunction with NRCS and the Flood Control District of Maricopa County.

Average annual equivalent costs for each alternative were prepared. Costs were brought to present value using the 2012 federal water projects discount rate of 3.750 percent, amortized over the 103-year project analysis period, and described in annual terms for comparison to project benefits. The net present value calculation assumed that flood protection would remain in place for all alternatives throughout the project life. Under the No Federal Action Alternative, Vineyard FRS was assumed to be reconstructed in project year 20, with Powerline and Rittenhouse reconstructed in years 25 and 30, respectively. For the build alternatives, construction was assumed to occur in three years. Project administration, permitting and engineering costs for all alternatives were assumed to occur one year prior to construction.

Annual operation and maintenance costs (O&M)for the Preferred Alternative were estimated by project engineers. For the No Federal Action alternative, O&M costs were assumed to be approximately $512,000 per year until the dam is rehabilitated or replaced. After rehabilitation/replacement, O&M costs were assumed to be equivalent to the Preferred Alternative O&M estimates.

3.4.1. Benefit-Cost Ratio

For water and related land resources implementation studies, standards and procedures have been established in formulating alternative plans. These standards and procedures are found in the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G). According to P&G, an alternative that reasonably maximizes net national economic development benefits is to be formulated. This alternative is to be

identified as the National Economic Development (NED) plan. A comparison of the alternatives was provided in the technical memorandum.

The Preferred Alternative (8A) is the plan that reasonably maximizes the net benefits and is therefore identified as the NED plan. It can be noted that for all three dams, the net benefits shown in the tables are higher for the No Federal Action alternative than for the Preferred Alternative. This occurs because the No Federal Action alternative assumes that the dams would not be rehabilitated or replaced until 20-30 years into the future. In the interim, the dams would continue to provide flood protection benefits. Therefore, the costs of No Federal Action are lower, while the benefits remain the same. However, the No Federal Action alternative does not meet the purpose and need of the project because it does not remove the safety risk presented by the aging dams for two decades into the future. This is judged to be an unacceptable risk to human life and property by NRCS and the sponsor. For dam rehabilitation projects with risk to human life, NRCS policy defines the NED Alternative as the "federally assisted alternative with the greatest net economic benefits." Therefore, the Preferred Alternative (8A) has been identified as the NED alternative.

The Preferred Alternative results in a benefit to cost ratio of 0.1 to 1.0 for Powerline FRS, a ratio of 0.1 to 1.0 for Vineyard FRS, and a ratio of 0.1 to 1.0 for Rittenhouse FRS. The benefit to cost ratio for the dams are less than 1.0, but still provides the greatest net benefits (or fewest negative net benefits) of any alternative that meets the purpose and need of the project.

3.4.2. Risks and Uncertainty

The areas of risk and uncertainty associated with the economic analysis include uncertainty associated with the hydrologic and hydraulic modeling, simplifying assumptions used to run the URB-1 model, and uncertainty related to the future changes in cost estimates as engineering design progresses.

Hydrologic modeling over a wide swath of floodplain introduces an element of uncertainty in estimating attenuation and resulting peak flows. The hydraulics analysis relies partially on engineering judgment and experience to designate ineffective/effective flow areas over the wide and shallow floodplain of the study area.

Several simplifying assumptions were used to create input for the URB-1 model. Parcel elevations were determined using topographic contour data. Residential parcels were proportionally assigned as either a single story or two-story residence based on the fieldview determination that these two housing types were interspersed throughout the study area. Content values for parcels were estimated based on a percentage of their tax assessed structure value. The structure and contents value for some parcels were estimated using Marshall Valuation Service data. While these assumptions represented the best methodology available within the scope of the analysis, the model results may slightly overestimate or underestimate damages due to the simplifying assumptions used to create the input data.

4. GEOTECHNICAL

This section provides an abbreviated summary of the geotechnical investigations and analyses for the PVR project. The reader is referred to the full geotechnical reports for further details and information in regards to the PVR structures.

The PVR geotechnical studies are documented in the following reports:

- "Powerline, Vineyard Road and Rittenhouse Flood Retarding Structures Rehabilitation or Replacement Project Final Geotechnical Summary and Analysis Report". (AMEC August, 2010)
- "Powerline, Vineyard Road and Rittenhouse Flood Retarding Structures Rehabilitation or Replacement Project Final Filter Alternatives Memorandum". (AMEC May, 2012)

4.1. Final Geotechnical Summary and Analysis Report

The purpose of the "Final Geotechnical Summary and Analysis Report" was to provide an overview of the existing geological and geotechnical conditions at the three dams. The results, findings and conclusion of the report were used by the project team in its development and evaluation of dam rehabilitation and/or replacement alternatives.

The geotechnical summary report presents summaries of the original geotechnical investigations, design and construction of the three dams and the Powerline Floodway; the subsequent geological and geotechnical investigations performed to evaluate cracking of the dams; and the methods of repairing the structures conducted previously. The history and causes of the cracking and the modifications that were made to safeguard against failure of the structures were presented and discussed, as was the current understanding of the geotechnical conditions of the embankments and foundation soils. This report also presents a description of the geological setting of the study area, an overview of the condition of the principal outlets and other penetrations in the embankments, and a characterization of the subsurface conditions at the auxiliary (emergency) spillways.

4.1.1. Previous Investigations

The Geotechnical Summary Report reviewed and provided summaries of eighteen (18) previous geotechnical related investigations for the PVR structures. This "Existing Conditions Summary Report" does not provide a synopsis of this summary provided in the Geotechnical Summary Report. The reader is referred to the Geotechnical Summary Report.

4.1.2. Planning Geotechnical Investigation

Field investigations conducted as part of the PVR project were based on the District's identification of a need to rehabilitate and/or replace the Powerline, Vineyard Road and Rittenhouse FRS dams. Locations of borings, test pits, test trenches and seismic refraction survey lines performed during previous investigations were plotted on site plans of the three structures. Based on a review of these data, 41 additional exploration borings and four additional seismic refraction surveys were conducted to fill in data gaps and further characterize geological and geotechnical conditions at and adjacent to the dams and the Powerline Diversion Channel.

4.1.3. Regional Geologic Setting

The PVR study area is near the junction of the Mexican Highland and Sonoran Desert sections of the Basin and Range physiographic province, just southwest of the boundary between the Basin and Range and Transition Zone physiographic provinces. The boundary between these two provinces is marked by the western edge of the Superstition and Goldfield mountains, which rise abruptly above the valley floor. These mountain ranges also mark the eastern margin of the down-dropped Phoenix Basin, which underlies much of the Phoenix metropolitan area and extends westward to the Sierra Estrella and White Tank Mountains. The Phoenix Basin formed between approximately 8 and 15 million years ago after cessation of the volcanic activity that formed the bulk of the Goldfield and Superstition mountains.

The Phoenix Basin is subdivided into several sub-basins. The study area is within the Mesa-Chandler sub-basin. On the west, this sub-basin is partially separated from the central Phoenix Basin by the bedrock highs of the Tempe Butte area. The Mesa-Chandler sub-basin is bounded by the Goldfield and Superstition mountains on the north and northeast, by Mineral Mountain on the east, and by the Santan Mountains on the southwest.

4.1.4. Local Geomorphic Setting

The Powerline FRS is underlain by deposits typical of a basin floor and identified as fine-grained distal alluvial fan/alluvial plain and terrace deposits with little soil development. These basin floor deposits are incised by younger Holocene piedmont and intramontane deposits identified as channel deposits of ephemeral streams consisting of stratified sand, silt, pebbles, cobbles and boulders with little or no soil development.

The northern and central portions of the Vineyard Road FRS are underlain by an upper horizon of fine-grained alluvial fan and terrace deposits consisting of sand, silt and fine gravel. The southern portion of the Vineyard Road FRS and the Rittenhouse FRS are underlain by an upper horizon of piedmont and intramontane, low terrace and alluvial fan deposits consisting of poorly sorted silt, sand, pebbles, cobbles and boulders with weak soil development. These deposits have minimal soil development and are all incised by ephemeral streams containing channel deposits of stratified sand, silt, pebbles, cobbles and boulders with little or no soil development. These near-surface deposits, which are similar to the Holocene soils described throughout this report, are underlain by moderately to strongly cemented, predominantly fine-grained Late Pleistocene deposits.

4.1.5. Local Geologic Setting

Surface Geology

The Powerline FRS is underlain by four geologic units: Holocene Alluvial Channels Holocene Alluvial Surface; Undifferentiated Holocene Alluvium and Holocene to Late Pleistocene Alluvium.

The Vineyard Road FRS is underlain by five geologic units: Holocene Alluvial Channels; Holocene Alluvial Surface; Undifferentiated Holocene Alluvium; Holocene to Late Pleistocene Alluvium; and Late Pleistocene Alluvium. The geologic units are the same units described above for the Powerline FRS, with the exception of Late Pleistocene Alluvium, which occurs at the far southern limit of the structure.

The Rittenhouse FRS is underlain by four geologic units: Holocene Alluvial Channels; Holocene Alluvial Surface; Late Pleistocene Alluvium; and Middle to Late Pleistocene Alluvium. The first three geologic units have been described above for the Powerline and Vineyard Road FRS. The fourth unit Middle to Late Pleistocene Alluvium is located beneath the southernmost portion of the FRS.

Near-Surface Geologic Profile

The FRSs are underlain by shallow low-density soils that were deposited at the distal end of coalescing alluvial fans during the Holocene era (the last approximately 11,000 years). The soils were deposited during semiarid climatic conditions similar to present-day conditions, and the depositional processes included sediment transport in channels and periods of flooding which resulted in avulsion of braided channels, debris flows and mudflows. These processes resulted in a high degree of stratification and variation in soils types. The Holocene soils typically vary from 10 to 20 feet in thickness and are dominated by sandy clay and clayey sand with subordinate amounts of silty sand, sandy silt and sandy gravel.

The Holocene soils are uncemented or exhibit discontinuous Stage I calcareous (lime) cementation, and are predominantly moderately firm to firm with some soft and very firm zones. The Holocene soils have a high potential for collapse settlement, and typically experience from 2 to 6 percent of vertical strain upon wetting under their own weight or low superimposed loads.

The Holocene soils are underlain by Late Pleistocene alluvium primarily consisting of silty sand, clayey sand, gravelly sand and sandy clay. These soils typically possess Stage II or III calcareous cementation, are characterized as being very firm to hard with some firm zones, and are essentially incompressible from the viewpoint of contributing to settlement of low embankments. Based on a review of geotechnical investigations conducted in the study area, it appears that the thickness of the Holocene soils varies considerably over short distances, suggesting that the contact between the Holocene and Pleistocene soils is a buried erosional surface with considerable past relief.

The depth of the Holocene/Pleistocene contact below the original ground surface, the depths of the cutoff trenches along the upstream side of the dams, and the depths of the central drains within the embankments are important considerations when considering several of the potential failure modes for the structures. The potential presence of poor foundation conditions beneath the dams and how these conditions relate to potential failure modes are discussed in Section 5.5 of this section.

4.1.5.1. SOIL PROFILES UNDERLYING STRUCTURES BASED ON ALL GEOTECHNICAL INVESTIGATIONS

The following descriptions of the geotechnical profiles at the structures are based on a review of published literature and available boring and test pit logs from previous geotechnical investigations and the results of subsurface investigations completed as part of this study.

Powerline FRS

The geotechnical profile underlying the Powerline FRS is best described as a three-layer profile. Unit P1 consists of Holocene soils with little to no cementation; Unit P2 is composed of Holocene to Late Pleistocene soils with little to no cementation; and Unit P3 soils are Pleistocene in age with Stage II to III cementation. The units are described below.

Vineyard Road FRS

The geotechnical profile at the Vineyard Road FRS is similar to the profile at the Powerline FRS, but it is best described as a two-layer profile rather than a three-layer profile. Unit V1 consists of Holocene soils with little to no cementation, and Unit V2 is composed of cemented Pleistocene soils that are similar to Unit P3 of the Powerline FRS. The number of seismic lines completed along the Vineyard Road FRS is not sufficient to characterize the subsurface seismic velocity profile in the same detail as at the Powerline FRS.

Rittenhouse FRS

The geotechnical profile underlying the Rittenhouse FRS varies from north to south. Soils beneath the northern portion of the dam (Stations 115+00 to 210+00) are similar to the soils underlying the Vineyard Road FRS. Most of these soils classify as silty to clayey sand or silty clay with some sand. These soils are best described by a two-layer profile similar to the profile beneath the Vineyard Road FRS. Unit R1N consists of Holocene soils with little to no cementation and Unit R2N is comprised of Pleistocene soils.

4.1.6. Discussions

This section contains discussions on the following topics:

- Failure modes (with an emphasis on the impacts of the presence of Holocene soils beneath the dams),
- Data gaps and recommendations for additional investigations

4.1.6.1. FAILURE MODES (WITH AN EMPHASIS ON THE IMPACTS OF THE PRESENCE OF HOLOCENE SOILS BENEATH THE DAMS

Site Specific Failure Modes.

Failure mode and consequence analyses (FMCA) were performed for each of the three FRS in 2001 and 2002. The objective of the FMCA was to gain an understanding of the most significant site-specific potential failure modes for each of the structures and the consequences that could result from these potential failures.

Several of the potential failure modes result from, or are exacerbated by, the presence of Holocene soils (poor foundation conditions) beneath the structures or inadequate penetration of the upstream cutoff trench or central filter into Late Pleistocene soils.

The most significant of these potential failure modes is seepage erosion or piping resulting from flow through Holocene soils beneath the dam embankments or along the dam/foundation contact. There are three potential pathways associated with this failure mode. The pathways are described as follows:

- Path A – This failure mode is initiated by flow into transverse and longitudinal cracks that do not extend through the central filter, but do extend into foundation materials underlying the central filter and are in contact with Holocene soils.
- Path B – This failure mode is initiated by flow from the impoundment into differential settlement cracks that extend below the central filter and are in contact with Holocene soils.

- Path C – This failure mode is initiated by flow through remnant upstream borrow areas that contain considerable amounts of gravel and provide potential seepage pathways along buried gravel-rich channels into Holocene soils that underlie the embankments.

Paths A and B were identified as Category I potential failure modes for both the Vineyard Road and Rittenhouse FRS, and Path C was identified as a Category II failure mode for both the Vineyard Road and Rittenhouse FRS. Path A was identified as a Category III failure mode for the Powerline FRS.

The presence of Holocene soils beneath the embankments also was identified as a contributing factor to a potential failure mode in which impounded water flows into a transverse crack and initiates seepage erosion leading to a breach of the embankment.

Two modes of failure were identified:

- Mode A – This failure mode is initiated by flow through a large (wide) transverse crack that extends across the central filter.
- Mode B – This failure mode is initiated by flow through multiple upstream longitudinal and transverse cracks to a flaw(s) in the central filter that causes seepage erosion of the central filter materials and loss of these materials through a downstream transverse crack. In general, this failure mode requires that cracks in the upstream and downstream sides of the embankment and the flaw(s) in the central filter be aligned in a near linear arrangement.

Failure Modes A and B were identified as Category I failure modes for all three structures.

The presence of Holocene soils beneath the embankments could also contribute to an additional potential failure mode: seepage-erosion due to development of an earth fissure through or beneath a structure. An earth fissure crossing a dam could create a continuous crack through the underlying foundation soils and/or embankment. If an undetected earth fissure were present during a major flood event, there would be a high risk of rapid seepage erosion through highly erodible Holocene soils located just below the embankment. This condition was identified as a Category I potential failure mode for the Powerline and Vineyard Road FRS and as a Category II potential failure mode for the Rittenhouse FRS.

Descriptions of Foundation Excavations and Central Filters

The three dams were constructed almost entirely using Holocene soils derived from upstream borrow areas, including the upstream cutoff trench, and from excavation of foundation soils below the footprint of the embankment. Excavation of the upstream cutoff trenches and excavation of the dam foundations resulted in the presence of “shelves” that generally extend 2 to 4 feet below original natural grades. The shelves beneath the Vineyard Road and Rittenhouse FRS extend from the upstream cutoff trench to a minimum of 22 feet downstream of the dam centerline. The shelf beneath the Powerline FRS extends from the upstream cutoff trench to a minimum of 10 feet downstream of the dam centerline.

Profiles of the upstream trench excavations and profiles of the shelves at the dam centerlines are presented on the as-built plans of the FRS, with the exception of the shelf at the Rittenhouse FRS. These profiles are discussed in the report sections that follow. In general, the upstream cutoff trench was designed to extend through the softer, collapse-prone Holocene soils and into the cemented Late Pleistocene soils along the entire length of the dam alignment.

Central filters were installed along the centerline of all three dams. The central filter installed in the Powerline FRS extends along the entire length of the embankment (from Stations 17+83 to 150+70). The filter has an average depth of 18 feet and a maximum depth of 42 feet. The depth of the filter was established by the NRCS on the basis of its 1986 crack location investigation. The central filter extends through the embankment and into native soils along much, but not all of the dam. There are several areas where the filter does not extend through the entire embankment.

The central filter in the Vineyard Road FRS extends along the entire length of the embankment (from Stations 85+00 to 360+00). As indicated on as-built plans of the filter, the central filter extends to depths of between 19 and 21 feet below the crest of the dam along most of its alignment, corresponding to depths of between 2.5 to 4.5 feet below the original ground surface. There are several areas where the filter does not extend through the entire embankment.

The central filter in the Rittenhouse FRS extends from Stations 80+00 to 210+00, but it was not installed in the southern 5,000 feet of the embankment between Stations 30+00 and 80+00. The filter was designed to extend 12 feet below the crest of the dam, except where deeper cracks were observed in the trench by an onsite NRCS representative. In areas where cracks extended beyond a depth of 12 feet, the filter was deepened until there was no further evidence of the presence of the crack. The central filter has an average depth of 12.8 feet between Stations 80+00 and 109+72 and an average depth of 15.8 feet between Stations 109+72 and 200+00. The filter varies in depth from 14.6 to 6.9 feet between Stations 200+00 and 210+00. Forty outlet drains were constructed between Stations 80+00 and 200+00 of the Rittenhouse FRS at approximately 1,000-foot intervals along the dam or as directed by the Engineer. The outlet drains slope toward the downstream toe of the dam and are designed to provide positive drainage from the central filter.

The central filters in the Powerline and Vineyard Road FRS are 3 feet wide, whereas the central filter in the Rittenhouse FRS has a nominal width of 2.6 feet. Unlike the central filters in the Powerline and Vineyard Road FRS, the filter in the Rittenhouse FRS is not continuous over the entire length of the dam nor was it designed to extend through the entire embankment into the underlying soils. Outlet drains were installed in the Rittenhouse FRS, but not the Powerline or Vineyard Road FRS.

Collapsing Foundation Soils

The Holocene soils beneath the dams have characteristics that are typical of collapsible soils, including depositional environment, low blow counts, low dry density (indicative of an open soil structure) and weak cementation. Some of the Late Pleistocene soils that underlie the Holocene soils have similar characteristics. The collapse potential of these soils was tested in the laboratory by performing one-dimensional consolidation tests using relatively undisturbed samples obtained during the current field investigation. The collapse potential of the samples tested ranged from 0.0 to 8.7 percent with an average collapse potential of 1.5 percent. The dry density of the 74 samples ranged from 88 to 124.2 pcf and averaged 104.5 pcf.

The formation of cracks due to collapsing foundation soils is the result of differential collapse that occurs when soils that underlie the structures are not equally wetted. The amount of collapse also depends on the thickness of the collapsing soil layer. Water has been impounded behind all three dams, most notably during October 1972. Impoundment of this water likely resulted in partial collapse of the Holocene soils, and to a lesser extent the Late Pleistocene soils,

underlying the upstream section of the embankments. The rate of infiltration into the Holocene soils is estimated to range from 0.5 to 3 feet per day (Hansen and others 1989). The flood event of 1972 likely resulted in the wetting of Holocene soils beneath the upstream slope of the embankments to a distance of 5 to 30 feet downstream from the upstream toe of the embankments. It is probable that this wetting resulted in differential collapse of a variable thickness of soils, resulting in longitudinal cracks developing at various elevations in the upstream slope of the embankments.

4.1.6.2. DATA GAPS AND RECOMMENDATIONS FOR ADDITIONAL INVESTIGATIONS

The following should be considered as part of planning and/or final design:

- No documentation of stability analysis is being performed for any of the structures, neither during the original design of the structures nor during subsequent studies. Depending upon the alternatives recommended a stability analysis should be considered for the structures.
- There is some indication that the materials in the central filters may have become cemented. Depending upon the alternatives recommended the condition of the filters and their susceptibility to cracking should be investigated.

4.2. Final Filter Alternatives Memorandum

This memorandum presented the results of a comparison between a central filter and an upstream sloping filter for the rehabilitation of the Powerline, Vineyard Road and Rittenhouse (PVR) Flood Retarding Structures (FRSs). This memorandum includes a discussion of the project background, an overview of the existing PVR structures and filters, a discussion of potential failure modes associated with the existing filter conditions, a general “compare and contrast” of a central filter versus an upstream sloping filter, a summary of case studies, and recommendations for a filter design specific to the PVR structures.

4.2.1. Project Background

4.2.1.1. EMBANKMENT CRACKING

Numerous cracks, both longitudinal and transverse to the dam alignment, were observed in the embankments in the early 1970s after water was first impounded behind the structures. Fugro, Inc. (1979) conducted a crack investigation of the Vineyard Road FRS and NRCS (1983, 1986) conducted crack investigations of the Vineyard Road and Powerline FRSs. Mapping of cracks was also performed during installation of the central filters (Fugro for the Rittenhouse FRS and NRCS (1983, 1991) for the Powerline and Vineyard Road FRSs. General results of these crack investigations are summarized in the “Final Geotechnical Summary and Analysis Report” (AMEC 2010).

The cracking was evaluated by the NRCS, and it was concluded that the cracking did not pose an imminent danger to the structures. Ongoing surveillance of these dams and other PL-566 dams in Arizona revealed an increase in the intensity and severity of cracking over time and, as a result, an NRCS study team was appointed to study the magnitude and severity of cracking in PL-566 dams. Based on the results of these studies, the study team concluded that transverse cracks in the dams were primarily caused by tension release due to desiccation and shrinkage, and that these transverse cracks pose the greatest hazard to the integrity of the structures.

4.2.1.2. INSTALLATION OF CENTRAL FILTERS

As a result of these findings, a phased approach was developed to further evaluate the existing condition of the dams, to design remedial measures to mitigate the cracking, and to repair the dams. Evaluations of the dams were performed by the NRCS and several geotechnical consulting firms between 1979 and 1986 and, based on the results of these investigations central filters were constructed in the three structures between 1978 and 1991. The central filters are designed to create a filter cake at the upstream interface between the filter and the embankment to prevent piping (internal erosion) along cracks that have developed in the embankment. The Powerline and Vineyard Road FRSs have filters that typically extend through the embankments and into native soils, except in a few isolated areas. In general, the central filters do not extend below the elevation of the upstream cutoff trenches. The Rittenhouse FRS filter generally does not extend through the embankment and into native soils or extend below the elevation of the upstream cutoff trench. Additionally, a central filter is not present in the southern end of the Rittenhouse FRS from Station 30+00 (the left abutment) to Station 80+00, a distance of 5,000 feet. It is the opinion of the project geotechnical engineer that the filters should extend into soils that possess Stage II cementation (or greater) and/or soils that are essentially incompressible and not susceptible to internal seepage erosion.

4.2.1.3. PRESENCE OF COLLAPSIBLE HOLOCENE SOILS

The FRSs are underlain by low-density alluvial fan soils, which were deposited during the Holocene (during the last approximately 11,000 years). These soils have a high potential for collapse settlement and typically experience from 2 to 6 percent of vertical strain upon wetting under self-weight or low superimposed loads. The Holocene soils are underlain by Late Pleistocene alluvium consisting of dense or hard, highly stratified deposits. Unlike the Holocene soils, which are uncemented or exhibit discontinuous Stage I calcareous cementation, the Late Pleistocene soils typically possess Stage II or III cementation (the reader is referred to the “Final Geotechnical Summary Report” for a presentation of the cementation stages) and are essentially incompressible from the viewpoint of contributing to settlement of low embankments. It appears that the thickness of the Holocene soils varies considerably over short distances, suggesting that the top of the Pleistocene alluvium was an erosional surface with varying topography. The orientation of drainage channels during deposition of the Late Pleistocene and Holocene deposits may have differed from the orientation of the present-day drainage system.

Based on these profiles, it appears that not all of the soils that are susceptible to collapse and internal erosion were removed from beneath the embankments or from the upstream cutoff trenches during construction of the dams, nor do the existing central filters in the embankments extend all the way through these soils and into incompressible soils that are not susceptible to internal erosion. Compression (collapse) of the softer, uncemented soils beneath the embankments may have resulted in differential settlement and cracking of the dams. Cracks that extend to the bottom of the embankments may be in contact with erodible soils, resulting in the potential presence of internal erosion pathways along the embankment-foundation interface below the central filters.

4.2.2. Foundation Excavations and Central Filter Construction

4.2.2.1. UPSTREAM CUTOFF TRENCH

The three dams were constructed almost entirely of soils derived from upstream borrow areas, including the upstream cutoff trench, and from excavation of foundation soils below the footprint of the embankment. Excavation of the upstream cutoff trenches and excavation of the dam foundations resulted in the presence of "shelves" that generally extend 2 to 4 feet below original natural grades. It is thought that the upstream cutoff trench was designed to extend through the contact between the softer, collapse-prone soils (typically referred to as Holocene soils) and the underlying competent, cemented soils (typically referred to as Late Pleistocene soils) along the entire length of the dam alignment; however, only limited portions of the upstream cutoff trenches extend to this contact at the PVR FRSs.

Central Filters

Central filters were installed along the centerline of all three dams. The central filters in the Powerline and Vineyard Road FRS are 3 feet wide, whereas the central filter in the Rittenhouse FRS has a nominal width of 2.6 feet. Unlike the central filters in the Powerline and Vineyard Road FRSs, the filter in the Rittenhouse FRS is not continuous over the entire length of the dam nor was it designed to extend through the entire embankment into the underlying soils. Outlet drains were installed in the Rittenhouse FRS, but not at the Powerline or Vineyard Road FRSs. The outlet drains (40 in total) were constructed between Stations 80+00 and 200+00 of the Rittenhouse FRS at approximately 1,000-foot intervals along the dam or as directed by the Engineer. The outlet drains slope toward the downstream toe of the dam and are designed to provide positive drainage from the central filter.

In a May 8, 2008 ADWR Inspection Report for the Powerline FRS, it was noted that during a recent geotechnical investigation that involved excavation of a shallow trench that exposed the upper portion of the central filter, there were similarities between the filter materials and the compacted embankment soils. Photo-documentation of this condition is presented in Appendix E of the report entitled "Earth Fissure/Ground Subsidence Instrumentation Installation Report and Monitoring Plan" (AMEC 2007), Noted similarities included "soil stiffness that supported vertical trench walls and cracking that extended into the central filter material." ADWR notes that this observation is contrary to the standard of practice for granular filter design wherein the filter should be free-flowing and self-healing.

Powerline FRS

The central filter installed in the Powerline FRS in 1991 extends along the entire length of the embankment (from Stations 17+83 to 150+70). The filter has an average depth of 18 feet and a maximum depth of 42 feet. The depth of the filter was established by the NRCS on the basis of its 1986 crack location investigation.

Vineyard Road FRS

The central filter installed in the Vineyard Road FRS in 1983 extends along the entire length of the embankment (from Stations 85+00 to 360+00). As indicated on as-built plans of the filter installation, the central filter extends to depths of between 19 and 21 feet below the crest of the dam along most of its alignment, corresponding to depths of between 2.5 to 4.5 feet below the original ground surface (SCS 1983).

Rittenhouse FRS

The central filter installed in the Rittenhouse FRS in 1979 extends from Stations 80+00 to 210+00; a filter was not installed in the southern 5,000 feet of the embankment between Stations

30+00 and 80+00. The filter was designed to extend 12 feet below the crest of the dam, except where deeper cracks were observed in the trench by an onsite NRCS representative during installation of the filter. In areas where cracks extended beyond a depth of 12 feet, the filter was deepened until there was no further evidence of the presence of the crack.

4.2.3. Existing Filter Potential Failure Modes

4.2.3.1. FUNCTION OF EXISTING FILTERS

Sand and gravel filters are used to prevent internal erosion or piping of soil through cracks in embankments or foundations of hydraulic structures. Properly graded filters designed in accordance with NEH-633, Chapter 26 criteria are capable of sealing cracks. As described in above central filters were installed to varying degrees in each of the PVR structures. Since the installation of these filters, studies have revealed potential concerns about the suitability of the soils in which the filters were founded and the depth of filter penetration. These concerns, which are documented in the Final Failure Mode Analysis Report, Structures Assessment Program – Phase 1 have led to an evaluation of the potential installation of new filter systems to mitigate the known failure modes.

4.2.3.2. POTENTIAL FAILURE MODES

To evaluate the need for an updated filter system, an understanding of the potential failure modes associated with partial penetrating filters and embankment cracking was developed. There are five likely potential failure modes related to the existing filter conditions at the PVR structures. The mechanism for failure in each case is internal erosion. Due to the relatively short impoundment duration anticipated at each of the PVR structures, the development of conditions leading to a potential dam failure are considered most likely to occur over time through a series of flood events and are considered unlikely to occur during a single flood event. The five potential failure modes are summarized as follows.

Failure Mode 1 (FM-1) – Internal erosion through transverse cracks in the embankment and a defect in the central filter.

- Desiccation cracking creates voids within the embankment allowing moisture to reach the central filter. Defects in the central filter, cementation and cracking or improper filter matching, allow for embankment material to migrate downstream ultimately leading to breach failure.

Failure Mode 2 (FM-2) – Internal erosion along the interface between the foundation and erodible soils beneath the central filter at the embankment-foundation interface (not in the embankment).

- Desiccation cracking or upstream buried channels of more permeable material allows moisture to reach the foundation-Holocene interface. Since the central filter is only a partially penetrating filter, moisture is able to migrate downstream along the embankment-foundation (embankment-soil) interface, ultimately leading to a breach failure.

Failure Mode 3 (FM-3) – Internal erosion through cracks in the embankment that extend beneath the central filter.

- Desiccation cracking creates voids within the embankment soils. Since the central filter is only a partially penetrating filter (along essentially all of the Rittenhouse FRS and only

minor sections of the Powerline and Vineyard Road FRSs), moisture is able to migrate downstream below the bottom of the central filter, ultimately leading to a breach failure.

Failure Mode 4 (FM-4) – Internal erosion through cracks in the embankment beneath the central filter along the erodible soils at the embankment-foundation interface (not in the embankment).

- Desiccation cracking creates voids within the embankment soils allowing moisture to reach the erodible foundation soils. Since the central filter is only a partially penetrating filter, moisture is able to migrate downstream below the bottom of the central filter through the softer, uncemented, collapse-prone soils, ultimately leading to a breach failure.

Failure Mode 5 (FM-5) – Internal erosion through cracks in the embankment (no central filter present).

- Desiccation cracking creates voids within the embankment soils allowing moisture to migrate downstream ultimately leading to a breach failure.

4.2.3.3. SUMMARY OF FAILURE MODES

Based on the existing central filter conditions, FM-3 and FM-5 are only applicable to the Rittenhouse structure. The partially penetrating central filter does not provide adequate protection from cracking through the embankment as demonstrated in FM-3. In addition, approximately 5,000 feet of the Rittenhouse structure does not contain any central filter, making the structure susceptible to FM-5.

The remaining failure modes, FM-1, FM-2 and FM-4, are applicable to all of the PVR structures. While more likely at the Powerline or Vineyard Road structures, these failure modes could potentially occur at any of the PVR structures. The likelihood is increased for the Powerline and Vineyard Road structures because of their existing central filters. At these structures the central filters extend from the crest down to the erodible soils with an average of 5 and 7.5 feet, respectively, between the bottom of the central filters and competent, essentially incompressible soils.

4.2.3.4. MITIGATION OF FAILURE MODES

In order to mitigate the failure modes presented above the installation of a new filter system is being considered as part of the PVR Rehabilitation or Replacement Project. The new filter systems should extend from the crest of the dams into the moderately to strongly cemented soils along the entire length of each structure and should include a nonwoven geotextile on the downstream side of the filter. ADWR has informed the District and the District's various dam rehabilitation project planning and design teams that District dam rehabilitation projects involving central filters must have a downstream geotextile (or much more costly alternative components or measures) for application approvals. To date, no feasible alternative has been identified to address ADWR's extensive concerns with central filters as part of the District's dam rehabilitation projects. The inclusion of a geotextile in the recommendation is to ensure any potential costs are captured in the planning level cost estimate that could be incurred by the project to meet regulatory approval requirements.

The installation of a new filter system with the addition of a downstream geotextile would mitigate FM-1 and FM-5. Extending the filter into competent soils would mitigate FM-3;

however, a filter match between the filter material and all encountered foundation soils would be needed to mitigate FM-2 and a filter match between the embankment materials and all foundation soils would be needed to mitigate FM-4. The use of a central filter does not mitigate FM-2 unless there is a filter match between the filter material and all foundation soils, which would be very difficult to design and construct. In addition, the presence of coarse-grained material in contact with the embankment materials in the upstream cutoff trench may result in piping and loss of material upstream of the filter. In order to mitigate FM-4, filter matches would be required between the embankment material and all foundation soils and the filter material and all foundation soils.

4.3. Filter Alternatives

Filters can be constructed several ways. Based on experience with similar flood retarding structures, the most likely alternatives for the PVR structures are a central filter or an upstream sloping filter. While both systems have the capability of mitigating the potential failure modes presented, each system has unique advantages and disadvantages and is highly dependent on the existing embankment and foundation conditions. In addition, it is noted that the upstream sloping filter concept for the PVR dams has been developed as part of this study and taken through the Failure Modes and Effects Analysis (FMEA) process. No potential failure modes for the upstream sloping filter concept were identified. If the central filter concept is to be carried forward into the final alternative selection phase of this study, it is recommended that the central filter concept first be brought to the same level of study as the upstream sloping filter concept.

4.3.1. Central Filter

Central Typical Design

The typical design of a central filter at the PVR structures would consist of two components. The first component is a granular material designed in accordance with NEH-633, Chapter 26 (NRCS 1994) to be filter matched to the embankment soils. The granular material would be placed in a loose condition in areas of existing embankment and compacted in areas of new embankment. The second component is a nonwoven geotextile placed on the downstream side of the granular material. The filter would generally be placed vertical along the centerline of the entire structure and extend from the required freeboard elevation to the elevation of competent foundation soils. In the case of the PVR FRSs, the existing central filter trenches would be excavated through to remove the existing filter material and extend the trench down to competent foundation soils. Competent foundation soils along the PVR FRSs are considered to be those soils with Stage II cementation or greater, which are commonly considered to be Late Pleistocene soils in the PVR area.

In addition, the required freeboard elevation for the PVR FRSs will require a crest raise. In order to facilitate this raise, a portion of central filter near the existing crest would be extended upstream, horizontally for a short distance before extending vertically at the new centerline. During a February 16, 2012 FMEA, it was suggested that the horizontal portion of the filter could be eliminated by overlapping the two vertical sections of filter. This would result in an upstream-downstream gap between the two sections of vertical filter. A potential failure mode was identified whereby a crack could propagate downstream from the partially penetrating upstream vertical filter over the top of the downstream vertical filter. The FMEA participants did not elect to carry this failure mode forward for further discussion and categorization, since other alternatives were proposed that would eliminate this condition.

4.3.2. Upstream Sloping Filter

Upstream Sloping Filter Typical Design

The typical design of an upstream sloping filter at the PVR FRSs would consist of a granular material designed in accordance with NEH-633, Chapter 26 (NRCS 1994) with a nonwoven geotextile placed on the downstream side of the filter material (see Figure 11). The filter would be placed along the entire upstream slope of the structure and extend from the required freeboard elevation down to competent soils as describe in Section 5.1.1. A portion of the upstream slope extending from the existing crest down throughout the upstream toe and terminating into competent soils would be excavated. A nonwoven geotextile would be placed on the slope, followed by placement of compacted filter material extending from competent foundation soils to the required freeboard elevation. The filter would then be covered with filter-matched embankment material.

4.4. Recommendations

Based on experience with filter construction, the major advantages to installing a central filter are the limited quantity of excavation required and the flexibility of construction sequencing. Central filter excavations result in a limited quantity of excavation because the only overexcavation occurs at the crest above the freeboard elevation, thus reducing the overall cost of construction. Central filters also provide flexibility in construction sequencing because excavation and backfill can be performed in tandem. This allows for the process to start and stop as needed with a limited section of excavation open at any given time. However, given the anticipated foundation soil conditions at the PVR structures and the inability to address all of the potential failure modes, the project geotechnical engineer (AMEC) believes the advantages of a central filter are greatly diminished.

The PVR embankments are underlain by 5 to 7.5 feet of erodible soils on average, and these erodible soils are as thick as 15 feet in some areas of the embankment. The contact between these erodible soils and the underlying competent soils is not marked by an abrupt change in character; rather, the contact is gradational and not easily observable from the crest of the dam. In addition, the structures have been constructed over a number of paleochannels (relic washes) that are more prone to sloughing. The potential for cave-ins, whether a result of loose soils or coarse-grained paleochannel deposits, could easily increase construction costs, especially given that the PVR FRSs have a combined length of approximately 11.5 miles. The presence of these materials would also introduce unmatched filter gradations.

If the final alternative selection for the PVR Rehabilitation or Replacement Project requires rehabilitation of the existing structures, AMEC recommends the construction of an upstream sloping filter. The filter system should consist of a downstream geotextile and filter-matched granular material. This type of filter would allow inspectors to more easily identify the subtle differences between erodible soils and cemented, competent soils, avoid the potential for substantial additional work resulting from cave-ins and the costs associated with this additional work.

5. GEOHAZARD

This section provides a summary of the geohazard reviews, investigations and analyses for the PVR project. The reader is referred to the full geohazard reports for further details and information in regards to the PVR structures.

The geohazard studies are documented in the following reports

- "Powerline, Vineyard Road and Rittenhouse Flood Retarding Structures Rehabilitation or Replacement Project Final Initial Subsidence and Earth Fissure Report". (AMEC August, 2010).
- "Powerline, Vineyard Road and Rittenhouse Flood Retarding Structures Rehabilitation or Replacement Project Final Earth Fissure Risk Zoning Memorandum". (AMEC May, 2012)

5.1. Final Initial Subsidence and Earth Fissure Report (GeoHazard Study)

The purpose of the geohazards investigation was to evaluate potential impacts of ground subsidence and earth fissuring on the selection and subsequent development of rehabilitation designs and/or replacement alternatives for flood protection afforded by the Powerline, Vineyard Road and Rittenhouse Flood Retarding Structures (FRS). The results, findings and conclusion of the report were used by the project team in its development and evaluation of dam rehabilitation and/or replacement alternatives.

The geohazard study and assessment involved the compilation, review and interpretation of existing technical data. This data included review of aerial photography and interferometric satellite-based synthetic aperture radar (InSAR) data, ground reconnaissance of the study area, surface resistivity surveys, development of subsidence predictions, and a preliminary delineation of earth fissure risks.

Existing Data Collection & Review

Available groundwater data were reviewed and a summary of historical groundwater decline in the project area was prepared. Included in this effort was review of the East Valley Water Forum scenarios for the east Salt River Valley sub-basin application of the Regional Groundwater Flow Model and the impact of the proposed Superstition Mountains Recharge Project on the Central Arizona Water Conservation District.

InSAR Review and Analysis

InSAR was used in this study to detect the rate and distribution of subsidence occurring in the study area over the time periods covered. This information was then further utilized in the characterization of bedrock/alluvial interface and deep alluvium and for the FRZ delineation

ADWR is currently applying InSAR as part of a long-range study of basin subsidence in Arizona. Recent interferograms developed by ADWR on the basis of 2000 to 2009 synthetic aperture radar data were compiled and analyzed for the project area. InSAR images previously provided by ADWR were also reviewed as part of this assessment.

Photogeologic Interpretations

High-resolution aerial digital imagery previously provided by the District was reviewed, and it proved to be an equivalent substitute for low-sun-angle afternoon photography. Lineament

analyses using both low-sun-angle aerial photography and high-resolution digital aerial imagery for the purpose of identifying potential earth fissures have been performed at Powerline FRS by AMEC in previous studies.

As part of the current study, aerial photographs and digital images were evaluated for purposes of identifying features indicative of the presence of earth fissures. These features include elongated fissure gullies, alignments of potholes and other small depressions, lineations in the vegetative cover and subtle linear ground features caused by shading. No conclusive evidence for earth fissuring was identified, except for the known earth fissure downstream of the Powerline FRS embankment at about Station 115+45 and the known earth fissures in the vicinity of Hawk Rock to the west of the Powerline FRS.

Geologic Reconnaissance

A ground reconnaissance was performed to inspect the project area for evidence of ground subsidence or earth-fissure-related features. Select lineaments within the study area with the potential to impact proposed facilities were observed from the ground. Very few lineaments outside of the immediate vicinity of Powerline FRS were selected for direct ground observation. No earth fissures or features indicative of possible earth fissures were observed at the project site, excepting previously known earth fissures in the vicinity of the Powerline FRS and Hawk Rock. As a consequence, slight adjustments were made to the alignment of some of the features and other features were eliminated, particularly features that were identified as being cultural in origin.

Deep Resistivity Profiling

Resistivity interpretations do not result in unique solutions; therefore, the interpreted results are approximate. However, reasonable trends are apparent that can assist in understanding the basin subsurface. Two-layer interpretations, typically used for a shallower and deeper interface, were performed. Shorter array spacing data were used to develop two-layer interpretations of the shallower subsurface. The longest array spacing data were used to develop two-layer interpretations in the deeper subsurface, and when appropriate, for an intermediate interface or to check against the possibility of high-resistivity deep bedrock. These interpretations provide general resistivity values and ranges of anticipated depth interfaces within the basin subsurface to depths of several hundred feet to as great as about 1,000 feet.

Future Subsidence Prediction

Based on the subsurface information available from literature, existing geophysical well logs and from the surface geophysical measurements, simplified basin vertical profiles were developed to estimate historic subsidence and the potential for future subsidence. It was assumed that basin material compression leading to subsidence was limited to the portions of the upper or middle alluvial units that were below the groundwater table; contributions of bedrock or the lower alluvial unit were assumed to be negligible. Estimates of subsidence could then be calculated from the resulting basin vertical profiles.

Based on these profiles, simplified estimates of subsidence were performed using the methods and procedures discussed in the AMEC white paper “Characterization for Subsidence Modeling and Percolation Theory–Based Modeling of Subsidence”.

Earth Fissure Risk Delineation

Using the data and analytical techniques discussed above, earth Fissure Risk Zones (FRZ) were developed. The risk zones were first delineated for the Powerline FRS and the northern portion of the Vineyard Road FRS as part of a previous investigation. The risk zones were then updated to account for the earth fissure discovered downstream of the Powerline FRS embankment at about Station 115+45. The risk zones around the Powerline FRS, the proposed Powerline IDSM and the northern third of the Vineyard Road FRS did not change as a result of this investigation. However, the earth FRZ were extended south to include the remainder of the Vineyard Road FRS and the Rittenhouse FRS and extended north to include the Powerline Diversion.

5.1.1. Geological Setting

The project site is within the Sonoran region of the Basin and Range physiographic province and is, in part, structurally separated from the central Phoenix valley by the bedrock highs of the Tempe Butte area. The study area lies within the Mesa-Chandler sub-basin, adjacent to the Superstition and Goldfield Mountains, which are composed of metamorphic and igneous bedrock. This sub-basin contains basin-fill deposits of the Salt River Valley that can be subdivided into three units: lower alluvial unit (LAU), middle fine-grained unit (MFGU) and upper alluvial unit (UAU).

The surficial geology for the PVR project is discussed in the *Draft Supplemental Earth Fissure Risk Technical Memorandum* prepared by AMEC on behalf of the District. The following sections discuss aspects of the geologic setting important to an appraisal of ground subsidence and earth fissuring, such as depth to bedrock and deep alluvial characteristics.

Basin Geometry and Depth to Bedrock

The buried shape and proximity of the bedrock-alluvium contact are likely the most dominant influences on where earth fissures form around Hawk Rock and near the Powerline FRS. These are regions where the gradient of the bedrock-alluvium interface is quite pronounced, with the thickness of the alluvium being variable. These conditions result in a differential subsidence profile, a prerequisite to earth fissure formation. Bedrock is present at the surface at Hawk Rock, which is about 4,000 feet west of the bend in the FRS embankment near Station 110+00. Understanding this bedrock geometry is one of the most important factors for delineating earth fissure risks for the project.

There are four data sets that either directly or indirectly estimate the depth to bedrock or shape of the bedrock-alluvium interface in the vicinity of the project: 1) Bouguer gravity data, 2) depth to bedrock, 3) bedrock elevations, 4) InSAR, and 5) geophysical measurements.

Bouguer Gravity Data

The Bouguer gravity anomaly represents corrected surficial gravity measurements. Differences in the data represent differences in subsurface density. The most significant variation in subsurface density is that between bedrock and overlying alluvium.

The gravity data indicate that the depth to bedrock increases to the north and northeast of Hawk Rock. These data also indicate that the depth of bedrock and basin thickness increases to the south and southeast of Hawk Rock.

ADWR is currently preparing a three-dimensional (3D) model of gravity data for the Superstition Vistas area. This study includes the project and Hawk Rock areas. The gravity data

analyzed for the ADWR study represent a much greater density of data than obtained from previous studies and includes historical gravity data acquired by the USBR and USGS in the vicinity of Hawk Rock and the Powerline FRS.

Laney and Hahn Depth to Bedrock

The depth to bedrock developed by Laney and Hahn is based on limited data from wells drilled in the area, geologic mapping and gravity data. These data were developed on a regional scale and do not reflect local variations in the depth to bedrock. This interpretation does provide a reasonable estimation of the depth of the bedrock-alluvium interface on a large scale, but the presentation does not show variations at a scale that is useful for delineating earth fissure risk.

The depth to bedrock presented in Laney and Hahn provides a better indication of the depth to bedrock than provided from Bouguer gravity data alone. However, the Laney and Hahn work is concerned mainly with broad, regional variations, and the 400-foot contour interval used is relatively large. Those data also indicate that the depth to bedrock is increasing to the northeast and south of Hawk Rock. The data indicate that the depth to bedrock is relatively shallow in the vicinity of the Powerline FRS and the Powerline FRS IDSM and increases to depths greater than 1,200 feet for most of the Vineyard Road FRS alignment, for the entire length of the Rittenhouse FRS, and along the Powerline Diversion.

USBR Bedrock Elevation Data and Well Data

As part of the original investigations of subsidence and earth fissuring for the CAP Canal that were performed by the USBR and USGS, contours of bedrock elevation were developed for the area around Hawk Rock, including much of the area around the Powerline FRS and the northern portion of the Vineyard Road FRS. These contours were developed from an interpretation of deep seismic refraction and gravity surveys performed by the USGS and USBR. These data were never finalized and did not undergo a full review process. However, the contours do provide an informed and valuable local interpretation of the shape of the bedrock-alluvium interface in this portion of the project. For purposes of the following discussion, the ground surface in the area is assumed to be at an elevation of 1,500 feet. Actual elevations within the project area generally range from an elevation of 1,560 feet in the vicinity of the CAP Canal to an elevation of over 1,600 feet at the Rittenhouse FRS crest.

The USBR data indicate that the depth to bedrock at the bend in the Powerline FRS embankment at about Station 110+00 is about 300 feet below the ground surface (bgs). It should be noted that more dense or more cemented material was encountered at a depth of 330 feet bgs, and schist bedrock was encountered at a depth of 335 feet bgs.

The USBR data indicate that the depth to bedrock from about Powerline Station 50+00 to 105+00 ranges from about 600 to 700 feet bgs, and that north of Station 110+00 the depth to bedrock increases rapidly. These data indicate that depth to bedrock increases very rapidly south of the Powerline FRS. Underneath the northern portions of the Vineyard Road FRS, the depth to bedrock ranges from about 800 feet bgs at Station 345+00 to about 1,700 feet bgs at Station 310+00 to approximately 1,500 feet bgs at Station 280+00. The next deep well to the southeast at about Vineyard Road FRS Station 271+00, encountered conglomerate at a depth of 650 feet bgs and granite at a depth of 1,770 feet bgs. Southward from this point, the data indicate that depth to bedrock continues to increase to depths greater than 2,000 feet bgs.

InSAR

InSAR provides what is probably the best indication of the shape of the bedrock-alluvium interface in the vicinity of Hawk Rock due to its full map-view and 3D coverage. The most important aspect of this is the indication of the presence of buried bedrock ridges that radiate outward from Hawk Rock and how those implied buried ridges relate to the location of known earth fissures. Most of the known earth fissures and all the known fissures not in the immediate vicinity of Hawk Rock follow the apparent crest of these implied buried ridges. When comparing the InSAR data and USBR bedrock elevation data, it appears that the InSAR data more accurately indicate the location of the implied buried ridges.

Geophysical Measurements

As part of previous and ongoing investigations in the Powerline FRS area, geophysical studies provide some indirect measurement of the depth to bedrock. As important to the detection of bedrock in the subsurface profile are measurements that do not indicate bedrock is present within the depths of investigation.

As part of this study, a deep resistivity sounding was performed at about the Powerline IDSM Station 21+00. The interpreted depth to bedrock from this sounding is approximately 1,000 feet bgs. Several deep resistivity profiles and deep ReMi profiles were performed as part of the *Earth Fissure Risk Zone Investigation Report, Powerline and Vineyard Flood Retarding Structures, Pinal County, Arizona* (AMEC 2006). A resistivity profile centered north-south on Powerline FRS Station 135+00 indicates that the depth to bedrock may be greater than 1,000 feet bgs, while a profile centered north-south on Powerline FRS Station 115+00 does not indicate bedrock within a depth of investigation of about 300 feet bgs. Deep ReMi profiles performed at about Powerline FRS Stations 85+00, 110+00, 115+00 and 135+00 indicate that the depth to bedrock is greater than 300 feet bgs at each of those locations.

Other deep resistivity soundings performed as part of this investigation did not indicate bedrock within the depth of investigation of approximately the greatest electrode spacing of 1,000 feet. Those results are consistent with the historic deep wells SG-6, SG-10 and SG-12, where bedrock was encountered at depths greater than 1,600 feet, or not encountered at all,

5.1.2. Deep Alluvium Characteristics

The magnitude of ground subsidence and the location of earth fissures throughout the project area are controlled by the interactions of groundwater decline and the material characteristics of the compressible alluvial basin materials on the geometry of the underlying alluvial sediment/bedrock interface. The thickness of the basin alluvial materials is highly variable across the project area, ranging from none at Hawk Rock (less than 1 mile west of the Powerline FRS) to depths of 1,600 feet bgs at the southern end of the Vineyard FRS and 2,000 feet bgs at the Rittenhouse FRS. Variations in subsidence appear to reflect variations in both the depth to bedrock and the composition of the deep basin materials.

Areas of minimal subsidence include the vicinity of Station 110+00 on Powerline FRS and the vicinity of Station 292+00 on Vineyard Road FRS. While shallow bedrock is clearly an influence at Powerline FRS Station 110+00, shallow bedrock does not appear to be present at or near Vineyard Road FRS Station 292+00 to minimize subsidence in that area. Even though deeper bedrock depths provide more presumably compressible alluvial materials under the Vineyard

FRS compared with the Powerline FRS, considerably more subsidence is occurring in the vicinity of the Powerline FRS. Furthermore, subsidence is continuing in the vicinity of the Powerline FRS where groundwater table depths are likely below the top of bedrock and the compressible basin alluvium is probably above the regional groundwater table.

Data available to characterize the material characteristics of the deeper alluvium in which ground subsidence occurs are limited primarily to those data derived from surface geophysics and several deep exploration wells completed by the USGS during CAP Canal investigations. Several deep exploration wells were completed by the USGS to measure alluvium thickness of the basin sediments. Information from these wells is discussed below.

Subsidence Characteristics of Alluvium

Subsidence magnitudes are both a function of groundwater level decline and alluvial material properties. Bell has reported typical subsidence rates of 1 foot of subsidence per 20 feet of groundwater level decline in clay-rich basin sediments, and 1 foot of subsidence per 40 to 60 feet of groundwater decline in more clastic basin alluvium materials. Local experience in basin alluvium characterization and modeling has verified both greater subsidence magnitudes and time-delay effects in subsidence relative to regional groundwater level declines in clay-rich alluvium of the MFGU sediments as compared to the mixed alluvium of the UAU. It also appears that significantly smaller to negligible contributions to subsidence occur in the older LAU. When not internally drained by pumping within the MFGU, time delay in subsidence of several too many years occurs due to low permeabilities in the clay-rich MFGU material that slow the process of internal pore pressure change that controls consolidation. However, when internally drained by pumping within the MFGU, rapid large-magnitude subsidence can result as “water of compaction” is removed. Removal of such “water of compaction” from silt and clay materials in an aquitard probably results in a mostly nonrecoverable reduction in pore volume that is manifested as ground subsidence.

5.1.3. Hydrogeological Conditions

Historic hydrographs of selected wells in the study area were reviewed. Historically, the groundwater in the project study area has declined significantly due to well withdrawals far exceeding natural recharge, as analyzed and discussed in previous reports. This decline likely commenced in the late 1940s as agricultural development began in earnest in the east valley. A reasonable estimate of predevelopment groundwater levels can be made from Well (D-01-08)15CCC, which had a groundwater elevation of about 1,325 feet amsl (water level depth of approximately 275 feet) in the late 1930s to early 1940s.

Multiple wells capable of moderate to high production rates are found throughout the study area, some of which are within 1 mile of the FRS facilities. Yields in these wells are often high, with discharges of 2,000 gallons per minute not uncommon. Transmissivities of the LAU, the probable screened intercept in many of the large-capacity wells, are reported to range from about 1,000 to 50,000 square feet per day (Laney and Hahn 1986). The average depth of the 76 active water wells within the study area is about 1,040 feet bgs, and well depths range from 651 to 2986 feet bgs.

Water level data for many of the wells in the historical database may or may not represent general head distributions in the region in which these wells are located. Operating wells have local cones of depression that may be reflected in the reported water level readings. Such detail

cannot be ascertained from the historic records. However, several of the historical hydrographs are for piezometers that were installed as part of the CAP Canal project. These are not pumping wells and should be more representative of the general groundwater levels at those locations along the CAP Canal. These piezometer installations were also typically nested so that changes in the total piezometric head at various depths in the alluvium have been monitored. However, an apparent discrepancy present in readings show a difference of about 100 feet in water level, was recorded between the nested piezometers prior to 2002. This apparent discrepancy was not present by 2006. It is not known if a correction has been made to the more recent data, possibly by adjusting the deeper piezometer to match the shallow piezometer, or if connection between the deep and shallow piezometers has developed over time.

The general trends in water levels for the years 1978 and 2009 across the study area, and the influence of major pumping centers that impacted those trends were reviewed. In 1978, groundwater levels at the northern and southern ends of the study area had dropped over 200 feet from the estimated predevelopment level, and were roughly 500 feet bgs (elevation about 1,100 feet amsl). In the middle of the study area, groundwater levels had dropped less, and were up to about 70 feet higher than in the surrounding area. Suburban growth in the vicinity north of the Powerline FRS, and the establishment of major agriculture to the southwest and west of the Rittenhouse FRS, were probable reasons for the development of major pumping centers in 1978.

By 2009, the water level trend across the PVR study area had changed significantly. Continued suburban development around the northern part of the study area had resulted in continued pumping of groundwater with a further groundwater level decline to nearly 600 feet bgs. Replacement of pumped groundwater by CAP water delivery for agricultural use resulted in significantly reduced pumping and recovery of groundwater levels by as much as about 80 feet from the 1980s to the present at the southern end of the study area. Groundwater levels remained stable and declined moderately (perhaps up to about 40 feet of decline from the 1970s to the present) through the Vineyard Road FRS section of the study area.

Proposed Superstition Mountains Recharge Facility

If constructed, the proposed Superstition Mountains Recharge Facility, located south of the Project study, area will use CAP water delivered to surface infiltration ponds adjacent to Queen Creek to recharge the regional groundwater aquifer. At full build-out, it is anticipated that CAP water will be recharged at the facility at a rate of 56,500 acre-feet per year for 20 years, after which the storage permits for additional recharge would be renewed. Results of modeling by Montgomery and Associates indicate that the recharge will impact groundwater levels throughout the project study area. After 20 years of operation 2030 groundwater levels are projected to rise above baseline levels by nearly 100 feet at the south end of the Rittenhouse FRS, more than 50 feet at the south end of the Vineyard Road FRS, and nearly 50 feet at the Powerline FRS and the north end of the Vineyard Road FRS. By the year 2100 groundwater levels are projected to rise above baseline levels by about 200 feet at the south end of the Rittenhouse FRS, about 125 feet at the south end of the Vineyard Road FRS, and about 50 feet at the Powerline FRS and the north end of the Vineyard Road FRS.

Estimated Future Conditions

Current groundwater modeling scenarios developed by ADWR for the east Salt River Valley provide estimated future groundwater conditions on which to base future predictions of land

subsidence. Two primary scenarios were evaluated and used for predictions of future subsidence to the years 2030 and 2100. The "base case scenario" was a future projection with no recharge occurring at the Superstition Mountains Recharge Facility and Scenario 2 was a projection with an operational Superstition Mountains Recharge Facility. Presentation of results included change-in-water-level contours plotted on figures with township boundaries for location reference; results obtained from these figures were considered to be approximate. For this evaluation, the modeled water level changes were estimated for five locations along the CAP Canal and FRS through the study area using the ADWR estimates. These locations are at the southern end of the Rittenhouse FRS, the southern end of the Vineyard Road FRS, SG-6 along the Vineyard Road FRS, the northern end of the Vineyard Road FRS, and the Powerline FRS IDSM alignment Station 20+00. These water level changes are summarized below. Results of the more recent Superstition Mountain Recharge Facility modeling are also summarized below.

Modeled Groundwater Levels by Others for Future Subsidence Scenarios

	Change in Groundwater Level, feet			
	Base Case Scenario - No Recharge Facility		**Scenario 2 - With Recharge Facility**	
Location	**2030**	**2100**	**2030**	**2100**
Powerline FRS IDSM Station 20+00	-25	-100	+50	+0 (+30)
North Vineyard Road FRS Station 350+00	0	0	+50	+50
Vineyard Road FRS Station 271+00, Well SG-6	+50	0	+50	+100 (+80)
South Vineyard Road FRS Station 90+00, Well SG-10	+80	0	+50	+150 (+125)
South Rittenhouse FRS Approximately Station 50+00	+100	0	+100	+200

Note: Groundwater level changes in parentheses are from more current 2009 modeling.

5.1.4. Discussion

Known Earth Fissures

There are known earth fissures in the Project area near Hawk Rock and one known earth fissure located immediately downstream of the Powerline FRS embankment at about Station 115+45. There also is a high probability that the earth fissure near Station 115+45 extends beneath the existing embankment. It is suspected that subsidence patterns at the Powerline FRS will continue into the future, potentially causing further development of fissures in this area.

The earth fissures in the vicinity of Powerline FRS and Hawk Rock appear to follow along or near the crest of buried ridges that radiate from Hawk Rock. The InSAR data show the locations of the implied buried ridges. Previous investigations have included continuous seismic refraction profiling for the purpose of identifying concealed earth fissures. Continuous seismic profiling has occurred along the proposed Powerline IDSM alignment and much of the alignment of Powerline FRS. Other than the earth fissure at about Powerline FRS Station 115+45, there are no known earth fissures in close proximity to the components of the project. It is noted that this

earth fissure may be an extension of the known earth fissure located about 700 feet west of the Powerline FRS embankment on the west side of Ironwood Road.

Estimated Historical Subsidence

Estimated Historic Subsidence 1940 to 2010

Location	Estimated or Measured Subsidence, feet		
	Estimated 1940 to 2010	Measured (approximate)*	Estimated at Profile Section (1 mile offset from location)
Powerline FRS IDSM Station 20+00	4.0	1986 to 2007 1.4**	3.1
North Vineyard Road FRS Station 350+00	1.6	1986 to 2007 0.6	1.0
Vineyard Road FRS Station 271+00, Well SG-6	0.8	1971 to 2001 0.5	0.5
South Vineyard Road FRS Station 90+00, Well SG-10	3.4	1971 to 2007 1.1	2.8
South Rittenhouse FRS Approximately Station 50+00	4.1	1971to1983 0.5	3.3

* Measurements are commonly combined multiple points measured over different time spans.
** Measured at Powerline FRS Station 130+00, about IDSM Station 0+00.

Predicted Future Subsidence

Future subsidence appears to be largely influenced by two factors, time-delayed unfinished subsidence from past or current groundwater declines, and future groundwater declines. Current and future groundwater declines are occurring or modeled to occur in the future only at the extreme northern end of the study area, which could result in impacts on the Powerline FRS. Groundwater levels throughout the rest of the study area are predicted to remain stable or rise in the future. The largest rise in groundwater levels is predicted to occur in the southern portion of the study area. Predicted future subsidence relative to current ground elevations are summarized below. Using current groundwater level model results, anticipated future subsidence in the study area could be greatly subdued compared to historic rates.

Future Subsidence Predictions by Scenarios

Location	Estimated Future Subsidence (feet)			
	Base Case Scenario - No Recharge Facility		Scenario 2 - With Recharge Facility	
	2030	2100	2030	2100
Powerline FRS IDSM Station 20+00	0.3	1.0	0.1	0.3
North Vineyard Road FRS Station 350+00	0.4	0.6	0.3	0.5
Vineyard Road FRS Station 271+00, Well SG-6	0.3	0.5	0.3	0.5

South Vineyard Road FRS Station 90+00, Well SG-10	0.0	0.2	0.0	-0.1

Future Subsidence Predictions by Scenarios (continued)

	Estimated Future Subsidence (feet)			
	Base Case Scenario - No Recharge Facility		Scenario 2 - With Recharge Facility	
Location	**2030**	**2100**	**2030**	**2100**
South Rittenhouse FRS Approximately Station 50+00	-0.1	0.2	-0.1	-0.2

Earth Fissure Risk Delineation

The risk zones were first delineated for the Powerline FRS and the northern portion of the Vineyard Road FRS as part of a previous investigation. The risk zones were then updated to account for the earth fissure discovered downstream of the Powerline FRS embankment at about Station 115+45. The risk zones were further discussed in relation to the proposed Powerline IDSM. The risk zones around the Powerline FRS, the proposed Powerline IDSM and the northern third of the Vineyard Road FRS did not change as a result of this investigation. However, the earth FRZ was extended south to include the remainder of the Vineyard Road FRS and the Rittenhouse FRS and extended north to include the Powerline Diversion. The definitions for the earth FRZ are presented below.

FRZ 1: Earth fissures are present and will likely continue to occur in the future as evidenced through the application of multiple investigative methods, including published and unpublished mapping, photolineament analysis, geophysical surveys, ground reconnaissance and trenching.

FRZ 2: Conditions for the past development of earth fissures are present through multiple lines of evidence; however, earth fissures have not been positively identified. A high probability of future development of earth fissures is present. Evidence supporting the possible presence of concealed fissures and probability of development of fissuring in the future includes strain calculations and predictions from subsidence modeling, InSAR and geodetic survey data, and photolineament analysis, as well as proximity to and trends of known earth fissures and the presence of known seismic anomalies, soil discontinuities and large transverse cracks in the FRS embankments.

FRZ 3: A probability of future earth fissure formation is present, but the risk is less than in FRZ 2, unless future differential subsidence occurs in FRZ 2, coupled with the currently elevated horizontal tensional strain. Evidence supporting this designation includes InSAR data, photolineament analysis, subsidence modeling and geodetic survey data.

FRZ 4: A low probability of future earth fissure formation exists. Evidence suggests that no significant tensional strain will develop from future subsidence.

A portion of the Powerline FRS embankment is located in FRZ 1 and in FRZ 2. Portions of the Powerline FRS, the proposed Powerline IDSM, and the Vineyard Road FRS are located within

FRZ 3. The Rittenhouse FRS, the Powerline Diversion, most of the Vineyard Road FRS, and portions of the Powerline FRS are located within FRZ 4.

The earth FRZ were approximated to reflect the earth fissure risk posed to the project through 2025, should current subsidence trends continue. To be conservative, the earth fissure risk delineations do not anticipate recharge from the proposed Superstition Mountains Recharge Facility. Recharge from the proposed facility would likely not affect the risk delineation in the vicinity of Powerline FRS, but it may have an effect on the risk delineation at Vineyard Road FRS.

5.1.5. Conclusions and Recommendations

The major concern relating to subsidence and earth fissuring is focused on the Powerline FRS. There is a known earth fissure immediately downstream of about Powerline FRS Station 115+45, and there is a high probability that the earth fissure is also present beneath the FRS embankment. The earth fissure risk is highest in the area around the Powerline FRS and the portion of the Vineyard Road FRS located in FRZ 3.

Predicted future subsidence is greatest in the area of the Powerline FRS, particularly portions to the north of the bend at about Powerline Station 110+00. Subsidence is predicted to continue in this area and will complicate future plans regarding the Powerline Diversion as it could potentially impact the grade of the channel and make draining water to the south challenging. Any future alternative options that require moving water from north to south in this area will also have to address the potential that future subsidence will impact the grade of channels or other infrastructure. Future subsidence predictions indicate that the potential for 1 to 2 feet of additional subsidence is likely in area north of about Powerline Station 110+00 and along the proposed IDSM alignment.

Other portions of the project are not anticipated to experience large amounts of subsidence in the future, and are anticipated to have a low risk for development of earth fissures. Results of this study indicate that the portion of the Vineyard Road FRS located in FRZ 3 may have a lower risk for earth fissures than previously thought. It is recommended that the District consider performing a future investigation to determine if the earth fissure risk in this zone is less than currently classified. It is recommended that any future investigation performed include close evaluation of available monitoring data, additional InSAR analysis, additional geophysical profiling, additional subsidence prediction, and updating the stress-strain model in this area.

5.2. Final Earth Fissure Risk Zoning Memorandum

The purpose of this memorandum was to address NRCs comments about subsidence and earth fissure risk zoning at the Powerline, Vineyard Road and Rittenhouse (PVR) Flood Retarding Structures (FRSs) as they relate to the PVR FRS Rehabilitation or Replacement Project. This memorandum starts with a general discussion of ground subsidence and earth fissuring due to groundwater withdrawals. This is followed by discussions of the investigative and modeling methods used to predict future subsidence and the risk of earth fissuring, and the history of earth fissure risk zoning at flood control structures in the Phoenix area. The memorandum culminates with a discussion of earth fissure risk zoning at PVR and responses to specific questions that NRCS has posed regarding PVR earth fissure risk zoning.

5.2.1. Subsidence and Earth Fissuring Due To Groundwater Withdrawal

Land subsidence and the development of earth fissures at the PVR FRSs, and at other flood control structures in the Phoenix area, are primarily a result of groundwater level declines..

Subsidence

Lowering the groundwater elevation in a column of alluvial basin material increases the effective stress and loading on the material column. If the column consists of granular materials, typically sands and gravels, compression of the material below the initial water level takes place rapidly. Until granular particle contact points are changed by compression, at least some of the compression can be recovered elastically if water levels rise and the effective stress is decreased. Compression that results from particles slipping or crushing tends to have much less elastic rebound. If the material column contains a significant fraction of fine-grained materials, such as clay, consolidation of the material below the initial water level takes place more slowly. The time frame of consolidation is a function of the permeability of the material, where lower permeability increases consolidation time. Consolidation is also a function of the distance to and the interconnectivity of higher permeability zones which can relieve the excess pore pressure by draining water from clay-rich materials. Greater distances to permeable drainage zones increase the consolidation time. Although consolidation increases can be modeled as an elastic phenomenon, consolidation does not typically recover with a decrease in loading.

Earth Fissure Development

Where differential rates and magnitudes of subsidence occur over relatively short distances, horizontal strains can become sufficient to cause earth fissuring. Jachens and Holzer (1979, 1982) evaluated the threshold tensile strains for fissuring based on studies in the Eloy-Casa Grande area of central Arizona. Jachens and Holzer (1982) concluded that most fissuring occurs at horizontal tensile strains in the range of 0.02 to 0.06 percent. This compares with threshold strains for cracking of compacted clays zones in dam embankments (or compacted clay liners) of about 0.1 to 0.3 percent (Leonards and Narain 1963; Covarrubais 1969).

Earth fissures in alluvial aquifers that have experienced large groundwater declines are likely associated with a process termed generalized differential compaction (Carpenter 1994). Three mechanisms are likely at play in the formation of fissures. These mechanisms include: 1) bending of a plate above a horizontal discontinuity in compressibility (Lee and Shen 1969), 2) dislocation theory representing a tensile crack (Carpenter 1994), and 3) vertical propagation of tensile strain caused by draping of the alluvium over a horizontal discontinuity in compressibility (Haneberg 1992). Due to these probable mechanisms, fissures commonly develop along the perimeter of subsiding basins, often in apparent association with exposed bedrock or shallow buried bedrock, suspected mountain-front faults, or distinct facies changes in alluvial materials.

Role of Groundwater Level Changes

One of the most important parameters for delineating earth fissure risk is groundwater declines, specifically, future groundwater declines. If groundwater declines do not occur, then significant subsidence will not occur. However, predicting future groundwater declines is particularly challenging due to the social-political factors that drive groundwater use. As a result, accurate prediction of future groundwater withdrawal is not possible. Related to this challenge is the influence of groundwater recharge facilities. To date it is unclear how recharge facilities impact subsidence. It’s well understood that in the immediate vicinity of a recharge facility groundwater

levels increase; however, how that increase influences more regional-scale groundwater elevations is less certain. Also uncertain are the overall operation of recharge facilities and the long-term availability of excess water for recharge. Other uncertainties are the socio-political impacts of recharge facilities.

The future behavior of groundwater elevations remains one of the most challenging and uncertain parameters to quantify and delineate earth fissure risks. These uncertainties tend to result in more conservative delineation of the potential risks in order to reduce the risk imparted by the uncertainties.

5.2.2. Investigative and Modeling Methods

Investigative Methods

There is a lack of published guidelines for the delineation of earth fissure risks, with the first guideline document for subsidence and earth fissure investigations being published in 2011 (Arizona Land Subsidence Interest Group 2011). Most of the investigative techniques and guidelines in this document were pioneered by AMEC as part of their work on District projects throughout the Phoenix area. The investigative methods have evolved through time and the Initial Subsidence and Earth Fissure Report, PVR Planning Study (AMEC 2010b) and the Supplemental Earth Fissure Risk Report, Powerline FRS Interim Dam Safety Measure (AMEC 2010c) represent the most recently completed, large-scale subsidence and earth fissure investigations in the Phoenix area as of the publication of this memorandum.

Detailed discussions of the methodologies utilized are included in these reports. In addition, AMEC has recently developed Procedural Documents (AMEC 2011b) that describe in detail the procedures for 11 methods of investigation for earth fissure risk delineation.

Modeling Methods

Sub-basins in the Salt River Valley are generally subdivided into three alluvial units: the upper alluvial unit (UAU), the fine-grained middle alluvial unit (MAU), and the lower alluvial unit (LAU) Prokopovich 1983; Laney and Hahn 1986). In order to model future subsidence, simplified basin vertical profiles are developed to estimate historical subsidence and predict the potential for future subsidence. Within the Phoenix area, it is assumed that basin material compression leading to subsidence is limited to the portions of the UAU and/or MAU that are below the groundwater table (i.e., saturated). Estimates of subsidence are then calculated using the basin vertical profiles.

Based on these profiles, simplified estimates of subsidence are performed using the methods and procedures discussed in AMEC's white paper "Characterization for Subsidence Modeling and Percolation Theory–Based Modeling of Subsidence" included in Appendix E of the Initial Subsidence and Earth Fissure Report (AMEC 2010b). Calculation of subsidence is based on a concept of increased loading due to falling groundwater levels with resulting increases in effective stress on the compressible sections of basin alluvium (each section is typically 100 feet in thickness) whose compression (and resulting ground subsidence) is a function of the moduli of the basin alluvium sections. This approach uses percolation theory (PT) to model relationships of basin density and modulus in basin alluvial sections. The resulting modulus profiles are variable (increasing with depth) and nonlinear through the compressible section of the basin alluvial profile.

The general process of calculating a subsidence estimate involves several tasks. Initial basin alluvial section densities and moduli are a function of the applied effective stress on the alluvial sections before groundwater declines began in the model. An increase in effective stress calculated from an increment of groundwater level decline corresponding to a historic period is then applied to the model. From this increase in effective stress loading, the resulting increment of subsidence from each compressible alluvial section is calculated based on its modulus and thickness; the overall subsidence for that period is the sum of the increments of the alluvial sections. With increased effective stress present through the basin alluvial profile, the densities and moduli of the alluvial sections are then recalculated to appropriate higher values to reflect the properties of the compressed alluvial profile. The next increment of groundwater decline and effective stress increase is then applied, and the process is repeated until the complete (simplified) groundwater decline history has been modeled.

Without modification, this PT-based modulus approach would result in immediate subsidence as the groundwater table falls and time-delayed consolidation behavior would not be effectively modeled. Time-delayed consolidation behavior is accounted for in the subsidence predictions by using a simplified exponential decay function.

Stress-strain profiles are modeled utilizing a finite-element geological model that assesses ground subsidence potential and deformation of alluvium in response to changes in groundwater levels in the regional aquifer system. The model is based on the concept that ground strains develop due to differential subsidence resulting from the decline of the water table at depth. Development of this model includes creating a geologic cross-section, applying groundwater decline with time to increase effective stresses within the geologic cross section, and modeling the resulting subsidence. The 2-dimensional subsurface profile is based on available information on geological materials within the subsurface profile and the subsurface geometry supplemented with deep resistivity and other geophysical data. Groundwater decline is based on historic hydrographs from relevant ADWR well records and/or predictive reports available in the literature. Two finite-element-based computer programs, SEEP/W and SIGMA/W, are used to develop the 2-D fully-coupled seepage and stress deformation model. SIGMA/W is used to compute displacements and stresses, and SEEP/W is used to compute changes in pore-water pressure with time. Using these two software products in a coupled manner makes it possible to perform reasonable subsidence and deformation analyses for specified time periods.

The subsidence prediction, PT-based modeling aids in the understanding of alluvial properties and their potential to subside. The stress-strain model estimates the location and magnitude of past, present and future ground strain. For the stress-strain modeling results a value of 0.02% tensional strain is utilized as the threshold for potential earth fissure formation. This value comes from a published value of 0.02 to 0.06% tensional strain for earth fissure development originally published by Jachens and Holzer (1982). The results of these two modeling methods are utilized in combination with all the other investigative methods to delineate earth fissure risk zones. The modeling results are primarily utilized to predict areas likely to experience future differential subsidence and tensional ground strain. The earth fissure risk zones are empirical in their derivation and represent the cumulative sum of all the findings of all methodologies utilized in a given investigation.

5.2.3. PVR Earth Fissure Risk Zones

This section provides an overview of the site-specific hydrogeologic conditions at the PVR sites, the history of earth fissure risk zoning at the PVR sites, and a discussion of monitoring techniques.

Overview of Hydrogeologic Conditions

The project is located within the Sonoran region of the Basin and Range physiographic province and is, in part, separated from the central Phoenix Valley by the bedrock highs of the Tempe Butte area. The following sections discuss aspects of the hydrogeological setting important to an appraisal of ground subsidence and earth fissuring.

Depth to Bedrock

With regard to the PVR area, the buried shape and proximity of the bedrock-alluvium contact are likely the most dominant influences on where earth fissures have formed and where they may form in the future. The Powerline FRS and nearby Hawk Rock are regions where the gradient of the bedrock-alluvium interface is quite pronounced and the thickness of alluvium is variable. These conditions result in a strong potential for differential subsidence, a prerequisite for earth fissure formation. Bedrock is exposed at the ground surface at Hawk Rock, which is located about 4,000 feet west of the bend in the Powerline FRS embankment near Station 110+00. Hawk Rock is the surficial expression of a much larger buried mass of bedrock that partially underlies the Powerline FRS. Understanding this bedrock geometry is one of the most important factors for delineating earth fissure risks for the PVR Rehabilitation or Replacement Project.

Data indicate that the depth to bedrock at the bend in the Powerline FRS embankment at about Station 110+00 is close to or slightly greater than about 300 feet below the ground surface (bgs), that the depth to bedrock from about Powerline Station 50+00 to 105+00 ranges from about 600 to 700 feet bgs, and that north of Station 110+00 the depth to bedrock increases rapidly. These data indicate that depth to bedrock increases very rapidly south of the Powerline FRS. Underneath the northern portion of the Vineyard Road FRS, the depth to bedrock ranges from about 800 feet bgs at Station 345+00 to about 1,700 feet bgs at Station 310+00 to approximately 1,500 feet bgs at Station 280+00. A deep well at about Vineyard Road FRS Station 271+00 encountered conglomerate at a depth of 650 feet bgs and granite at a depth of 1,770 feet bgs. Southward from this point, the data indicate that depth to bedrock continues to increase to depths greater than 2,000 feet bgs.

InSAR provides what is probably the best indication of the shape of the bedrock-alluvium interface in the vicinity of Hawk Rock and the Powerline FRS due to its full map-view and 3D coverage. The most important aspect of this is the indication of the presence of buried bedrock ridges that radiate outward from Hawk Rock and how those implied buried ridges relate to the location of known earth fissures. Most of the known earth fissures near Hawk Rock, and all the known fissures not in the immediate vicinity of Hawk Rock, follow the apparent crest of these implied buried ridges. When comparing InSAR data and U.S. Bureau of Reclamation bedrock elevation data, it appears that InSAR data more accurately indicate the location of the implied buried ridges.

Deep Alluvial Characteristics

A review of selected geophysical data and geologic logs indicates that there are significant lithologic variations present in the alluvial basin profile. The discussion below is summarized from the Initial Subsidence and Earth Fissure Report (AMEC 2010b) and the reader is referred to that report for a detailed discussion of the deep alluvial characteristics.

Geophysical logs in a borehole about 1 mile northwest of Powerline FRS show very low resistivities indicating significant clay content. Based on the amount of subsidence that has occurred in this area, highly compressible clays are anticipated to be present in this area.

The character of the geophysical logs for wells located near, or to the north and west of, the Powerline FRS indicated the presence of zones of significant thickness with resistivities less than about 10 ohm-m. Therefore, subsidence that results from consolidation of clay-rich materials occurs relatively slowly. These areas are shown by InSAR to have been actively subsiding during the 1990s in spite of relatively constant regional groundwater levels.

Historical deep wells were completed near the CAP alignment at or to the south of the Vineyard Road FRS. The character of the geophysical logs for these wells is consistent with the published descriptions of the upper alluvial unit (UAU), and very different from wells completed within the middle fine-grained unit (MFGU) northwest of the Powerline FRS. Between depths of 600 and 1,200 feet bgs, at least 16 zones of higher resistivity (greater than 10 ohm-m), typically at least a few feet thick, could be identified. These higher-resistivity zones were interpreted to contain more granular, higher-permeability materials, rather than clayey material. This alluvial basin section was thus interpreted to include significant interbedded or interfingered units, fluctuating between sandy/gravelly horizons and clay-enriched horizons. With sufficient interconnection of the higher-resistivity, higher-permeability horizons, the basin alluvium could have been drained more rapidly as the groundwater level dropped, and subsidence would have occurred much faster than in the clay-rich alluvium to the north. Geophysical logs indicate that the basin alluvium south of the Vineyard Road FRS appears to be relatively clay poor compared to basin alluvium to the northwest of the Vineyard Road FRS. Below depths of about 1,200 feet bgs the resistivities increased and rarely fell below 10 ohm-m.

Hydrogeologic Conditions

A reasonable estimate of predevelopment groundwater levels can be made from well data indicating a groundwater elevation of about 1,325 feet above mean sea level (amsl), corresponding to a depth to water of approximately 275 feet, in the late 1930s to early 1940s.

In 1978, groundwater levels at the northern and southern ends of the study area had dropped over 200 feet from the estimated predevelopment level, corresponding to a depth to water of about 500 feet bgs or an elevation about 1,100 feet amsl. In the middle of the study area, groundwater levels had dropped less, and were up to about 70 feet higher than in the surrounding area. Suburban growth in the area north of the Powerline FRS, and the establishment of major agriculture to the southwest and west of the Rittenhouse FRS, were probable reasons for the development of major pumping centers in 1978.

By 2009, the water level trend across the PVR study area had changed significantly. Continued suburban development in the northern part of the study area had resulted in continued pumping of groundwater with a further groundwater level decline such that the depth to water was nearly 600 feet bgs. Replacement of pumped groundwater by CAP water delivery for agricultural use resulted in significantly reduced pumping and recovery of groundwater levels by as much as 80

feet from the 1980s to the present. Groundwater levels remained stable or declined moderately (perhaps up to about 40 feet of decline from the 1970s to the present) through the Vineyard Road FRS section of the study area.

Development of Earth Fissure Risk Zones

ADWR has developed groundwater models that predict future groundwater withdrawals given their present, general understandings of the groundwater hydrology of the area and socio-political trends. The Initial Subsidence and Earth Fissure Report (AMEC 2010b) for the PVR Rehabilitation or Replacement Project utilized ADWR predictions for future groundwater withdrawal that were published as part of the East Valley Water Forum Scenarios for the East Salt River Valley Sub-Basin (Hipke 2007). ADWR recently updated it's predictions with Modeling Report No. 22 (Hipke 2010).

As part of the Earth Fissure Risk Zone Investigation Report for the Powerline and Vineyard Road FRSs (AMEC 2006), a stress-strain model was developed for the Powerline FRS embankment. (For a detailed discussion of the model and model parameters, please refer to that report.) One of the modeled scenarios assumed 4 feet per year of groundwater drawdown until the year 2025, whereas other model scenarios were tied to historical groundwater data from predevelopment through 1978, 1986, 1992 and 2004. Based on these predictions, the earth fissure risk zones were originally approximated to reflect the earth fissure risks posed to the Powerline FRS and the northern 1/3 of Vineyard Road FRS through 2025 if current subsidence trends continued. The Initial Subsidence and Earth Fissure Report (AMEC 2010b) updated these risk delineations to account for a design life of 100 years; the level of investigation for the 2010 report was more general and intended for planning purposes and not final design. Any future earth fissure risk zoning studies, either at PVR or any of the District's other flood control structures, should utilize the most current ADWR groundwater predictions, which at the time of publication of this document is Modeling Report No. 22 (Hipke, 2010). The groundwater prediction (or predictions) used in future earth fissure risk zoning studies should be selected by reaching a consensus among stakeholders, since the modeling results are based on a number of variables, both scientific and social-political.

Monitoring

Monitoring strategies currently utilized at Powerline and Vineyard Road FRSs are discussed in detail in the Instrumentation and Monitoring Plan Revision No. 2 (AMEC 2011a). These strategies include 1) review of InSAR products, 2) review of aerial photography and photogeological lineament analyses, 3) monitoring by survey including vertical and horizontal movement, 4) annual ground inspection, and 5) review of regional groundwater conditions.

The purpose of the monitoring system is to obtain the necessary information to identify and assess potential adverse impacts resulting from the potential development of earth fissures and to assess impacts of subsidence on the embankment dam crests. This risk reduction is realized by quantifying the rate and distribution of ground deformation in the vicinity of the structures, coupled with the ability to detect ground rupture along the dam alignments. The system encompasses regions of elevated earth fissure risk along the two structures, with instrumentation located between Powerline FRS Stations 102+50 to 127+50 and Vineyard Road FRS Stations 280+00 to 310+00. Additional instrumentation is proposed for the region between the existing Powerline FRS and the planned Interim Dam Safety Measure (IDSM) and along the alignment of

the planned IDSM. The monitoring plan includes the establishment of alert levels and response actions to any exceedance of alert levels.

5.2.4. Recommendations

Many of the outstanding issues associated with earth fissure risk zoning at the PVR FRSs could be addressed through a final design level of subsidence and earth fissure investigation. Such an investigation would likely include additional subsidence refraction profiling, deep resistivity soundings, seismic reflection profiling, future subsidence prediction models and updated stress-strain models. Through such an investigative process the existing earth fissure risk zones would be updated based on a better understanding of site conditions and predicted groundwater declines. This evaluation would include the forthcoming ADWR update to the modeled gravity and depth to bedrock in the area and the updated predictions for groundwater declines as presented in ADWR's Modeling Report No. 22 (Hipke, 2010).

A quantitative risk assessment could also be considered as a means of quantifying the earth fissure risk associated with each earth fissure risk zone, although there would still likely be a large degree of uncertainty at the end of this assessment. This assessment could be supplemented by targeted failure modes and effects analyses that would address specific identified failure modes and lead to the best solution for mitigating the failure mode(s).

For the alternatives evaluation, AMEC recommends the following:

Powerline FRS:

> Structures located within moderate earth fissure risk zones at the Powerline FRS should be planned as hardened structures. Additionally, due to the level of uncertainty, the moderate risk zones in this area are on the higher end of moderate as opposed to the lower end of moderate. It should be anticipated that the planned IDSM will need to be hardened as part of the rehabilitation project.

Vineyard Road FRS:

> Based on our current understanding of earth fissure risk conditions at the Vineyard Road FRS, the section of embankment located within the moderate earth fissure risk zone does not need to be hardened; however, this area should be the subject of a robust monitoring program. Our recommendation is based on our current understanding of the subsurface profile in this area and the results of recent InSAR data. This data suggests the moderate risk zone at the Vineyard Road FRS is on the lower end of moderate as opposed to the higher end of moderate.

It is noted that dam concepts involving earth fissure risk zones mitigated through hardened dam segments and cutoff walls have been taken through the FMEA process (workshop and report) as part of this study and no potential failure modes have been identified for these concepts. It is recommended that any additional concept to be considered for final alternative selection involving earth fissure risk zones without hardened dam segments and/or without cutoffs (such as an embankment dam only with long-term monitoring) should also be taken through an FMEA workshop prior to alternative selection.

6. ENVIRONMENTAL STUDIES

This section provides a summary of the environmental reviews and analyses conducted by Kimley-Horn for the PVR project. The purpose of the environmental investigations was to identify the existing environmental conditions of the PVR structures within the modified easement area and an adjacent buffer area around the easement limits. The environmental evaluation included an overview of the site biology, cultural resources, hazardous materials, social population/demographics, and Section 404 of the Clean Water Act planning considerations. The environmental studies are documented in the following reports.

- "Powerline, Vineyard Road and Rittenhouse Flood Retarding Structures Rehabilitation or Replacement Project - Biological Evaluation". (Kimley-Horn July, 2010)
- "Powerline, Vineyard Road and Rittenhouse Flood Retarding Structures Rehabilitation or Replacement Project – Social Population and Demographics Existing Conditions Study". (Kimley-Horn July, 2010)
- "Powerline, Vineyard Road and Rittenhouse Flood Retarding Structures Rehabilitation or Replacement Project – Cultural Resources Existing Conditions Study". (Kimley-Horn July, 2010)
- "Powerline, Vineyard Road and Rittenhouse Flood Retarding Structures Rehabilitation or Replacement Project – Hazardous Materials Technical Memorandum". (Kimley-Horn July, 2010)
- "Powerline, Vineyard Road and Rittenhouse Flood Retarding Structures Rehabilitation or Replacement Project – Significant Nexus Analysis". (Kimley-Horn May, 2012)

6.1. Biological Evaluation

The purpose of the biological evaluation was to document the existing habitat conditions of the project area, and document any species or species specific habitat observed during field biological reconnaissance visits. This assessment focused on gathering general habitat information for the project area and the potential for any threatened, endangered, candidate, or other sensitive species or associated species habitat to occur within the project area.

6.1.1. Habitat Considerations

The majority of the project area is flat and sparsely vegetated, with the majority of the vegetation occurring along the ephemeral washes. Very dense mesquite bosques, containing velvet mesquite (*Prosopis velutina*), blue paloverde (*Parkinsonia florida*), catclaw acacia (*Acacia greggii*), and cottonwoods (*Populus fremontii*) (very rare) are present near and adjacent to the FRSs. The mesquite bosques provide valuable food, shelter, and travel corridors for multiple mammal, avian, and reptile species. Additionally, a higher plant species diversity was observed within the mesquite bosques. The majority of the mesquites observed within the bosque ranged from 20-30 feet in height. The width of the mesquite bosque ranged from 200 feet to over 650 feet.

6.1.2. Threatened and Endangered Species

The Arizona Game and Fish Department's (AGFD) Heritage Data Management System (HDMS) provided a list of special status species that have been documented as occurring within 5 miles of the project area. Additionally, the U.S. Fish and Wildlife Service (USFWS) threatened,

endangered, proposed, and candidate species list for Pinal and Maricopa Counties was reviewed by Kimley-Horn's qualified biologist to determine species potentially occurring in the project vicinity. Kimley-Horn's qualified biologist reviewed this list and determined that no threatened, endangered species or their habitat would be potentially affected by a future proposed project.

6.1.3. Species of Concern

The AGFD online review tool did list three "species of concern": the western burrowing owl (*Athene cunicularia hypugaea*), Tucson shovel-nosed snake (*Chionactis occipitalis klauberi*), and pocketed free-tailed bat (*Nyctinomops femorosaccus*) as occurring within 5 miles of the project area. The Tucson shovel-nosed snake was listed by the AGFD as occurring within the project area. The Tucson shovel-nosed snake is listed a candidate species by the USFWS. Candidate species are defined as "Species for which USFWS has sufficient information on biological vulnerability and threats to support proposals to list as Endangered or Threatened under the Endangered Species Act (ESA). However, proposed rules have not yet been issued because such actions are precluded at present by other listing activity". None of these "species of concern" are federally listed species which typically require further analysis for federally funded projects. However, the Tucson shovel-nosed snake is a species that maybe become listed in the near future and the western burrowing owl is protected under the migratory bird act.

6.2. Social Population and Demographics Existing Conditions Study

The "Social Population and Demographics Existing Conditions Study" (Kimley-Horn, 2010) (SPDECS) was completed in preparation for the economic analysis for the PVR project. The purpose of this study is to document the existing social conditions, conduct a preliminary analysis of the data, discuss population and demographic characteristics and identify populations with the potential for disproportionate adverse impacts as part of Phase II of the PVR project.

The boundaries of the study area for SPDECS are the eastern border of the modified easement area upstream of the FRSs on the east, US 60/Superstition Freeway alignment on the north, the East Maricopa Floodway on the west and the Ocotillo Road alignment on the south.

6.2.1. Social Environment

The demographic composition of the study area was calculated using the decennial Census 2000 data sets from the United States Census Bureau (Census 2000). Census tracts (CT) and the block groups (BG) within these census tracts are large, relatively permanent, statistical subdivisions that do not cross county boundaries. For the purposes of the analysis, the demographic composition has been conducted to the block group level.

The PVR FRSs SPDECS area lies within 15 CT containing 21 BG. The CTs and BGs extend beyond the SPDECS area, but not to an extent that the data represents demographic characteristics inconsistent of those strictly within the SPDECS area boundaries. Since the SPDECS area encompasses portions of multiple communities as well as unincorporated county land, data was collected for the Cities of Mesa, Gilbert and Apache Junction, the Town of Queen Creek, both Maricopa and Pinal Counties as well as the State of Arizona. This information was used for comparison purposes in the future analysis of impacts.

The majority of the total population encompassing the PVR FRSs SPDECS area is White (Non-Hispanic) which comprises 86.9% of the population for all the CT/BGs. The total minority population for all the CT/BGs is 13.1% with the breakdown of racial and ethnic demographics as

follows: Black or African American 1.4%; American Indian and Alaskan Native 1.0%; Asian 1.2%; Native Hawaiian and other Pacific Islander 0.2%; Other 6.6%; Population of Two or More Races/Not Hispanic or Latino 2.8%.. The percentages of racial, ethnic and total minority populations appear to be consistent with those of the surrounding communities. (*Hispanic or Latino refers to ethnicity and is derived from the total population; 'Hispanic or Latino' is not classified as a separate race. The total minority population minus the Hispanic or Latino is 13.1%.)

The median household income for the PVR FRSs SPDECS area is between $32,055 (CT 3.06, BG 1) and $101,124 (CT 4226.12, BG 2). This represents a slightly lower median income than the neighboring communities. However, the total number of households that are below the poverty level for the study area is less than that of the City of Gilbert, the community with the lowest number (and percentage) of households below the poverty level of those in the project vicinity.

The Title VI Related Statutes minority populations vary by CT and BG but the total percentages for all the CT/BGs combined are as follows: Elderly 18.0%, Disabled 14.5% and Female Head of Household 5.9%. Both the total elderly and disabled populations within the SPDECS area have considerably higher percentages than both Maricopa County and the City of Gilbert.

The Limited English Proficiency (LEP) populations vary by CT and BG, but the total percentages for all the CT/BGs combined are 2.2% and are consistent with those of the surrounding communities.

The existing population demographics were documented to identify the level or degree of total population densities and population densities for the minority groups encompassing the PVR FRSs SPDECS area. In compliance with Title VI and the related statutes, Executive Order 12898, and Executive Order 13166 the populations include racial/ethnic minorities, low-income, elderly, disabled, female head-of-household, and limited English proficiency populations. This data will be used to evaluate and compare impacts to these populations from the alternatives that are developed and analyzed for the project. The alternatives will not have significant impacts on these populations.

6.2.2. Community Cohesion

Community cohesion refers to the aggregate relationship between the quality and quantity of residential interactions. This can be signified by the degree to which residents have a sense of belonging to their neighborhood or community, their level of community participation, and the level to which members of the community interact socially with one another. Community cohesion can be affected by land use planning decisions. Factors associated with community cohesion include the walk-ability of a neighborhood, the level of security or safety within the neighborhood, the quality of public service, the availability of parks and social settings, the population demographics, and the level of neighborly interactions.

Impacts to the communities within the PVR FRSs SPDECS area are anticipated to be minimal and may vary depending on the alternatives developed as part of the PVR FRSs Rehabilitation or Replacement Project in Phase II.

6.2.3. Displacement/Relocation

The displacement of people and businesses is governed by the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended. The purpose of this Act is to

ensure the fair and equitable treatment of individuals whose real property is acquired or who are displaced as a result of a federal or federally assisted project. Property ownership, economic impacts and land use (e.g. commercial, residential, or agricultural) will all need to be factored into potential displacement/relocation analysis. No displacement and relocation impacts will result from proposed alternatives formulated for the PVR project.

6.3. Cultural Resources

6.3.1. Existing Conditions Study

Kimley-Horn prepared the "*Powerline, Vineyard road and Rittenhouse Flood Retarding Structures Rehabilitation or Replacement Project Cultural Resources Existing Conditions Study*" (Kimley-Horn, July 2010). The purpose of the report was to document the review of the previous cultural resource documentation as part of the existing conditions study for the PVR Rehabilitation or Replacement Project and to determine if additional Class I level studies were needed. The purpose of a Class I Literature Review is to document the previous cultural resource investigations and previously recorded sites/resources within a one mile buffer of a project area.

A review of NRCS project documentation for the flood retarding structures indicates that there were no known cultural resource considerations during original design and construction of the dams. There are also no known cultural considerations during the repairs of the dams conducted by the NRCS during 1978 to 1991.

A Class III cultural resource survey was completed in December 2009 for geotechnical studies related to the PVR FRSs Rehabilitation or Replacement Project. The survey entitled, Class III Cultural Resources Survey Along the Powerline, Vineyard, Rittenhouse Flood Retarding Structures Between Queen Creek and Apache Junction, Pinal County, Arizona (Jones and Florie 2009) included the results of a "site file check" as well as those of the field survey for the specific geotechnical work that was to be performed. The review area for the PVR FRSs 2009 cultural resource study is a one mile buffer around the PVR FRSs structures.

The 2009 Class III report was prepared in compliance with the National Historic Preservation Act of 1966 (as amended); Arizona State Antiquity laws (A.R.S. § 41-841 et seq); and the State Historic Preservation Act (A.R.S. § 41-861 through § 41-864). The site file check for the review area (including the one mile buffer) that was conducted as a component of that report included site records and project files at the State Historic Preservation Office (SHPO) and the AZSITE cultural resource database. Hereinafter, the site file check component of the 2009 Class III survey effort is referred to as the "2009 cultural resource study".

Previous Research

The 2009 cultural resource study indicated that at least 59 cultural resource investigations/surveys have taken place within the review area. Most of these previous survey areas are linear in nature and cut across the review area. Nine of these surveys are over 10 years old and therefore would require re-evaluation and resurvey in accordance with SHPO guidance. Two other investigations were extensive block surveys, conducted for the Lost Dutchman Heights project areas. These surveys covered portions of the review area in the vicinity of the Powerline FRS.

Previously Recorded Cultural Resources

Within the review area there were 72 previously recorded archaeological sites and one archaeological district identified in the 2009 cultural resource study. Though the vast majority of these sites are prehistoric artifact scatters, some with features of habitation sites (approximately 69), there are several historic sites and an archaeological district.

Of the 72 previously recorded sites, seven have been determined eligible for the National Register of Historic Places (NRHP); 33 are Recommended as eligible for the NRHP; two have been Determined as not eligible; six are Recommended as not eligible; and 24 have not been evaluated. The archaeological district is Recommended as eligible. (Note: Sites "Determined" eligible/not eligible have been evaluated by the SHPO; sites "Recommended" have been evaluated only by their recorder and not the SHPO).

Conclusions and Recommendations

Additional Class III studies are anticipated during final design of the project. The location and acreage of the survey(s) will be driven by the footprint of the project. The inclusion of a more robust literature review in the anticipated future Class III documents will be an efficient way of gathering and presenting that data. Appropriate avoidance and mitigation procedures will be followed during implementation of this project.

Formal consultation with the Arizona State Historic Preservation Office (SHPO) has been recently initiated following identification of the Preferred Alternative. The initial SHPO consultation correspondence is on file with the NRCS. Consultations with SHPO will continue through the design phase as final alignments, borrow materials, and other disturbance areas are further identified.

Formal consultation with Tribal Historic Preservation Offices (THPOs) have recently been initiated following identification of the Preferred Alternative. The THPO consultation letters are in progress. Consultations with THPOs will continue through the design phase as final alignments, borrow materials, and other disturbance areas are identified.

6.3.2. Cultural Resources Survey

The Sponsor conducted a Class III cultural resources survey for the area of potential effect (APE) for the Preferred Alternative ("*Draft Class III Cultural Resources Survey for the Flood Control District of Maricopa County Vineyard Road and Rittenhouse Flood Retarding Structures Project*", Archeological Consulting Services April, 2013). The purpose of the survey was to conduct a site reconnaissance of the APE for identification and location of cultural resource sites. The site survey was completed in April 2013. The cultural resources survey identified potential sites that may require mitigation prior to construction. Mitigation will be conducted in a phased approach prior to construction of the elements of the PVR preferred alternative.

The Class III survey identified 10 newly recorded sites. In addition, 11 previously recorded sites are known to occur within the APE. These 11 sites were documented recently as part of the Lost Dutchman Heights project area survey as well as other smaller surveys along the CAP canal. The Class III report noted for the 11 previously recorded sites that four of the sites have been mitigated in previous cultural studies. The remaining 7 sites, if these cannot be avoided, the Class III report recommends testing for either Phase I date recovery or determination for eligibility in the National Register.

Data recovery is recommended for 4 of the 10 newly recorded sites, if these cannot be avoided,. Three of the newly recorded sites were recommended as ineligible for inclusion in the National Register. The eligibility of 3 of the newly recorded sites could not be determined at the survey level. If these sites cannot be avoided, the Class III report recommends that archeological testing be conducted.

Based on the known sites in the APE, the majority of the cultural resources present are either prehistoric sites without evidence of habitation (which includes scatters of artifacts on the surface, or artifacts with remnants of agricultural features, and/or other non-habitation features) or historical sites (which includes farming or ranching features, or simply scatters of historical artifacts). Based on experience with recent data recovery efforts in central and southern Arizona, cultural resources mitigation costs have been estimated.

6.4. Hazardous Materials Technical Memorandum

Kimley-Horn retained the services of Environmental Data Resources, Inc. (EDR), a third party database search company, to conduct a search of regulated facilities within and in the immediate vicinity of the project area. Based on the results of the EDR search, there were no hazardous material concerns within the project area that should impact the project alternatives.

6.5. Significant Nexus Analysis

Kimley-Horn prepared a Significant Nexus Analysis (SNA) for the Powerline, Vineyard Road and Rittenhouse (PVR) Flood Retarding Structures (FRSs) Rehabilitation or Replacement Project.

6.5.1. Lower Gila River

In October 2008, a 6.9-mile reach of the Lower Gila River from Powers Butte to Gillespie Dam was designated a “traditional navigable water” or TNW by the U.S. Army Corps of Engineers (Corps). Therefore, the nearest TNW to the project area is the Lower Gila River from Powers Butte to Gillespie Dam. The project limits consist of the District’s modified easement area (6,237 acres) with the Arizona State Land Department (ASLD), which includes the FRSs, flood pool areas, Powerline Floodway, and maintenance access roads. This SNA includes the project limits and extends to the TNW via the Powerline Floodway, the East Maricopa Floodway (EMF) and Gila River.

6.5.2. Lost Dutchman Heights

On June 29, 2010, the Corps determined that the 7,700-acre Lost Dutchman Heights (LDH) project (Corps file No. SPL-2008-00674-SDM) and the ephemeral washes within the project area did not have a significant nexus to the TNW (Gila River) and issued an Approved Jurisdictional Delineation that stated there are not waters of the U.S. within the project area. That project and the current PVR project overlap and much of the information in the LDH submittal is also applicable to the PVR project.

6.5.3. Purpose of Significant Nexus Analysis

The purpose of the significant nexus analysis was to assess the flow characteristics and functions of the tributaries within the project area to determine if they significantly affect the chemical, physical, and biological integrity of the TNW. For each of the following situations, a significant nexus exists if the tributary has more than a speculative or insubstantial effect on the chemical, physical and/or biological integrity of the TNW.

Considerations when evaluating significant nexus include, but are not limited to the volume, duration, and frequency of the flow of water in the tributary and its proximity to the TNW, and the functions performed by the tributary. It is not appropriate to determine significant nexus based solely on any specific threshold of distance (e.g. between a tributary and the TNW).

6.5.4. Conclusion of Significant Nexus Analysis

The low frequency of flow events in combination with the peak discharges volumes from the project area ranging from approximately 80 to 150 cfs, the likelihood of flow from the project area reaching the TNW is low. Therefore, the project waters have a low capacity to carry pollutants or flood waters to the TNW, or to reduce the amount of pollutants or flood waters reaching a TNW. Furthermore, the project waters have a low capacity to transfer nutrients and organic carbon that support downstream food webs. The combined peak discharge from the project area (244 cfs) is insignificant in comparison to peak discharge in the TNW (75,883 cfs), and represents 0.3% of the peak flow in the TNW. Therefore, no significant nexus exists with regard to physical and chemical integrity.

The project area provides no habitat for aquatic organisms in the downstream TNW, though ponding areas may provide habitat for several invertebrate species. The only listed species overlap is for the Sonoran desert tortoise which could use ephemeral washes and the adjacent uplands as dispersal habitat. The potential for the project area to contribute biologically to the TNW downstream is unlikely and inconsequential. Furthermore, the project waters have a low capacity to transfer nutrients and organic carbon that support downstream food webs. Therefore, no significant nexus exists with regard to biological integrity.

The waters analyzed do not significantly affect the chemical, physical, and biological integrity of the downstream TNW and therefor appear not to be jurisdictional waters of the U.S. Concurrence of no waters of the U.S. on the project site has been received by the Corps in their letter dated February 11, 2013.

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Appendix E Other Supporting Information

Kimley-Horn and Associates, Inc.

Powerline, Vineyard Road and Rittenhouse Flood Retarding Structures Rehabilitation or Replacement Project

Summary of Operation, Maintenance and Monitoring Quantities for Level III Alternatives Analysis

Designed By: TDD Date: 01/11/2013
Checked By: RAE Date: 01/11/2013

			Alternative 8A Rehabilitation/Replacement		Alternative 8B Rehabilitation/Replacement	
			Replace Powerline FRS, Convert Rittenhouse FRS to Levee, Rehabilitate Vineyard Road FRS		Replace Powerline FRS, Rehabilitate Vineyard Road and Rittenhouse FRS	
	Unit cost	Unit	Quantity	Cost	Quantity	Cost
Recurring Cost of Powerline, Vineyard Road and Rittenhouse Elements						
Recurring O&M and Monitoring for Engineering Elements						
Estimated Annual Operation and Maintenance						
Powerline FRS						
Channel	$ 1,000	AC	222	$ 222,000	222	$ 222,000
SubTotal				$ 222,000		$ 222,000
Estimated Annual Monitoring						
Powerline FRS						
Channel in MFRZ	$ 5	LF	3,350	$ 16,750	3,350	$ 16,750
SubTotal				$ 16,750		$ 16,750
Subtotal Powerline O&M and Monitoring for Engineering Elements				**$ 238,800**		**$ 238,800**
Total Project Cost				**$ 238,800**		**$ 238,800**
100-year Project O&M Cost (I = 3.75%, n=100 years)				**$ 6,207,604**		**$ 6,207,604**

Opinion of Probable Cost for Level III Alternatives Analysis

Designed By: TDD Date: 01/11/2013
Checked By: RAE Date: 01/11/2013

Line Item	Item Description (Reference the Unit Price Descriptions for additional detail)	Unit cost	Unit	Alternative 8A Rehabilitation/Replacement: Replace Powerline FRS, Convert Rittenhouse FRS to Levee, Rehabilitate Vineyard Road FRS (Upstream Sloping Filter) Quantity	Cost	Alternative 8A Rehabilitation/Replacement: Replace Powerline FRS, Convert Rittenhouse FRS to Levee, Rehabilitate Vineyard Road FRS (Hybrid Filter) Quantity	Cost	Alternative 8B Rehabilitation/Replacement: Replace Powerline FRS, Rehabilitate Vineyard Road (Upstream Sloping Filter) and Rittenhouse FRS (Upstream Sloping Filter) Quantity	Cost	Alternative 8B Rehabilitation/Replacement: Replace Powerline FRS, Rehabilitate Vineyard Road (Hybrid Filter) and Rittenhouse FRS (Hybrid Filter) Quantity	Cost	Alternative 8B Rehabilitation/Replacement: Replace Powerline FRS, Rehabilitate Vineyard Road (Hybrid Filter) and Rittenhouse FRS (Central Filter) Quantity	Cost
	Remove Existing FRS												
	Remove Existing FRS and stockpile												
A1	Remove Powerline FRS (full length)	$ 3.00	CY	586,580	$ 1,759,740	586,580	$ 1,759,740	586,580	$ 1,759,740	586,580	$ 1,759,740	586,580	$ 1,759,740
A2	Remove Powerline FRS IDSM (full length)	$ 3.00	CY	117,370	$ 352,110	117,370	$ 352,110	117,370	$ 352,110	117,370	$ 352,110	117,370	$ 352,110
	SubTotal				$ 2,111,850		$ 2,111,850		$ 2,111,850		$ 2,111,850		$ 2,111,850
	Total Remove Existing FRS				$ 2,111,850		$ 2,111,850		$ 2,111,850		$ 2,111,850		$ 2,111,850
	Principal Spillway Modifications												
	Remove Existing Principal Spillway												
B1	Remove Existing Conduit, Cradle, Seepage Collars - Powerline (36-in)	$ 150.00	LF	164	$ 24,600	164	$ 24,600	164	$ 24,600	164	$ 24,600	164	$ 24,600
B2	Remove inlet riser/outlet structure - Powerline	$ 2,000.00	EA	2	$ 4,000	2	$ 4,000	2	$ 4,000	2	$ 4,000	2	$ 4,000
	SubTotal				$ 28,600		$ 28,600		$ 28,600		$ 28,600		$ 28,600
	Total Principal Spillway Modifications				$ 28,600		$ 28,600		$ 28,600		$ 28,600		$ 28,600
	Existing Irrigation Outlet Removals												
	Remove Existing Irrigation Outlets												
C1	Remove Existing 12-in CMP and headwalls - Powerline (Sta 141+50)	$ 200.00	LF	77	$ 15,400	77	$ 15,400	77	$ 15,400	77	$ 15,400	77	$ 15,400
	SubTotal				$ 15,400		$ 15,400		$ 15,400		$ 15,400		$ 15,400
	Total Existing Irrigation Outlet Removals				$ 15,400		$ 15,400		$ 15,400		$ 15,400		$ 15,400
	New Channels (Earthwork)												
	New Non-Fissure Channels												
	Powerline FRS												
D1	Channel Earthwork	$ 3.00	CY	1,587,300	$ 4,761,900	1,587,300	$ 4,761,900	1,587,300	$ 4,761,900	1,587,300	$ 4,761,900	1,587,300	$ 4,761,900
D2	Stockpiling and blending of spoil excavation	$ 1.50	CY	1,587,300	$ 2,380,950	1,587,300	$ 2,380,950	1,587,300	$ 2,380,950	1,587,300	$ 2,380,950	1,587,300	$ 2,380,950
	SubTotal				$ 7,142,850		$ 7,142,850		$ 7,142,850		$ 7,142,850		$ 7,142,850
	Total New Channels (Earthwork)				$ 7,142,850		$ 7,142,850		$ 7,142,850		$ 7,142,850		$ 7,142,850
	New Channels (Hardened Segments)												
	New Fissure-Resistant Channels												
	Powerline FRS												
	Excavated Trench				$ -		$ -		$ -		$ -		$ -
E1	Trench Excavation and Backfill	$ 3.00	CY	18,000	$ 54,000	18,000	$ 54,000	18,000	$ 54,000	18,000	$ 54,000	18,000	$ 54,000
E2	Geotextile	$ 2.50	SY	35,800	$ 89,500	35,800	$ 89,500	35,800	$ 89,500	35,800	$ 89,500	35,800	$ 89,500
E3	Permeable Backfill	$ 26.00	CY	15,900	$ 413,400	15,900	$ 413,400	15,900	$ 413,400	15,900	$ 413,400	15,900	$ 413,400
	Channel Section				$ -		$ -		$ -		$ -		$ -
E4	Channel Over Excavation and Backfill	$ 5.00	CY	15,300	$ 76,500	15,300	$ 76,500	15,300	$ 76,500	15,300	$ 76,500	15,300	$ 76,500
E5	12" Prepared Subgrade	$ 5.00	CY	15,300	$ 76,500	15,300	$ 76,500	15,300	$ 76,500	15,300	$ 76,500	15,300	$ 76,500
E6	Geotextile	$ 2.50	SY	94,200	$ 235,500	94,200	$ 235,500	94,200	$ 235,500	94,200	$ 235,500	94,200	$ 235,500
E7	Concrete	$ 300.00	CY	7,700	$ 2,310,000	7,700	$ 2,310,000	7,700	$ 2,310,000	7,700	$ 2,310,000	7,700	$ 2,310,000
E8	6x6 W 2.9x2.9 Welded Wire mesh	$ 0.75	LB	178,000	$ 133,500	178,000	$ 133,500	178,000	$ 133,500	178,000	$ 133,500	178,000	$ 133,500
	SubTotal				$ 3,388,900		$ 3,388,900		$ 3,388,900		$ 3,388,900		$ 3,388,900
	Total New Channels (Hardened Segments)				$ 3,388,900		$ 3,388,900		$ 3,388,900		$ 3,388,900		$ 3,388,900

Opinion of Probable Cost for Level III Alternatives Analysis

Designed By: TDD Date: 01/11/2013
Checked By: RAE Date: 01/11/2013

				Alternative 8A		Alternative 8A		Alternative 8B		Alternative 8B		Alternative 8B	
				Rehabilitation/Replacement		Rehabilitation/Replacement		Rehabilitation/Replacement		Rehabilitation/Replacement		Rehabilitation/Replacement	
Line Item	Item Description (Reference the Unit Price Descriptions for additional detail)			Replace Powerline FRS, Convert Rittenhouse FRS to Levee, Rehabilitate Vineyard Road FRS (Upstream Sloping Filter)		Replace Powerline FRS, Convert Rittenhouse FRS to Levee, Rehabilitate Vineyard Road FRS (Hybrid Filter)		Replace Powerline FRS, Rehabilitate Vineyard Road (Upstream Sloping Filter) and Rittenhouse FRS (Upstream Sloping Filter)		Replace Powerline FRS, Rehabilitate Vineyard Road (Hybrid Filter) and Rittenhouse FRS (Hybrid Filter)		Replace Powerline FRS, Rehabilitate Vineyard Road (Hybrid Filter) and Rittenhouse FRS (Central Filter)	
		Unit cost	Unit	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
	Basin/Channel Side inlets												
	Tributary Confluence Erosion Control												
	Powerline FRS												
F1	Small basin/channel side inlet	$ 17,300.00	EA	1	$ 17,300	1	$ 17,300	1	$ 17,300	1	$ 17,300	1	$ 17,300
F2	Medium basin/channel side inlet	$ 52,100.00	EA	1	$ 52,100	1	$ 52,100	1	$ 52,100	1	$ 52,100	1	$ 52,100
F3	Large basin/channel side inlet	$ 125,500.00	EA	1	$ 125,500	1	$ 125,500	1	$ 125,500	1	$ 125,500	1	$ 125,500
	SubTotal				$ 194,900		$ 194,900		$ 194,900		$ 194,900		$ 194,900
	Total Basin/Channel Side inlets				$ 194,900		$ 194,900		$ 194,900		$ 194,900		$ 194,900
	Improvements to Powerline North Diversion Channel												
	New Channel												
G1	Channel excavation	$ 3.00	CY	11,800	$ 35,400	11,800	$ 35,400	11,800	$ 35,400	11,800	$ 35,400	11,800	$ 35,400
G2	Gabion Basket outlet protection at Baseline Road	$ 200.00	SY	218	$ 43,600	218	$ 43,600	218	$ 43,600	218	$ 43,600	218	$ 43,600
G3	Pavement removal/replacement	$ 100.00	CY	178	$ 17,800	178	$ 17,800	178	$ 17,800	178	$ 17,800	178	$ 17,800
G4	Culvert removal	$ 300.00	LF	150	$ 45,000	150	$ 45,000	150	$ 45,000	150	$ 45,000	150	$ 45,000
G5	Earthwork	$ 3.00	CY	355	$ 1,065	355	$ 1,065	355	$ 1,065	355	$ 1,065	355	$ 1,065
G6	Reinforcing steel	$ 0.75	LBS	35,018	$ 26,264	35,018	$ 26,264	35,018	$ 26,264	35,018	$ 26,264	35,018	$ 26,264
G7	Concrete	$ 300.00	CY	253	$ 75,900	253	$ 75,900	253	$ 75,900	253	$ 75,900	253	$ 75,900
G8	Riprap	$ 65.00	CY	396	$ 25,740	396	$ 25,740	396	$ 25,740	396	$ 25,740	396	$ 25,740
	SubTotal				$ 270,769		$ 270,769		$ 270,769		$ 270,769		$ 270,769
	Total Improvements to Powerline North Diversion Channel				$ 270,769		$ 270,769		$ 270,769		$ 270,769		$ 270,769
	Site Preparation												
	Clearing and Grubbing												
H1	Clearing and Grubbing	$ 12,000.00	AC	266	$ 3,192,000	266	$ 3,192,000	266	$ 3,192,000	266	$ 3,192,000	266	$ 3,192,000
	SubTotal				$ 3,192,000		$ 3,192,000		$ 3,192,000		$ 3,192,000		$ 3,192,000
	Total Site Preparation				$ 3,192,000		$ 3,192,000		$ 3,192,000		$ 3,192,000		$ 3,192,000
	Subtotal Powerline Structures				**$ 12,882,500**		**$ 12,882,500**		**$ 12,882,500**		**$ 12,882,500**		**$ 12,882,500**
	Subtotal Additional Elements				**$ 3,462,800**		**$ 3,462,800**		**$ 3,462,800**		**$ 3,462,800**		**$ 3,462,800**
	Subtotal Structure Cost				**$ 16,345,300**		**$ 16,345,300**		**$ 16,345,300**		**$ 16,345,300**		**$ 16,345,300**
	Landscaping and Aesthetics "Lite" Approach (5%)				$ 817,300		$ 817,300		$ 817,300		$ 817,300		$ 817,300
	Environmental Mitigation				$ 720,000		$ 720,000		$ 720,000		$ 720,000		$ 720,000
	Cultural Resources Mitigation				$ 602,000		$ 602,000		$ 602,000		$ 602,000		$ 602,000
	Contingency (25%)				$ 4,086,400		$ 4,086,400		$ 4,086,400		$ 4,086,400		$ 4,086,400
	Subtotal Structure, Environmental and Landscape Cost				**$ 22,571,000**		**$ 22,571,000**		**$ 22,571,000**		**$ 22,571,000**		**$ 22,571,000**
	ADWR Permit (2% dams)				$ 452,000		$ 452,000		$ 452,000		$ 452,000		$ 452,000
	Mobilization (3%)				$ 678,000		$ 678,000		$ 678,000		$ 678,000		$ 678,000
	Engineering (3%)				$ 678,000		$ 678,000		$ 678,000		$ 678,000		$ 678,000
	Supplemental General Conditions (1%)				$ 226,000		$ 226,000		$ 226,000		$ 226,000		$ 226,000
	CQC Plan and Testing (1%)				$ 226,000		$ 226,000		$ 226,000		$ 226,000		$ 226,000
	Construction Management (3%)				$ 678,000		$ 678,000		$ 678,000		$ 678,000		$ 678,000
	Total Project Cost				**$ 25,509,000**		**$ 25,509,000**		**$ 25,509,000**		**$ 25,509,000**		**$ 25,509,000**