Continuing Authorities Program

Section 205 Small Flood Risk Management Project

Hatch, New Mexico

Detailed Project Report and

Environmental Assessment

September 2019

US Army Corps of Engineers®
Albuquerque District

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U.S. ARMY CORPS OF ENGINEERS
ALBUQUERQUE DISTRICT

FINDING OF NO SIGNIFICANT IMPACT For SMALL FLOOD RISK MANAGEMENT PROJECT, HATCH, NEW MEXICO

Under the authority of Section 205 of the Flood Control Act of 1948, the U.S. Army Corps of Engineers (USACE) in cooperation with, and at the request of the Doña Ana County Flood Commission, proposes to implement the Small Flood Risk Management Project (Project) that would reduce flood damage in the Village of Hatch, in Doña Ana County, New Mexico.

The proposed Project is located on the southern edge of the Village of Hatch along the Spring Canyon Arroyo. The proposed dam would be constructed of an earthen embankment with a roller compacted concrete spillway. Borrow material for the dam would be obtained from the area directly behind the proposed dam. The outlet works would drain water from the retention basin into the Colorado Drain. The inlet channel, which would bring water from the Spring Canyon Arroyo to the dam, would be excavated and lined with roller compacted concrete, transitioning to soil cement then riprap. A subsurface drainage system would be needed on the downstream toe of the dam for seepage control. The proposed project is designed to detain the 0.2% chance exceedance event from the Spring Canyon Watershed and slowly release the stored water over approximately 96 hours. The proposed construction period would be approximately 12 months and would be expected to start in 2020.

Studies for the Project began in 2004, and a scoping letter was sent in March 2006 to all interested Federal, State, and local agencies, Tribes, non-governmental organizations and stakeholders.

Alternatives considered include a number of structural and nonstructural flood risk management (FRM) measures. An array of alternative plans including the No-Action Plan were analyzed and compared against each other to identify the recommend plan. The recommended plan is the alternative that maximized net benefits (e.g., damages prevented) while protecting the environment, best meets project objectives, and complies with pertinent laws and regulation.

The proposed Project is regulated under the provisions of Section 404 of the Clean Water Act (CWA) and is authorized under a Nationwide Permit No. 43 for Stormwater Management Facilities. Because the proposed action meets the conditions of this Nationwide Permit, the 404(b)(1) analyses have already been completed. All conditions under the permit would be adhered to during construction. Section 401 of the CWA does apply to this project, as there would be discharge associated with construction activities or other disturbance within waterways. Nationwide Permit No. 43 has a conditional Water Quality Certification that has been issued by the New Mexico Environmental Department, Surface Water Quality Bureau. The proposed project will comply with the state water quality standard and general conditions under the conditional Water Quality Certification. All Best Management Practices described throughout the document would be adhered to during project implementation.

Best Management Practices to protect the environment that would be implemented as part of this project include the following.

- All fuels, oils, hydraulic fluids and other similar substances would be appropriately stored out of the floodplain and must have a secondary containment system to prevent spills if the primary storage container leaks. Construction equipment would be inspected daily and monitored during operation to prevent leaking fuels or lubricants from entering any surface water.
- The contractor would be required to have emission control devices on all equipment.
- To control dust and wind erosion, soils within the construction zone would be kept wet. Stockpiles of debris, soil, or other materials that could produce dust would be watered or covered. Materials transported on or off-site by truck would be covered. The contractor would be required to comply with local sedimentation and erosion-control regulations.
- Best management practices would be implemented regarding the treatment and disposal of waste material. Proper disposal of all waste material at commercial disposal areas or landfills would occur.
- Activities would be limited to the designated or otherwise approved areas and would be shown on the construction drawings for construction areas, staging access, and borrow use. USACE approval of any additional areas will be required regardless of their ownership or distance to the construction sites to ensure protection of vegetation, water quality, threatened and endangered species, cultural resources and other significant resources. The USACE's Contracting Officer will coordinate with the USACE Environmental Resources Section to approve any changes in access routes, non-commercial borrow sites, staging areas, disposal sites, and other high-use areas
- A Stormwater Pollution Prevention Plan is required. Aquatic and riparian habitat would be protected with silt fencing, geotextiles, or straw bales to prevent runoff of sediment from areas disturbed by construction.
- Excavated surfaces behind the dam would be seeded with certified weed-free native vegetation.

The proposed project would result in only minor, temporary, adverse impacts to water quality, air quality, noise levels, soils, vegetation, land use, floodplains, wildlife, and waters of the United States during construction. The project would have minimal long-term adverse impacts to floodplains, land use and water quality. There would be long-term benefits to human health and safety from a significant reduction in flood hazards which would outweigh these short-term adverse impacts. The following elements have been analyzed and would not be significantly affected by the planned action: socioeconomic environment, climate, water quality, noise levels, wetlands, biological resources, endangered and threatened species, prime and unique farmland, and cultural resources. There would be no adverse cumulative effects to the environment from the proposed project.

The proposed project has been fully coordinated with Federal, State, Tribal, and local governments with jurisdiction over the ecological, cultural, and hydrological resources of the study area. Based upon these factors and others discussed in detail in the Detailed Project Report/ Environmental Assessment, the proposed action would not have a significant effect on the human environment. Therefore, an Environmental Impact Statement would not be prepared for the conduct of the subject project.

26 SEP 19
Date

Larry D. Caswell, Jr.
Lieutenant Colonel, U.S. Army
District Engineer

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EXECUTIVE SUMMARY

1. Study Information

This is a USACE planning document incorporating a Detailed Project Report and integrated Environmental Assessment (DPR/EA). The DPR/EA presents the results of investigations completed to determine whether Federal participation is warranted for FRM on Spring Canyon in the Village of Hatch, New Mexico. The project sponsor is the Doña Ana County Flood Commission.

The project area is located in the northwest corner of Doña Ana County, New Mexico (Figure 1). The Village of Hatch (Hatch) is located at the intersection of US Highway 85 and State Highway 26, approximately 35 miles northwest of Las Cruces, New Mexico. The Spring Canyon watershed contributing to flooding in the village covers approximately 7.18 square miles (sq mi) to the south of Hatch. An upstream detention dam addresses 5.4 sq mi of this drainage area. Despite this detention dam, constructed in 1939, flooding continues to occur in Hatch as the result of precipitation in Spring Canyon. Flows enter Hatch from the south and become trapped behind the elevated Hatch Canal (a key component of a regional gravity-fed irrigation system). As the majority of the developed portions of Hatch lie upstream of the Hatch Canal, ponding floodwaters regularly inundate the village. The entire Village of Hatch lies within the 1% chance exceedance floodplain for Spring Canyon. It is currently estimated that the mean 1% chance exceedance flood would cause damages of about $23.6 million to structures and contents in the study area.

The investigations undertaken to assess the alternatives that could address or reduce the extensive flooding damages in the area are presented in the DPR/EA. The Environmental Assessment (EA) addresses the perceived effects of alternative plans developed to provide higher levels of FRM for floodplain communities, transportation infrastructure, and agriculture from flood flows originating in Spring Canyon. Together, the DPR/EA presents a complete package addressing the planning objectives and environmental impacts of the project.

The proposed earthen embankment dam would be located upstream of the Village of Hatch adjacent to the Spring Canyon Arroyo. The dam site is just south of where the Colorado Drain and the Rodey Lateral meet. Suitable material from the existing spoil berm will be included in borrow for earthen dam construction. Two relocations would have to be performed prior to any borrow excavation. These consist of an abandoned leach field and an existing waterline both located within the retention basin area. In addition, an existing spoil levee, 1,100 feet in length, would have to be removed prior to the excavation of a new trapezoidal channel. The existing levee is located at the south end of the proposed retention basin, near the mouth of Spring Canyon. The upstream end of the inlet channel, which would convey water from the Spring Canyon to the dam, would be constructed of roller compacted concrete, transitioning to soil cement and then riprap. The outlet works would drain water from the retention basin into the Colorado Drain.

2. Problem

Flooding originating from Spring Canyon flows regularly causes significant damage to residential, commercial and agricultural areas of Hatch, and has the potential to pose life safety risks. Three significant floods occurred in 1988, 1992, and 2006 with up to three feet of water within the residential streets of Hatch. There are 159 residential homes, 139 commercial/public structures, 43 mobile homes, and 197 detached outbuildings within the 1% chance exceedance floodplain. Flood damages to these structures totaled approximately $1,400,000 in 1988; $1,750,000 in 1992; and several million in 2006. Numerous homes and businesses experienced flood damage while many families lost the majority of their belongings and were displaced from their homes for several months. These property damage estimates do not include damages to streets, utilities, vehicles, and agricultural properties, which also occurred, and therefore likely underestimate true flood damages in the community.

3. Plans Considered

Alternatives considered include a number of structural and nonstructural FRM measures. An array of alternative plans, including the No-Action Plan, were analyzed and compared against each other to identify the recommended plan. The recommended plan is the National Economic Development (NED) plan or the plan that maximizes net benefits while protecting the environment, best meets project objectives and is acceptable to the officials and citizens of Hatch and Doña Ana County.

Nonstructural measures such as early warning systems, raising or flood-proofing individual structures, relocating structures or evacuating the floodplain were considered as stand-alone alternatives and in combination with other measures. The analyses of raising or flood-proofing individual structures, relocating structures or evacuating the floodplain indicated these measures could not be efficiently or effectively implemented and the existing level of flood risks would not be significantly reduced. Early warning systems and updating the existing emergency actions plans will be included with the recommended alternative.

Structural alternatives were identified in conjunction with the Doña Ana County Flood Commission (the sponsor) and the Village of Hatch. Structural measures considered consisted of combinations of structures such as ring levees, dams or channel improvements designed to detain, divert, or exclude the flow of water from flood-prone areas to reduce damages to property and infrastructure, and hazard to life or public health. Analyses were conducted during the feasibility study in order to determine which level of protection would provide the maximum net economic benefits while protecting the environment. In this effort, three dam alternatives were analyzed to determine the optimum benefit/cost relationship. The alternative dams were designed to reduce flows exiting Spring Canyon to a safe capacity for discharge into the Colorado Drain for events ranging from the 4% chance flood event (recently referred to as the 25-year event) to the 0.2% chance flood event (recently referred to as the 500-year event).

4. Recommended Plan

The recommend plan is referred to as “Dam C” or “the dam” in the following sections of this DPR/EA. Dam C is the recommended plan since it met all the planning objectives and contributes to NED, maximizing net economic benefits consistent with protecting the

Nation's environment. Dam C is the NED Plan and is sized for a 0.2% chance exceedance event which will detain a storage capacity of 283 AF. This storage capacity consists of a 30 AF sediment pool and 253 AF of water. The maximum height of embankment for Dam C is 22.6 feet and the dam includes a roller compacted concrete spillway and apron, and concrete outlet works with gate and tower. Dam C is approximately 4,191 feet in length. Access roads will be required on both sides of the dam and ramps will also be constructed to access the top of the dam. Fencing will enclose the retention basin and gates will be provided as needed for access to the new dam. A new trapezoidal channel will transport runoff from nearby Spring Canyon into the retention basin of Dam C. A new storm drain line will be provided to collect and remove standing water located outside the proposed dam area.

5. Project Impacts

The effects of the recommended plan on the physical environment of the study area can be characterized as minimal. The proposed project would result in a disturbance of approximately 2.5 acres (ac) of upland vegetation. However, due to years of drought conditions, this area has minimal, low quality vegetation. There is about 1.0 acre of riparian habitat within the project area, along the south bank of the Rodey Lateral. Although direct removal of riparian vegetation along Rodey Lateral is not anticipated, if construction activities were to cause damage, mature standing trees and shrubs would be replaced at a 1:1 ratio.

6. Benefits and Costs

The plan that maximizes net benefits is Dam C with a benefit/cost ratio of 4.8 and $1,925,840 in net benefits (October 2018). The total first cost of the recommended plan is $12,735,000 at Oct. 2019 price levels.

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NOTE: Sections required under the National Environmental Policy Act for the Environmental Assessment are noted by an asterisk (*) in the Table of Contents

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Acronyms

ac	acres
AEP	annual exceedance probability
AF	acre-feet
ASTM	American Society for Testing and Materials
ATR	agency technical review
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic feet per second
CMP	corrugated metal pipe
CWA	Clean Water Act
DOI	U.S. Department of the Interior
DPR	Detailed Project Report
DPR/EA	Detailed Project Report/Environmental Assessment
EA	Environmental Assessment
EAD	expected annual damages
EBID	Elephant Butte Irrigation District
EM	engineer manual
EO	Executive Order(s)
EQ	environmental quality
ER	engineer regulation
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FRM	flood risk management
FRM-PCX	Flood Risk Management Planning Center of Expertise
ft	feet
FWCA	Fish and Wildlife Coordination Act
g	unit of peak ground acceleration
HEC	Hydrologic Engineering Center (USACE)
HEC-FDA	Hydrologic Engineering Center-Flood Damage Assessment
HEC-HMS	Hydrologic Engineering Center Hydrologic Modeling System
HEC-RAS	Hydrologic Engineering Center River Analysis System
HPD	New Mexico Historic Preservation Division
HTRW	hazardous, toxic and radioactive waste
ICOLD	International Commission on Large Dams
ITA	Indian trust assets
LERRD	land, easements, rights-of-way, relocation and disposal areas
MCE	maximum credible earthquake
mmhos/cm	millimhos per centimeter
Mw	moment magnitude (of an earthquake)
NED	national economic development
NEPA	National Environmental Policy Act
NMDGF	New Mexico Department of Game and Fish
NMED	New Mexico Environment Department
NMSHD	New Mexico State Highway Department
NMWQCC	New Mexico Water Quality Control Commission

NPDES	National Pollutant Discharge Elimination System
NR#	National Register number
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
OBE	operating basis earthquake
OMRR&R	operation, maintenance, repair, replacement, and rehabilitation
OSE	other social effects
OSE-DSB	New Mexico Office of the State Engineer - Dam Safety Bureau
P.L.	Public Law
PGA	peak horizontal ground acceleration
Phase I ESA	Phase I environmental site assessment
PMF	probable maximum flood
PMP	probably maximum precipitation
Project	Small Flood Risk Management Project in Hatch, New Mexico
REC	recognized environmental conditions
RED	Regional Economic Development plan
RTI	Resource Technology, Inc.
SVOC	semi-volatile organic compounds
SWQB	NMED Surface Water Quality Bureau
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	volatile organic compounds

Project Information

1.1 Project Authorization

This integrated DPR/EA addresses alternative plans for the Small Flood Risk Management Project, Hatch, NM and was prepared as a response to the following authorities provided by Congress:

> Flood Control Act 30 June 1948, Section 205 (P.L. 858, 80th Congress, 2nd Session, and H.R. 6419), as amended, which reads:
>
> *That the Secretary of the Army is hereby authorized to allot from any appropriations heretofore or hereafter made for flood control, not to exceed $2,000,000 for any one fiscal year, for the construction of small flood-control projects not specifically authorized by Congress, and not within areas intended to be protected by projects so authorized, which come within the provisions of section 1 of the Flood Control Act of June 22, 1936, when in the opinion of the Chief of Engineers such work is advisable: Provided, That not more than $100,000 shall be allotted for this purpose at any single locality from the appropriations for any one fiscal year: Provided further, That the provisions of local cooperation specified in section 3 of the Flood Control Act of June 22, 1936, as amended, shall apply: And Provided further, That the work shall be complete in itself and not commit the United States to any additional improvement to insure its successful operation, except as may result from the normal procedure applying to projects authorized after submission of preliminary examination and survey report.*

1.2 *Project Area

The study area comprises portions of the urbanized area within the Village of Hatch, consisting of residential, public and commercial structures. Hatch is located in the northwest corner of Doña Ana County, New Mexico, near the Rio Grande. Hatch is a fairly small population center within the county. The 2010 Census identified 1,648 persons within the Village and 209,233 persons within the county. Agriculture comprises the main industry within the study area, while the county has a heavy Federal government presence in the White Sands Test Facility and the White Sands Missile Range. The project area resides in the following congressional districts (Figure 1):

- Senator Tom Udall (D)
- Senator Martin Heinrich (D)
- Congressional Representative Xochitl Torres-Small, NM-02 (D)

Hatch faces a flood threat from two drainages of the Sierra de Las Uvas, which are immediately south of the village. Hatch has received significant flooding, with up to three feet of water in 1988, 1992, and 2006, from these drainages.

Hatch is located at the mouth of Spring Canyon. Short lived, very intense summer storms result in flash flood flows down this normal dry stream channel. These storms are the primary source of flooding in the project area. Floodwaters entering Hatch from this drainage have no clear pathway to the Rio Grande due to the construction of the elevated Hatch Main Canal. Consequently, floodwaters impounded behind the Hatch Main Canal remain in place until evaporated. The Rodey Lateral is another elevated drain that borders Hatch along its southern edge and can impound flood waters from the Sierra de Las Uvas (Figure 2).

Hatch is situated east of the Continental Divide within the Mexican Highland Section of the Basin and Range Physiological Province. The area is characterized by gently sloping plains separated by rugged mountain ranges. It is located within the Rio Grande floodplain, bounded to the north by the north-south aligned Caballo Mountains and to the south by the Sierra de Las Uvas. Spring Canyon rises in the Sierra de Las Uvas and flows north to Hatch, and historically to the Rio Grande. An existing upstream detention dam, Spring Canyon Dam, addresses 5.4 sq mi. of the 7.18 sq mi. drainage area (see Section 1.9.1for a full description of Spring Canyon Dam). Spring Canyon Dam was constructed by the U.S. Department of Agriculture's (USDA) then Soil Conservation Service (now referred to as the Natural Resources Conservation Service or NRCS) in 1939 for the purpose of detaining flood water and sediment.

Elevations in the study area range from almost 6,000 feet in the Sierra de Las Uvas to 4,030 feet at the confluence with the Rio Grande. Stream slopes are steep throughout most of the watershed, but are mild in the Rio Grande Valley. Development is rural and agricultural in the valley and almost non-existent elsewhere in the Spring Canyon watershed.

1.3 *Purpose and Need for Action

The purpose of the proposed project is to reduce flood damages and life safety risk within the project area in the Village of Hatch. The flood hazard in the project area is extensive. It is currently estimated that the mean 1% annual chance exceedance flood would cause damages of about $23.6 million to structures and contents in the study area. The larger portion of the Village of Hatch is in the 1% chance exceedance floodplain (Figure 3). Significant flooding occurred in 1988, 1992, and again in 2006, with up to three feet of water ponding throughout the village (Figure 4). Additional flood history is discussed in Appendix I Plan Formulation. Numerous homes and businesses experienced flood damage; many families lost the majority of their belongings and were displaced from their homes for several months. Flows come from Spring Canyon and Placitas Arroyo, which lie west of Hatch, and travel through the village toward the Rio Grande. The flood events from these two sources have been independent. This DPR/EA discusses the methods and findings of the study to reduce flood risk from the flows originating from Spring Canyon. Flows from Placitas Arroyo are currently being addressed by a separate project by the Village of Hatch.

1.4 Integrated Report

This report is an integrated USACE planning document, incorporating a DPR/EA as required by the National Environmental Policy Act (NEPA). The report describes the planning process and the analyses used to identify the recommended plan. This DPR/EA: (1) describes the risk of flooding in the Village of Hatch, New Mexico; (2) evaluates a range of alternatives to reduce flood risk, including potential environmental impacts; (3) describes measures to minimize or mitigate for potential environmental impacts; (4) identifies an alternative for implementation; (5)

describes coordination, consultation, and public involvement for the study; and (6) describes the status of compliance with Federal and State laws, Executive Orders (EO) and other requirements.

1.5 Federal Interest

A feasibility cost sharing agreement between the Doña Ana County Flood Commission (Sponsor) and the USACE was signed on 20 May 2004 initiating the studies and analyses for the DPR/EA. The results of completed DPR/EA are the final response determining whether there is Federal interest in implementing a FRM project in Hatch.

All of Hatch is located in the 1% chance exceedance floodplain. Significant flows have flooded the community three times over the past 25 years, affecting private and commercial properties, and public infrastructure. The most recent flood occurred in July 2006. There are 159 residential, 139 commercial/public, 43 mobile homes, and 197 detached outbuildings within the 1% chance event floodplain. Flood damages totaled approximately $1,400,000 in 1988; $1,750,000 in 1992; and several million in 2006. Numerous homes and businesses experienced flood damage while many families lost the majority of their belongings and were displaced from their homes for several months.

Initial investigations determined that there is a Federal interest in constructing FRM projects in Hatch. This DPR/EA presents the results of studying and implementing a project to reduce the potential of flooding from the Spring Canyon drainage. The Spring Canyon drainage area covers approximately 8.1 sq mi. Of the lowest (most downstream) 0.86 sq mi forms the developed area of Hatch, leaving 7.18 sq mi of watershed contributing to flooding in the Village. An existing detention dam located upstream of the project area, controls 5.4 sq mi of this drainage area, but is not designed to retain the probable maximum flood (PMF). Significant flooding in Hatch also originates from precipitation downstream of this existing structure.

1.6 Non-Federal Sponsor

The Non-Federal Sponsor is the Doña Ana County Flood Commission

Director
Doña Ana County Flood Commission
County Government Center
845 N. Motel Blvd, Room 1-250
Las Cruces, NM 88007

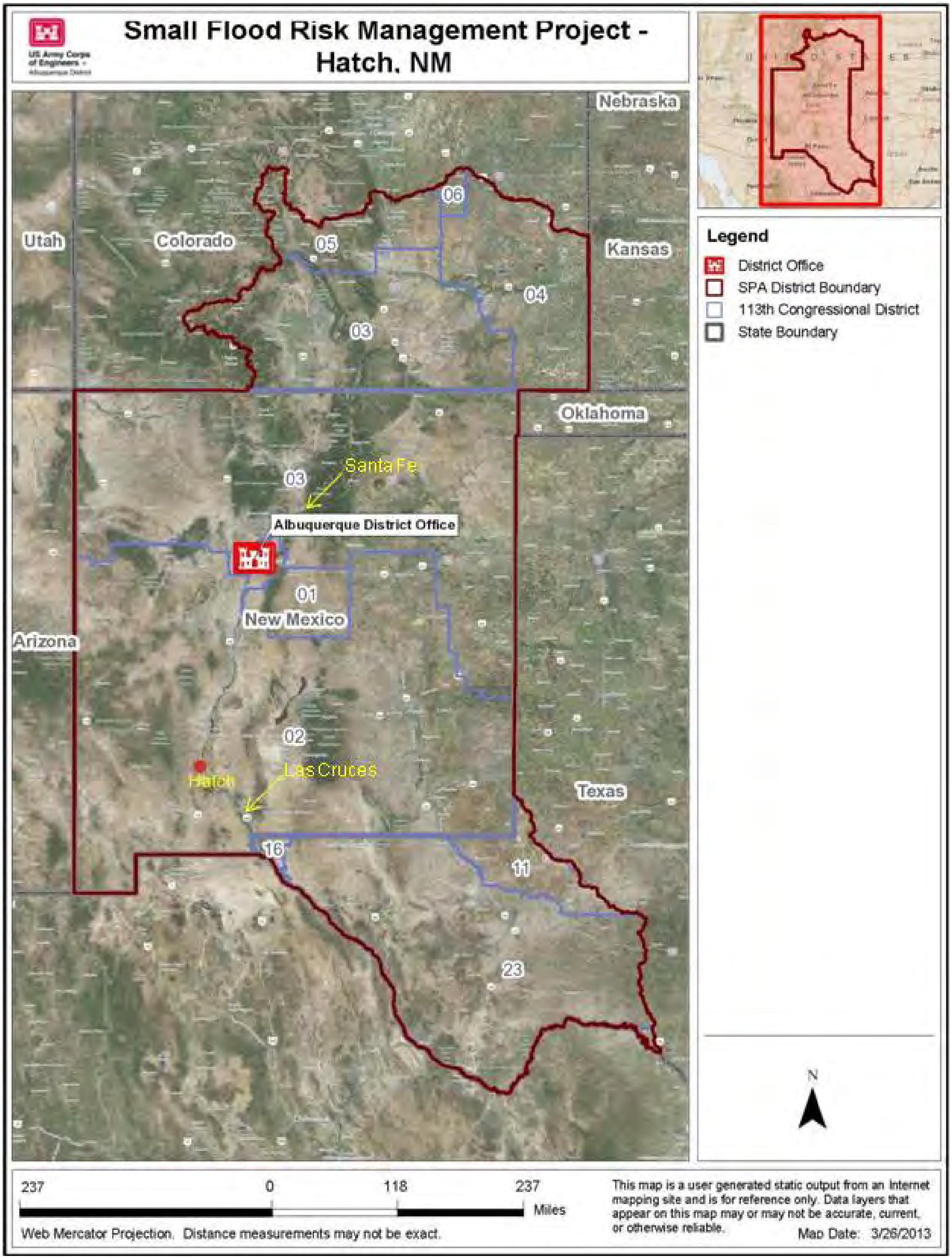


Figure 1 Map of the Albuquerque District boundaries and Congressional districts.

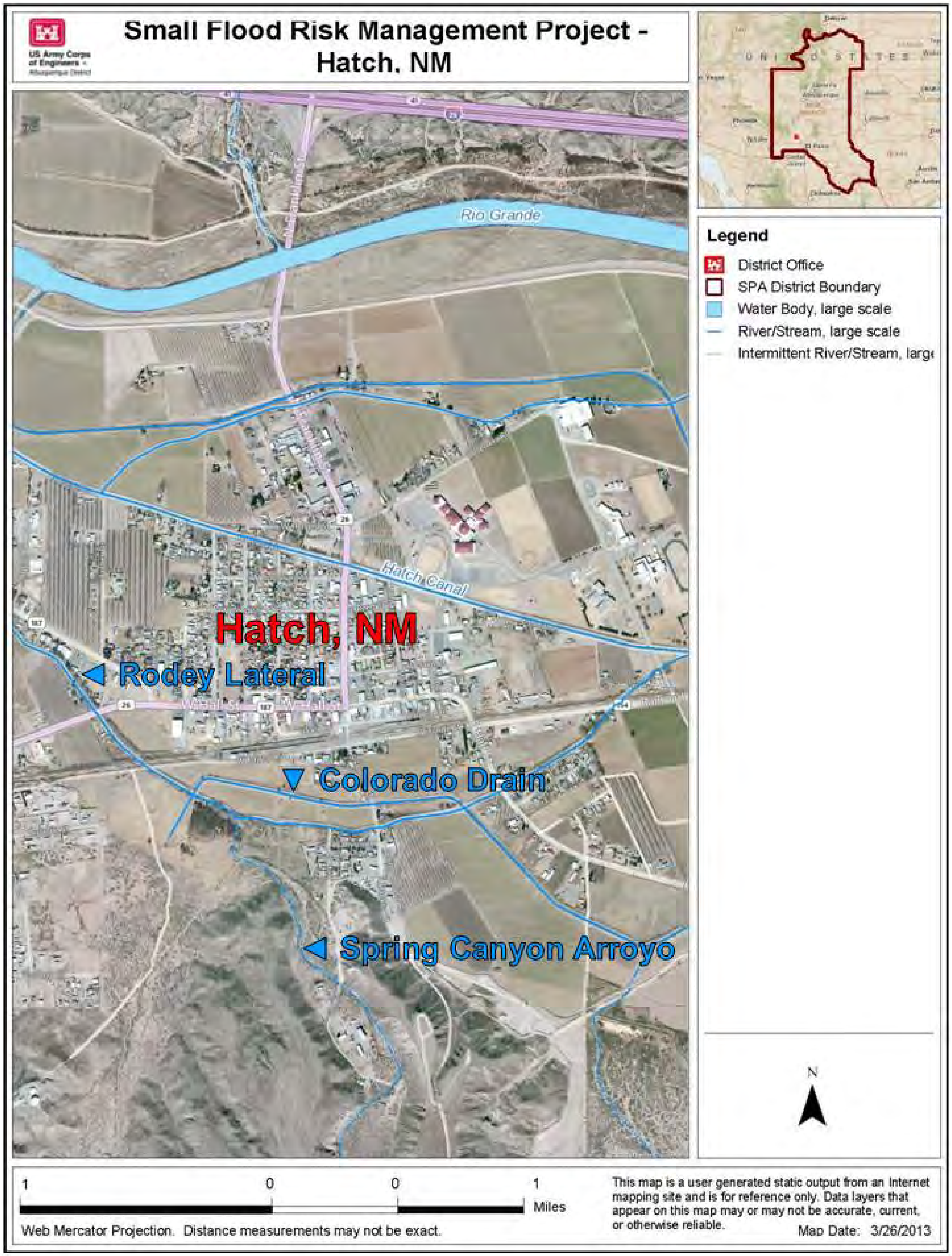


Figure 2 Map of the project location.

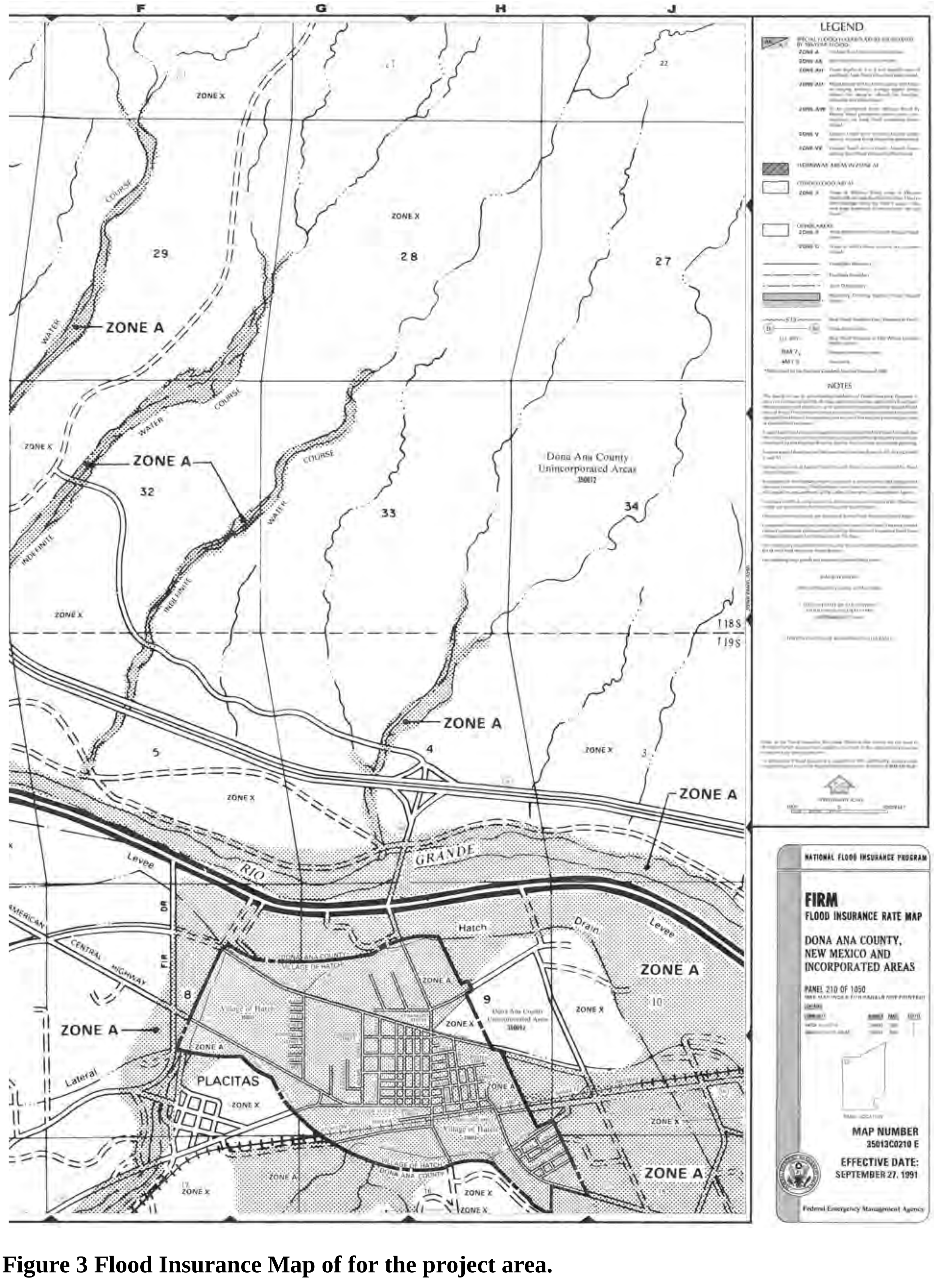


Figure 3 Flood Insurance Map of for the project area.

Figure 4 Flooding in downtown Hatch, NM in August 2006.

(Photo from article by David Crowder at NewsPaperTree.com)

1.7 Public and Agency Scoping

Scoping letters were mailed on March 13, 2006, to appropriate Federal, State, and local government agencies, as well as private individuals and agencies who may have a potential interest in or who have expressed an interest in the proposed project. A public meeting was held in Hatch, New Mexico, on April 19, 2007. Coordination and consultation communications have taken place between the USACE and the Village of Hatch, the Doña County Flood Commission, the South Central New Mexico Stormwater Coalition, the Elephant Butte Irrigation District (EBID), U.S. Fish and Wildlife Service, and members of the environmental community through meetings, field trips, presentations, written and verbal correspondence.

1.8 Planning Process and Report Organization

1.8.1 Planning Process

The USACE plan formulation process was used to identify and develop an array of alternative solutions to the FRM problem in Hatch, and to evaluate these alternatives in terms of efficiency, completeness, effectiveness, and acceptability and their ability to meet project objectives.

Through this process, described in greater detail in Chapter 3 of this report and in Appendix I – Plan Formulation, alternatives are developed, screened and evaluated to identify one alternative recommended for implementation.

The DPR/EA was prepared in accordance with the applicable Engineering Regulations (ER) including but not limited to:

- USACE Engineer Regulation (ER) 1105-2-100, *Planning Guidance Notebook*
- USACE ER 1110-2-1150, *Engineering and Design for Civil Works Projects*
- USACE ER 405-1-12, *Real Estate Handbook*, Chapter 12
- USACE ER 1110-2-1302, *Civil Works Cost Engineering*
- 33 Code of Federal Regulations (CFR) Section 230, *Procedures for Implementing NEPA* (ER 200-2-2). This regulation establishes USACE procedures for implementing NEPA and the Council on Environmental Quality (CEQ) regulations
- Other pertinent regulations including EO 11988, *Floodplain Management* (1977). USACE ER 1165-2-26 contains USACE' policy and guidance for implementing EO 11988

ER 1105-2-100, *Planning Guidance Notebook* dated 22 April 2000, as amended, outlines the planning process used by the PDT in this feasibility study. The project begins by listening to local concerns and identifying opportunities for USACE to assist the project Sponsor in addressing these concerns. This "problems and opportunities" step identifies those local problems that fall within USACE authorities for action, and the opportunity to fix these problems becomes the project purpose. The purpose of this project is to reduce flood damages and life safety risk in the Village of Hatch, NM.

The second step is an assessment of existing conditions in the study area, which allows USACE to understand the underlying causes of the problem(s) being addressed. This information is also used to understand what conditions in the project area might be like in the future if no project is constructed, but existing conditions, ongoing trends, and other anticipated projects occur. This information is presented in Chapter 2 – Existing and Expected Future Without-Project Conditions.

The next step in the process is the plan formulation step. During plan formulation, management measures are identified that address all or part of the problem(s) being addressed. The goal of this step is to cast as wide a net as possible, so that potentially valuable solutions are not subsequently overlooked. The comprehensive list of alternatives is then screened using technical, economic, environmental considerations and other criteria. Measures or alternatives found to be infeasible are removed from further consideration and no further analysis is done with these alternatives. The remaining alternatives are then compared to each other, and to a future in which no action is taken (the No Action Alternative). The remaining or focused array of alternatives after these screening steps are evaluated to determine their ability to accomplish the project objectives and compared using the criteria outlined in Section 3.3. As part of this evaluation potential impacts of each alternative on the natural environment, threatened and endangered species, cultural resources, local socioeconomic conditions, and other factors are identified. This information is presented in Chapter 4 –Foreseeable Effects of the Proposed Alternative. The alternatives are also evaluated on the basis of economics. The output of alternatives in damages prevented and measured in dollars is compared to the cost of the alternative to describe efficiency. The efficient alternative will be the plan that is least cost per the unit of output. The analysis will also identify the alternative that maximizes net benefits. This plan will be the NED plan subject to the verification that no significant detrimental environmental impacts result from that plan relative to other alternatives. The recommended alternative will be the one that best meets all of the planning criteria. The recommended plan is then described in greater detail, and subjected to a more detailed cost estimate.

The remaining chapters of the report summarize other aspects of the study, such as coordination and staffing. The final product of this feasibility study is a detailed project report and Environmental Assessment (EA) that will serve as the basis for obtaining funding to implement the recommended plan.

1.8.2 *Public Concerns

The entire Village of Hatch is in the 1% chance exceedance event floodplain. Significant flooding has occurred in Hatch, causing substantial damage to residences, businesses, and crops. Flood flows from Spring Canyon are trapped within the village, causing significant and recurrent flood damage to the approximately 400 structures in the 1% chance exceedance event floodplain. Should a Federal project not be constructed, flood flows would continue to adversely impact Hatch, threatening the Village's agricultural industry, structures, and human health and safety.

Flows from Spring Canyon exceed 800 cubic feet per second (cfs) at the 10% chance exceedance event. Although there is no single defined drainage path or river within Hatch, there are numerous parallel flow paths through the community. Underground storm drainage systems designed to handle a 20% chance exceedance storm event have been installed in Hatch, but are overwhelmed in larger events.

Flows coming from Spring Canyon travel through Hatch toward the Rio Grande causing damages to building and infrastructure as well as delays to:

Emergency Response

- Doña Ana County Sheriff's Office
- Hatch Police Department
- Hatch Fire Department
- Hatch Ambulance Service

Government Services

- United State Post Office
- New Mexico Government Building
- New Mexico Motor Vehicle Department
- Hatch Public Library
- Hatch Magistrate Court
- Hatch County Clerk's Office

Utilities

- Hatch Public Works
- Zia Natural Gas Company
- El Paso Electric

Infrastructure

- NM Highway 154
- NM Highway 187
- Burlington Northern – Santa Fe Railroad
- NM Highway 185
- NM Highway 26
- Elephant Butte Irrigation District

1.8.3 Problems and Opportunities

Water resources projects are planned and implemented to solve problems, meet challenges, and seize opportunities. In the planning setting, a problem can be thought of as an undesirable condition, while an opportunity offers a chance for progress or improvement. The identification of problems and opportunities gives focus to the planning effort and aids in the development of planning objectives. Although problems and opportunities are considered in plan formulation, they should not be confused with planning objectives for which solutions will be formulated or plans recommended.

Public scoping done for this project identified the following problems and opportunities to address the problems.

Problems:

- There is a risk of flood damage to existing properties, infrastructure and agricultural lands from long term (days to weeks) inundation within the floodplains of the study area. A substantial amount of damage to buildings, infrastructure, utilities, and agriculture has occurred and will occur in the future during flood events. Additional flood history is discussed in Appendix I Plan Formulation.
- Floods originating in Spring Canyon can propagate and reach the village of Hatch in less than an hour. With no flood warning system, weather stations or stream gauges along the arroyo, residents of Hatch have little to no warning of impending flash floods
- There is a risk of flood hazard to health and human safety within the study area. Water depths in the occupied floodplain of over 3 feet can occur during flood events. Loss of life is the major concern.
- Health could be affected as a result of low water quality of floodwaters and latent effects such as mold in water damaged buildings.
- Hatch has little storm water infrastructure that is capable of allowing conveyance of flood water from the populated areas into the Rio Grande.
- Sediment carried by flood flows causes damage to structures, storm water and irrigation infrastructure and delays to transportation within the study area.

Opportunities:

- Reduce the potential for flood damages to infrastructure and delays to transportation and utilities caused by inundation.
- Provide adequate warning for residents to reach safety ahead of flash floods.

- Reduce risks to health and human safety from excessive flood depths.
- Reduce risks to health and human safety from latent effect on water damage such as mold or unsanitary conditions during inundation.
- Improve infrastructure to convey flood water from the damage area or prevent flood water from entering damage area.
- Reduce damages and delays caused by sediment carried by flood waters.

1.8.4 Planning Objectives and Constraints

Federal Planning Criteria
The primary Federal goal of water and related land resource project planning is to contribute to NED consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable EO, and other Federal planning requirements. Contributions to the NED are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to the NED are the direct net benefits that accrue in the planning area and the rest of the Nation. Contributions to the NED include increases in the net value of those goods and services that are marketed, and also of those that may not be marketed.

Through coordination with local and regional agencies, the public involvement process, site assessments, interpretation of prior studies and reports, the following planning objectives were considered in the evaluation of alternatives for FRM in Hatch.

Planning Objectives. The objectives, which are derived from the problem and opportunity statements above, guide the plan formulation process. The objectives developed in this study include:

- Reduce flood damages to existing properties, infrastructure and agricultural lands in the study area from floods originating in Spring Canyon.
- Provide adequate warning for residents to reach safety ahead of flash floods.
- Reduce risks to health and human safety from latent effect on water damage such as mold or unsanitary conditions during inundation.
- Reduce damages to existing properties, storm water and irrigation infrastructure and delays to transportation in Hatch from sediment deposition.

Planning Constraints. Unlike planning objectives, which represent desired positive changes, planning constraints represent restrictions that should not be violated. The planning constraints identified in this study include:

- The project is limited to runoff from the Spring Canyon drainage area.
- Any constructed project must comply with the New Mexico State Engineer and Interstate Compact requirements that any stored surface runoff must be released within 96 hours.
- FRM features should not induce or compound negative effects to flooding or environmental resources outside the study area.

1.8.5 Plan Selection

The alternative plan with the greatest net economic benefit consistent with protecting the Nation's environment (NED plan) is to be selected unless the Secretary of a department or head of an independent agency grants an exception when there is some overriding reasons for selecting another plan, based on other Federal, State, Tribal, local and international concerns.

Together, the Federal objective and plan selection criterion for civil works projects, including FRM, indicate that, at the individual project level, USACE should formulate, evaluate, and select plans to recommend for Federal involvement that provide the greatest net economic benefits to the nation as a whole, subject to an environmental protection constraint. This direction is based on the presumption that Federal civil works investments should be considered only for project plans that maximize net economic benefits—measured in terms of a single index of monetary value—realized by the nation as a whole.

FRM seeks to reduce flood risks by *managing the floodwaters* to reduce the probability of flooding (including by levees and dams) and by *managing the floodplains* to reduce the consequences of flooding. FRM requires integrating and synchronizing programs at various levels of government designed to reduce flood risk.

1.9 Existing and Ongoing Water Projects

Hatch is an agricultural community located at the confluence between Spring Canyon and the Rio Grande. Existing FRM projects along Spring Canyon (Spring Canyon Dam) and the Rio Grande (Elephant Butte Dam) have reduced but not eliminated flood risk to the community. In addition, the community is traversed by regional, economically-critical irrigation ditches and drains. These features are described below.

1.9.1 Spring Canyon Dam

The Spring Canyon Dam located upstream of the project area within Spring Canyon (Figure 5). The dam was constructed in 1939 by the NRCS to detain flood water and sediment (Figure 6). It addresses 5.4 sq mi of the 7.18 sq mi watershed upstream from Hatch, leaving 1.78 sq mi unregulated. Spring Canyon Dam has an ungated low level outlet and has an existing storage capacity of 450 acre feet (AF) at spillway crest, based on 2004 topographic mapping. The dam captures the 1% chance exceedance event with no flow over the spillway. The 0.2% chance exceedance event will reach a maximum water surface elevation of 0.2 feet above spillway crest. Spring Canyon Dam is maintained by the Village of Hatch with NRCS oversight. No deficiencies have been noted other than an undersized spillway that was not designed to pass the Probable Maximum Flood (PMF). Spring Canyon Dam is a concrete gravity structure with an earthen wing dike on the north abutment.

Figure 5 Vicinity Map of Existing Spring Canyon Dam

Figure 6 Existing Spring Canyon Dam

Based on hydrologic models that include the performance of Spring Canyon Dam, there is a significant remaining flood risk from the unregulated portions of the watershed. As mentioned previously, there have been several large flood events from Spring Canyon since the Spring Canyon Dam was in place. Any project proposed as a result of this study would work in concert with Spring Canyon Dam to reduce flood risk to the Village of Hatch.

1.9.2 The Rio Grande Project in New Mexico and Texas

The Rio Grande Project (RGP) furnishes irrigation water supply for about 178,000 ac of land and electric power for communities and industries in the area. RGP lands occupy the river bottom land of the Rio Grande Valley in south-central New Mexico and west Texas. About 60% of the lands receiving water are in New Mexico; 40% are in Texas. Physical features of the RGP include Elephant Butte and Caballo Dams, 6 diversion dams, 139 miles of canals, 457 miles of laterals, 465 miles of drains, and a hydroelectric powerplant.

1.9.2.1 Elephant Butte Irrigation District

The EBID is a quasi-municipal agency of the State of New Mexico. EBID operates, maintains, and owns the irrigation distribution system which was constructed by the United States Bureau of Reclamation (BOR) as part of the RGP, including the canals, laterals, drains, wasteways, operation/ maintenance roads on both banks, and structures. EBID facilities within the project area include the Rodey Lateral and Colorado Drain (Figure 2).

1.9.3 International Boundary & Water Commission

The United States Section of the International Boundary & Water Commission (USIBWC) operates and maintains three flood control systems on the Rio Grande. These flood control systems are: the Upper Rio Grande Flood Control System, Presidio Valley Flood Control System, and the Lower Rio Grande Flood Control System. Within the Upper Rio Grande Flood Control System which encompasses Hatch, there are flood control levees along the Rio Grande from Caballo Dam to Little Box Canyon, Texas. There are no other USIBWC facilities within the project area.

1.10 *Regulatory Compliance

This DPR/EA was prepared by the U.S. Army Corps of Engineers, Albuquerque District, in compliance with all applicable Federal statutes, regulations, and EO, including the following:

- National Historic Preservation Act (16 U.S.C. 470 *et seq*.)
- Archaeological Resources Protection Act (16 U.S.C. 470 *et seq*.)
- Clean Water Act (CWA, 33 U.S.C. 1251 *et seq.*)
- Clean Air Act (42 U.S.C. 7401 *et seq.*)
- Endangered Species Act (16 U.S.C. 1531 *et seq*.)
- EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations
- Occupational Safety and Health Act of 1970 (29 U.S.C. 651 *et seq*.)
- EO 11988, Floodplain Management
- National Environmental Policy Act (42 U.S.C. 4321 *et seq*.)
- CEQ Regulations for Implementing the Procedural Provisions of NEPA (40 CFR Part 1500 *et seq*.)
- Native American Graves Protection and Repatriation Act (25 U.S.C. 3001 *et seq*.)

- EO 11593, Protection and Enhancement of the Cultural Environment
- EO 11990, Protection of Wetlands
- U.S. Army Corps of Engineers' Procedures for Implementing NEPA (33 CFR Part 230; ER 200-2-2 *Procedures for Implementing NEPA*)
- Farmland Protection Policy Act (7 U.S.C. 4201 *et seq.*)
- EO 13112, Invasive Species
- Federal Noxious Weed Act (7 U.S.C. 2814)
- Migratory Bird Treaty Act (16 U.S.C. 703 *et seq.*)
- Fish and Wildlife Coordination Act (48 Stat. 401; 16 USC 661 *et. seq.*)
- Section 438 of the Energy Independence and Security Act of 2007 (Public Law 110-140 Section 438, 121 Stat. 1492, 1620)
- EO 13524, Federal Leadership in Environmental, Energy, and Economic Performance
- EO 13653, Preparing the United States for the Impacts of Climate Change

This DPR/EA also reflects compliance with all applicable State of New Mexico and local regulations, statutes, policies, and standards for conserving the environment such as water and air quality, endangered plants and animals, and cultural resources.

2 *Existing and Expected Future Without-Project Conditions

This section describes the existing conditions of the project area and evaluates the "future without-project conditions". This chapter evaluates the future without-project conditions, commonly also known in the NEPA process as conditions resulting from the No-Action Alternative. Evaluation of these conditions is part of the study process that considers what would happen in the future if no Federal project is implemented. Because these projections become more unpredictable the farther into the future they are made, the future without-project conditions were defined to a point 50 years into the future and are also called the Project Year 50 conditions. Additional detailed descriptions of the resources in the project area are provided in the accompanying technical appendices of this report.

2.1 Climate and Climate Change

Hatch, NM has a semi-arid to arid climate, with average annual precipitation totaling approximately 10.48 inches. Daily high temperatures in January average 57.6°F, with minimum overnight temperatures averaging below freezing (25.6°F). Average January precipitation is 0.52 inches. By contrast, daytime highs in July typically average 96.1°F with overnight minimums averaging 65.5°F. Average July precipitation is 1.99 inches. Although July is the warmest month, August has the highest average monthly precipitation at 2.44 inches. Temperatures have gradually risen at a rate of approximately 0.8°F / decade since 1960 in nearby West Texas (Nielsen-Gammon, 2011) and at about 0.6°F per decade since 1970 for New Mexico as a whole (Tebaldi et al., 2012).

Precipitation in the study area is strongly unimodal, peaking in July and August. This pattern reflects the importance of summer and early fall monsoon precipitation and the general paucity of precipitation at other times of the year. Monsoon precipitation comes in the form of convective storms with relatively localized precipitation. The largest one day total on record at nearby Caballo Dam, NM is 3.96 inches on 23 September 1990 (Western Regional Climate Center, 2014a), approximately the 200-year or the 0.005 chance event (NOAA/NWS, 2014). At Hatch, the largest one day total precipitation was 3.46 inches on 23 August 1987, (Western Regional Climate Center, 2014b), approximately the 200-year or the 0.005 chance event (NOAA/NWS, 2014). At 32.6° N latitude, Hatch lies south of the winter mid-latitude storm track, resulting in little or no snowfall in most years.

Monthly pan evaporation rates exceed precipitation by an order of magnitude. Annual pan evaporation at Caballo Dam for the period 1938-2005 averaged 107.06 inches (Western Regional Climate Center, n.d.). Pan evaporation rates were averaged the least in December at 3.48 inches and the most in June at 14.8 inches, and above 13 inches in both May and July. Annual pan evaporation at Las Cruces for the period 1959-2005 averaged 92.91 in (Western Regional Climate Center, n.d.). Pan evaporation rates averaged the least in December at 2.79 inches and the most in June at 12.9 inches, and above 12 inches in both May and July.

There has been no detectable trend in precipitation for the Southwest as a whole or for the Hatch area over the period of record for precipitation gauges. Analysis of flood trends was not conducted under ECB 2016-25, Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Work Studies, Designs, and Projects, due to the lack of gauging stations on unregulated streams in the area.

Climate change is anticipated to impact the study area primarily through temperature increases, which are projected to rise by as much as 3.5°F to as much as 8.5°F by 2100. Temperature increases are likely to drive evaporation increases. There is strong model agreement in the direction and magnitude of projected temperature change.

Changes in precipitation are less certain, although winter precipitation is likely to decrease. Some models predict precipitation decreases of 3-9% in all seasons. Summer precipitation may increase in intensity, result in stronger, wetter storms interspersed with longer dry periods. Hurricanes are likely to increase in strength and moisture content. During late summer, larger, more-persistent hurricanes may provide additional moisture in the monsoon source regions. These changes may increase flood risk in the Lower Rio Grande. Models disagree on future precipitation trends due to:

- High inter-annual precipitation variability.
- Uncertainty over how future precipitation drivers, such as El Niño-Southern Oscillation and hurricanes, might evolve.
- Inability of models to resolve mesocale (local) climate phenomena, such as individual thunderstorms, which makes it difficult to estimate how precipitation variables might change on a scale relative to flooding along Spring Canyon.

The USACE Climate Preparedness and Resilience Community of Practice (CPR CoP) Climate Hydrology Assessment Tool (https://maps.crrel.usace.army.mil/projects/rcc/portal.html) indicates a small but statistically significant increase in annual maximum monthly flows over the 21st Century relative to current conditions in the Rio Grande-Mimbres Basin as a whole. The increase is small compared to the variability, which is relatively stationary through time (Figure 7). Hatch is located at the northern end of this region. Similarly the CPR CoP Vulnerability Tool suggests a potential increase in monthly flood flow magnitudes for this basin but provides no quantitative increase in that magnitude. How either of these findings might translate into projected changes in instantaneous peak flood flows in the project area is unclear and cannot be quantified at this time. Following ECB 2016-25, there is no accepted method for quantitatively assessing climate change impacts to PMFs at this time.

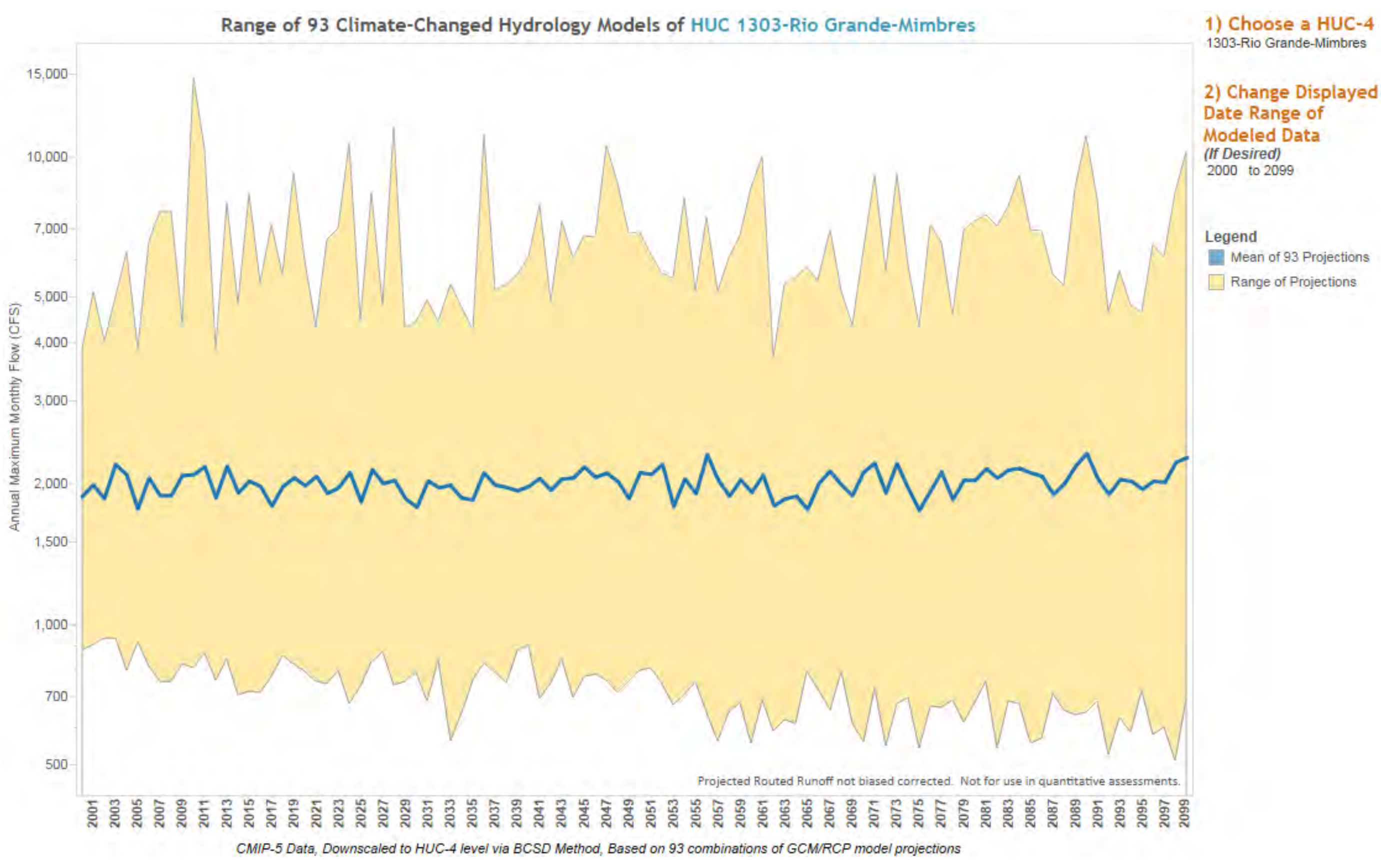


Figure 7 Potential change in future annual maximum monthly.

There is insufficient evidence at this time to conclude that there will be significant changes to extreme flood hydrology over the lifetime of this project in the Hatch area. Although models disagree significantly over whether or how much precipitation in the area might increase, and whether or not these increases might translate into increased flood risk, in the most extreme cases the amount of projected increase is small. All alternatives, including the recommended plan, would benefit the community if climate change in the Project Area results in more heavy downpours and flooding in the short- and long-term. The selected alternative is anticipated to perform as designed to provide a high level of FRM while remaining resilient despite any changes in hydrology.

USACE has no formal method for determining the impact of the project on climate. However, the impacts on climate due to greenhouse gas emissions from construction alternatives, including the recommended plan, future O&M activities, borrow and disposal areas, and use of staging/access areas are unlikely to be significant.

2.2 Hydrology, Hydraulics and Sedimentation

2.2.1 Purpose of Hydrologic Analysis

The purpose of the hydrologic analysis is to determine new peak discharge frequency relationships and design hydrographs for a portion of the drainage area in Doña Ana County, New Mexico. This study establishes peak discharge frequency and flood hydrographs for eight events (Table 1: 50%, 20%, 10%, 4%, 2%, 1%, 0.5% and 0.2% chance flood for year event equivalent) specifically for existing conditions for Spring Canyon in Hatch.

Table 1 Flood occurrences equivalents.

Percent (%) Exceedance Event = Year Frequency	% Exceedance Event = Year Frequency
50% = 2-year	2% = 50 year
20% = 5 year	1% = 100-year
10% = 10 year	0.5% = 200year
4% = 25 year	0.2% = 500-year

2.2.2 Spring Canyon Watershed Description

Spring Canyon is an ephemeral drainage that rises in the Sierra de Las Uvas and flows northward towards Hatch and the Rio Grande. Elevations range from almost 6,000 feet in the Sierra de Las Uvas to 4,030 feet at the confluence with the Rio Grande. Stream slopes are steep (greater than 20%) throughout most of the watershed, but are mild in the Rio Grande Valley (.007%). Hatch is located at the mouth of Spring Canyon. Short lived, very intense summer storms result in flash flood flows down this normal dry stream channel. These storms are the primary source of flooding in the project area. Floodwaters entering the village from this drainage have no clear pathway to the Rio Grande due to the construction of the elevated Hatch Main Canal. Consequently, floodwaters impounded behind the Hatch Main Canal remain in place until evaporated. The Rodey Lateral is another elevated drain that borders Hatch along its southern edge and can impound flood waters from the Sierra de Las Uvas.

The Spring Canyon drainage area upstream from Hatch is 7.18 sq mi at Rodey Lateral. An existing feature, the Spring Canyon Dam is located within the watershed upstream from Hatch. It addresses 5.40 sq mi of the 7.18 sq mi watershed upstream from Hatch, leaving 1.78 sq mi unaddressed. Spring Canyon Dam has an ungated low level outlet and has an existing storage capacity of 450 AF at the spillway crest, based on 2004 topographic mapping. The dam addresses the 1% chance exceedance event with no flow over the spillway. The 0.2% chance exceedance event will reach a maximum water surface elevation of 0.2 feet above spillway crest.

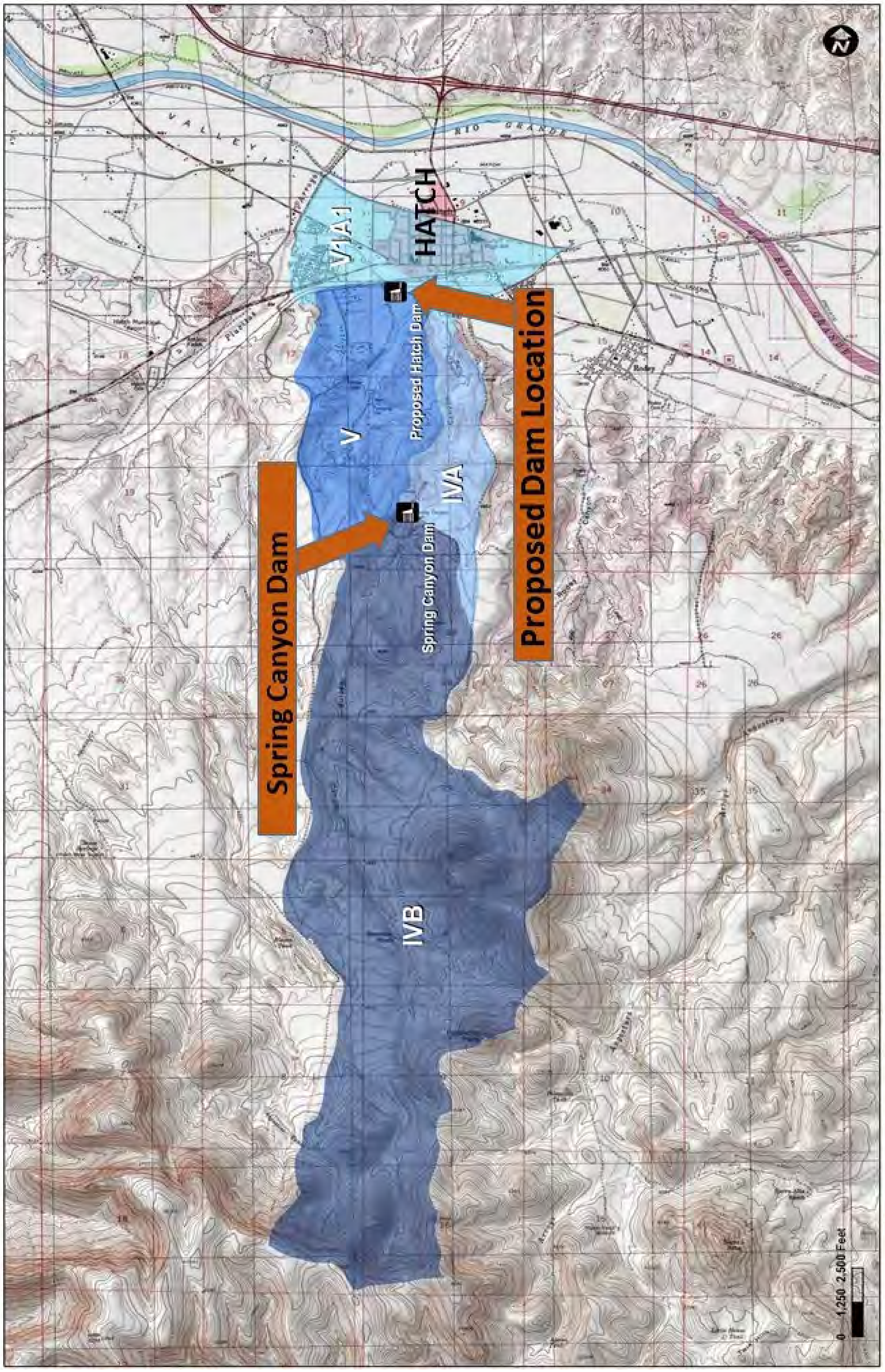


Figure 8 Watershed boundaries and subbasins and 1% floodplain (VIAI, light blue)

The subbasins shown in Figure 8 are described as follows:

- Subbasin IVB - Upper Spring Canyon Watershed, Area = 5.4 sq mi
- Subbasin IVA - Lower Spring Canyon Watershed, Area = 0.56 sq mi
- Subbasin V – Watershed containing small arroyos located immediately west of Spring Canyon that feed directly into a low ponding area at Rodey Lateral just upstream from the Village of Hatch, NM, Area = 1.22 sq mi
- Subbasin VIAI – Local Drainage area of the community the Village of Hatch, NM, Area = 0.86 sq mi

Model Methodology

Due to the lack of stream gage data, a detailed hydrologic model was developed using NOAA Atlas 14 data. This method assumes that the rainfall frequencies used in the model will produce the same frequency runoff (i.e., the 1% rainfall equates to the 1% runoff event).

This study uses the Hydrologic Engineering Center (HEC) Hydrologic Modeling System (HEC-HMS) software program for its hydrologic analysis. The program contains a number of uncoupled deterministic mathematical models, providing modelers with choice as to methods deemed appropriate for a particular watershed. Errors introduced due to the use of uncoupled models are minimized by using a small time interval for calculations, 5 minutes in this case. All the mathematical models use constant parameter values, assuming that the values are stationary in time, when, of course, in reality they are not. However, at the time scale of a single event, the amount of change in these parameters is negligible, justifying the assumption of constant parameter values.

The HEC-HMS model consists of 5 major components: (1) the basin model, which is a physical description of the watershed; (2) the initial and constant loss method; (3) Snyder's unit hydrograph; (4) hydrograph routing: and (5) a meteorological model, which specifies how precipitation will be generated for each subbasin. The control specifications/information are used to control when model simulations start and stop, and the time interval for the calculations. The following discussion describes the methods and data used for this study analysis.

Many parameters from an existing HEC-1 model developed by Resource Technology, Inc., for the Doña Ana County Flood Commission were adapted for use in this study. Subarea parameters such as drainage area and unit hydrograph time of concentration were retained from the original model, but rainfall and hydrograph routing were adapted for this study.

2.2.3 Infiltration Rates

All of the models in this study used the initial and constant loss method. Published national soils and land use data are used to develop preliminary values for the initial loss in inches, the constant loss in inches/hour, and percent impervious for each subbasin. Aerial photography data taken in 2004 and 2005 was then used to verify land use and imperviousness with each subbasin. Finally, engineering judgment was used to determine the actual values used in the models based on the nature of the published precipitation and evaporation rates of the study area. Table 2 lists the values used in this study.

Rainfall intensity-duration was obtained from NOAA Atlas 14. The hypothetical storm method was used to generate hyetographs. Storm durations of 24 hours and a computation period of five minutes were used. The depth-area reduction of 0.81 for 7.18 sq mi was obtained from Hydro-40.

2.2.4 Unit Hydrograph

The Snyder's synthetic unit hydrograph method was used for translating the precipitation into basin runoff. The HEC-HMS software also includes empirical methods that have been developed for estimating the time base of the hydrograph and the width at 50% peak flow. A previous study for the El Paso area completed by the USACE Albuquerque District in 1982, developed a relationship between Snyder's C_t coefficient and drainage area slope, based on flood reconstructions in nearby drainages.

Snyder's method requires the calculation of t_p, the basin lag time in hours, and C_p, the unit hydrograph peaking coefficient. The basin lag time is defined as the length of time between the centroid of precipitation mass and the peak flow of the resulting hydrograph.

The coefficient C_p, sometimes called the storage coefficient, measures the steepness of the hydrograph that results from a unit of precipitation. Snyder's equation is shown below:

$$t_{p(hrs)}=C_t(LL_c)^{0.3}$$

where C_t = basin coefficient related to the basin slope; L = longest flow path along the main stream from the outlet to the divide; and L_c = length along the main stream from the outlet to a point nearest the watershed centroid.

For all the subbasins in this study, the value of C_t was determined from the C_t versus slope curve developed for El Paso by the USACE Albuquerque District in 1982.

The value of C_p in all subbasins was determined by the relationship: $C_p = C_p640$, where C_p640 = 430 for slopes < 0.015, or = 392 for slopes >0.015.

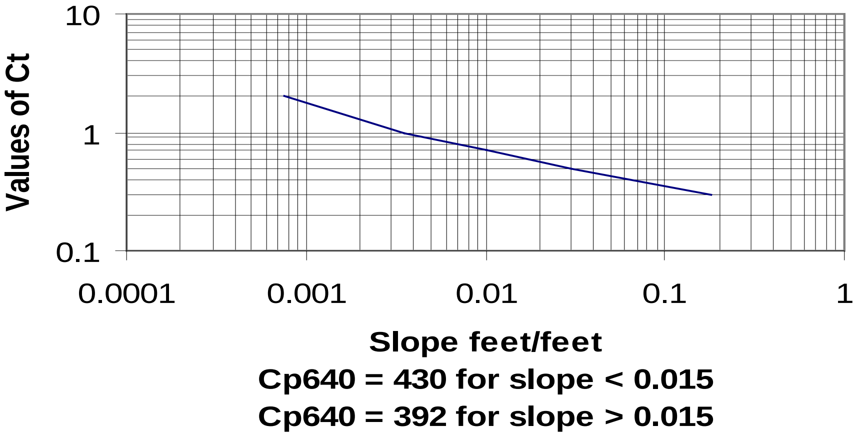


Figure 9 Snyder's Ct versus slope for Hatch area

Snyder's time of concentration and storage coefficient were obtained from the relationship shown in Figure 9. The Snyder's parameters used in this analysis are listed in Table 2.

Table 2 Subbasin drainage area, Snyder's coefficients, loss rates, and impervious cover.

Subbasin Name	Drainage Area (sq mi)	Snyder's t_p (hrs)	Snyder's C_p	Initial Loss (inches)	Constant Loss (in/hr)	Impervious Cover (%)
IVB (Upper Spring Canyon Watershed)	5.40	1.19	0.61	0.9	0.2	0
IVA (Lower Spring Canyon Watershed)	0.56	0.62	0.61	0.9	0.2	0
V	1.22	0.53	0.61	0.9	0.2	0
V1A1	0.86	0.36	0.67	0.9	0.2	20

t_p=time of hydrograph peak, C_p=dimensionless peaking coefficient

2.2.5 Hydrograph Routing

The Muskingum-Cunge routing method was used in this analysis. This method requires determination of (1) the total length of the reach the hydrograph will be routed through, (2) the average slope for the whole reach, (3) the Manning's n roughness coefficient averaged for the whole reach, and (4) a simplified physical description of a typical cross-section for the reach. The 8 point cross-sections for the model were developed using the Doña Ana County Flood Commission 2004 topographic mapping.

2.2.6 Flood Frequency Results

Peak discharges for selected locations are shown in Table 3. An equivalent period of record of 15 years was assigned for risk and uncertainty adjustments of average annual damages in accordance with guidance in Engineer Manual (EM) 1110-2-1619, *Risk Based Analysis for Flood Damage Reduction Studies* (1996).

2.2.7 Spring Canyon Inundation Mapping

Because flooding in Hatch is the result of ponding, the application of a riverine hydraulic model such as Hydrologic Engineering Center River Analysis System (HEC-RAS) software is not appropriate. Instead floodplain boundaries were determined with a storage elevation relationship in a HEC-HMS model updated and refined from the original HEC-1 model developed by Resource Technology Inc. for the Doña Ana County Flood Commission that was retained for use in this study.

Inflow into the ponding area within Hatch is from Spring Canyon. Outflow from the area is through Colorado Drain and the Village of Hatch storm drain system. Peak water surface elevations were determined by routing the 50%, 20%, 10%, 4%, 2%, 1%, 0.5%, and 0.2% chance frequency floods through the pond. See the pre-project inundation maps included in Appendix A - Hydrology & Hydraulics.

2.2.8 Hydrology – Future Spring Canyon Without-Project Conditions

Development is not anticipated in the Spring Canyon watershed. The majority of the Spring Canyon watershed above Hatch is currently public land, managed either by the Bureau of Land Management or the State of New Mexico. Therefore, future without-project condition hydrology is expected to remain unchanged from the existing condition hydrology.

Table 3 Instantaneous peak discharges for selected locations.

Location (Conc. Points)	**Drainage Area (sq mi)**	**10% chance exceedance event**		**4% chance exceedance event**		**2% chance exceedance event**		**1% chance exceedance event**		**0.2% chance exceedance event**	
		(cfs)	(AF)	(cfs)	(AF)	(cfs)	(AF)	(cfs)	(AF)	(cfs)	(AF)
at Rodey Lateral (IVA + IVB + V)	7.18	167.5	279	197.2	422	235.3	529.2	254.4	641.7	293	910.3
at Hatch, NM (IVA + IVB + V + VIAI)	8.04	300	325.8	300	486.8	300	607.4	300	733.9	1001.8	72.9

Note: cfs = cubic feet per second; AF = acre-feet.

2.2.9 Hydraulics

The existing Spring Canyon Dam is a concrete gravity structure under the jurisdiction of the New Mexico Office of the State Engineer, Dam Safety Bureau (OSE-DSB) and has a hazard potential classification of “high” based on proximity to downstream residents. The Village of Hatch, NM is listed as the Owner. The last inspection report for Spring Canyon Dam was dated March, 17, 2014 and is included in Appendix A – Hydrology & Hydraulics. As stated in the inspection report, the primary deficiency is related to the spillway capacity.

The OSE-DSB rules and regulations require high hazard dams such as this to be capable of withstanding, without catastrophic failure, the flood discharge resulting from the critical probable maximum precipitation event, which is termed the probable maximum flood (PMF). A quick calculation of the capacity of the spillway using the weir equation and the PMF determined by the USACE envelope curve indicates a spillway capacity for this structure of approximately 80% of the PMF. The owner needs to have an updated hydrologic and flood routing analysis performed by a qualified Professional Engineer licensed in New Mexico as part of the preparation of the forthcoming State of New Mexico Emergency Action Plan. An incremental damage assessment (IDA) is an option to determine whether the inadequate spillway capacity is acceptable.

At the mouth of Spring Canyon, there is an existing training dike that diverts flow into a low ponding area behind an embankment of the Rodey Lateral. A 42-inch diameter corrugated metal pipe (CMP) culvert passes water under the Rodey Lateral into the head of Colorado Drain. The Rodey Lateral embankment is approximately 9 feet above the invert of the 42-inch CMP.

The training dike is a non-engineered structure that is not routinely maintained. If the training dike fails due to piping or overtopping, water from Spring Canyon will not be diverted into the ponding area behind the Rodey Lateral embankment, but will instead continue directly west to the Rodey Lateral.

There is no spillway at the ponding area behind the Rodey Lateral embankment. Any flood waters in excess of the capacity of the 42-inch diameter CMP will pond behind the Rodey Lateral embankment. If the flood water volume exceeds the storage capacity of the ponding area, then water will flow into and over Rodey Lateral. The volume of the ponding area is approximately 100 AF compared to the volume of the 10% chance exceedance event of 235 AF.

Rodey Lateral is normally full with irrigation water and has effectively no capacity to convey additional flood waters. Consequently, flood flows, whether they are from a failure of the training dike or from an overflow of the ponding area, or both, will overtop Rodey Lateral and continue on to Colorado Drain and into Hatch. Rodey Lateral is not designed to withstand overtopping and would likely breech under this condition. Therefore, once overtopping occurs, the entire flood volume is assumed to enter Hatch.

The Colorado Drain is an earthen channel intended for groundwater relief, to convey excess irrigation water, and local drainage to the Rio Grande. It extends 3.7 miles to the south where it eventually outfalls to the Rio Grande and has a potential conveyance capacity, if unobstructed, of approximately 300 cfs. Flood flows from Spring Canyon in excess of the 300 cfs capacity of Colorado Drain flow directly into Hatch and adjacent agricultural lands. Various irrigation canal embankments and raised roadways prevent the spread of flood waters within Hatch so that any flood waters reaching the Village proper will pond until they are pumped out or gradually drain away (Appendix A – Hydrology & Hydraulics.

2.2.10 Hydraulics – Future Spring Canyon Without-Project Conditions

Development is not anticipated in the Spring Canyon watershed. The majority of the Spring Canyon watershed above Hatch is currently public land, managed either by the Bureau of Land Management or the State of New Mexico. Therefore, future condition without-project hydraulics is expected to remain unchanged from the existing condition hydraulics.

2.3 Economics

2.3.1 Areas of Consideration

The study area comprises portions of the urbanized area within the Village of Hatch, consisting of residential, public and commercial structures. Hatch is located in the northwest corner of Doña Ana County, New Mexico, near the Rio Grande. Hatch is a fairly small population center within the county. The 2000 U.S. Census determined that 1,673 of the county's 174,682 people lived within the village. The 2010 Census identified 1,648 persons within the Village and 209,233 persons within the county. Agriculture comprises the main industry within the study area, while the county has a heavy government presence in the White Sands Test Facility and the White Sands Missile Range.

Hatch faces a flood threat from two drainages in the Sierra de Las Uvas, which are immediately south of the village. Hatch has received significant flooding, with up to three feet of water in 1988, 1992, and 2006 from these sources (Figure 4). Briefly, the two sources are termed throughout this report as Spring Canyon and Placitas Arroyo (Figure 10).

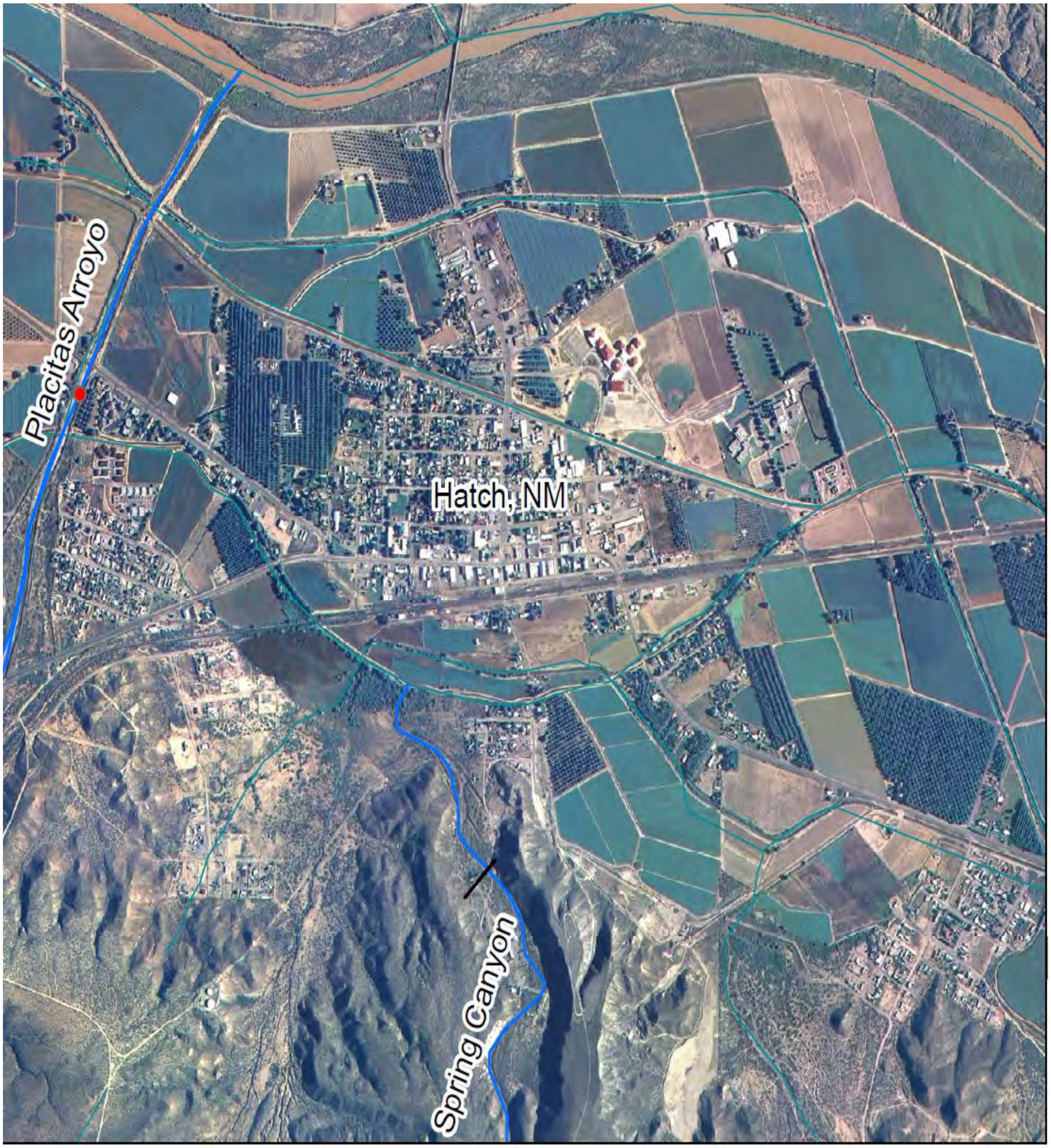


Figure 10 Aerial image of the Hatch including sources of flows.

Placitas Arroyo drains north from the Sierra de Las Uvas to the Rio Grande, with the arroyo channel paralleling the west side of Hatch. Hatch was flooded from Placitas Arroyo in 2006, but local efforts to increase channel capacity and to increase that capacity at road crossings have substantially mitigated the flood threat from the Placitas Arroyo. Further discussion on Placitas Arroyo can be found in section 6.0 of the Appendix B - Economics. This economic analysis will only focus on flood issues originating in Spring Canyon. All tables in this section refer to the Economic Appendix (Appendix B), unless otherwise noted.

2.3.2 Computation of Damages Caused by Flooding

Consistent with the requirements set forth in EC 1105-2-412, *Assuring Quality of Planning Models,* HEC-FDA version 1.4.1 was used to compute expected annual damages (EAD). Corps guidance stipulates that the plan which reasonably maximizes net NED benefits, consistent with the Federal objective, be identified. Project benefits for Flood Risk Management (FRM) measures are identified through successive iterations of existing and future without-project scenarios, changing key hydrologic and/or hydraulic variables as the measures warrant. Hydrologic Engineering Center-Flood Damage Assessment (HEC-FDA) is the only model certified for formulation and evaluation of FRM plans using risk analysis methods, and was used in this study. Damages were computed in August 2014 price levels at the FY 14 interest rate of 3.5%. Dam C, the recommended plan, was updated using current cost (deflated to August 2014 price levels) and calculated at the FY 17 interest rate of 2.875%. The period of analysis is 50 years.

2.3.3 Placitas Arroyo

Placitas Arroyo runs through agricultural fields on the west side of Hatch, in an area with few structures or other improvements. Hatch was flooded by flows from Placitas Arroyo in August 2006. The Village of Hatch is currently planning additional improvements that are expected to substantially increase channel capacity. Current hydraulic analysis indicates the Placitas Arroyo could safely contain the mean 1% chance exceedance event if the planned improvements are made. After the improvements are made to the Placitas Arroyo, the floodplain will be distinct and separate from the Spring Canyon floodplain, so any proposed solutions on Spring Canyon will not carry a residual risk of flooding from Placitas Arroyo. Additional discussion of the Placitas Arroyo can be found in Appendix A- Hydrology & Hydraulics.

2.3.4 Potential Flood Damages

It is currently estimated that the mean 1% chance exceedance flood would cause damages of about $23.6 million in the study area. Table 4 presents the single occurrence damages associated with the 10%, 2%, 1%, and 0.2% chance exceedance events in the assorted floodplains. These tables were generated using HEC-FDA results for descriptive purposes only, to better understand the nature of the damages reported by HEC-FDA. HEC-FDA was used to compute average and equivalent annual damages for structures and their contents, as well as vehicles only. It should be noted that many intangible damages (such as loss of life, disruption to community services, and increased health risks) that could occur because of flooding are not represented in these damage values.

Future flood damages resulting from basin development/growth in the floodplain or from future hydrologic and hydraulic changes have not been included, but are not expected to be significant for several reasons: 1) local realtors contacted noted that growth in Hatch and the surrounding area has been flat and may remain stagnant in the future, 2) local realtors have noted that most recent development in the study area has occurred outside the floodplain, and 3) hydrologic and hydraulic conditions are not expected to change from current conditions.

Table 4 Single occurrence damages, without-project conditions, Hatch, NM.

Land Use Category (x $1,000 Aug2014 price level @ 3.50% interest rate)	EVENT 10%	2%	1%	0.20%
Residential	$3,037	$4,039	$4,388	$5,174
Res. Content	$1,481	$1,964	$2,134	$2,573
Commercial	$1,174	$1,925	$2,185	$2,810
Comm. Content	$4,144	$8,713	$10,787	$14,347
Public	$1,142	$2,051	$2,239	$2,687
Pub. Content	$809	$1,605	$1,902	$2,311
Apartment	$9	$11	$12	$14
Apt. Content	$3	$3	$4	$4
Subtotal - Structures	$5,362	$8,026	$8,824	$10,685
Subtotal - Contents	$6,437	$12,285	$14,827	$19,235
Total	**$11,799**	**$20,311**	**$23,651**	**$29,920**

2.3.5 Average Annual Damages

Table 5 presents the average (equivalent) annual damages that could occur from flooding in the study area without any flood protection, by land use category and floodplain. Risk and uncertainty analysis was used to derive average annual damages. Hydrologic and hydraulic uncertainty was combined through Monte Carlo simulations within HEC-FDA. When flooding from all sources is considered, the study area faces the risk of approximately $2.8 million in average annual damages to just structures and their contents ($3.2 million over all damage categories). A sensitivity analysis was conducted to illustrate that when HEC-FDA was computed “without risk,” the total EAD damages decreased roughly by $635,500 to $2,634,151. FDA will use all uncertainties in values (such as structure content, other), first floor stage and depth damage functions to compute stage damage. If not selected (i.e., computing without risk) the stage damage is computed without these uncertainties.

The economic implications of the future without-project are broadly negative. The investment at risk within the project area is substantial enough that the future without-project will subject the study area to the possibility of long-term adverse impact on the local economy, and dislocations of residents and industry may even result. In the short term, with an absence of flooding, the current trends in-place for the local economy, tax base, population, and employment may remain intact. However, if major flooding occurred the long term effects are likely to include: business interruptions that could jeopardize workers jobs and wages, potential losses in population and employment, diminished economic stability, and reductions in the tax base (given net movement out the protected areas) and generally diminished property values.

Table 5 Average annual damages by land use category, Hatch, NM.

Average Annual Damages (x $1,000 August 2014 price level) 3.50% interest rate	
LAND USE CATEGORY	
Residential	$ 857.29
Commercial	$ 1183.64
Public	$ 753.77
Apartment	$ 2.60
Subtotal - Structures and Contents	$ 2,797.30
Streets, roads	$ 88.93
Utilities	$ 0.13
Railroad	$ 1.81
Vehicles	$ 156.17
Agriculture	$ 0.73
Irrigation Drains	$ 0.47
Emergency Costs	$ 45.68
TOTAL	**$ 3,091.22**

2.4 Environmental Resources

The following sections will examine the existing conditions and expected future without-project conditions of each of the project area's environmental resources.

2.4.1 Water Resources

2.4.1.1 Surface Water

Surface water flows enter a training dike at the mouth of Spring Canyon, which diverts flow into a low area behind an embankment of Rodey Lateral. This embankment acts as a *de facto* detention basin. A culvert passes water under Rodey Lateral into the head of Colorado Drain. Colorado Drain is a ditch intended for groundwater relief and to convey excess irrigation water to the Rio Grande. It runs 3.7 miles to the south where it eventually joins the Rio Grande. Flood flows in excess of the capacity of the diversion dike, de facto detention basin, or Colorado Drain flow directly into Hatch and adjacent agricultural lands. Canal embankments and raised roadways prevent the spread of flood waters so that the floods pond in Hatch until they gradually drain away. Table 6 shows the current and future-without project instantaneous peak discharges for selected locations.

Table 6 Without-project peak discharges in the project area.

Location	Drainage Area (sq mi)	10% chance exceedance event (cfs)	2%chance exceedance event (cfs)	1% chance exceedance event (cfs)	0.2% chance exceedance event (cfs)
Inflow to Spring Canyon Dam	5.4	1342	2498	3003	4170
Outflow from Spring Canyon Dam	5.4	180	201	211	582
Spring Canyon at Rodey Lateral	7.18	913	1665	1969	2665

Values are in cfs, present conditions/future-without project condition.

Erosion to soils within Spring Canyon occurs and would likely continue to occur in the project area in the future without-project condition. When flows occur, large amounts of sediment would be transported down the arroyo. Eroding soils also degrade surface water quality. Significant amounts of urban development is not anticipated in the upstream drainage area that would increase the volume of stream flows and exacerbate flooding.

Encroachment of Spring Canyon can be a serious problem. It is caused by small earth-moving activities in years past as well as dumping of trash and debris that limit the available surface water floodplain. This problem is beyond the scope of this small project's proposed alternatives; however, encroachment should be addressed, monitored, and prevented by the Village of Hatch. By narrowing the available floodplain, the chance for overbank flows increases.

2.4.1.2 Groundwater

Groundwater in the Hatch area occurs in floodplain deposits of the Rincon Valley. The Rincon Valley is a narrow strip along the Rio Grande from the Caballo Reservoir Dam to approximately 5 miles south of Rincon, New Mexico (Anderholm 2002). The alluvial floodplain deposits in the Rincon Valley form a long, continuous aquifer approximately 80 feet deep and 2 miles wide. This aquifer can be segregated in two hydrogeologic units, the lower and upper. Both units are in-fill from the erosion of the Santa Fe group (Wilson 1981). The lower unit comprises 30 to 40 feet of gravel. The upper unit comprises thin sand, gravel, and clay lenses and layers. A thin sandy clay unit and an underlying clay unit mark the base of the aquifer.

This stretch of the Rio Grande is a gaining stream. Shallow groundwater discharges into the Rio Grande through the Rincon Valley (Anderholm 2002). Hatch, Rincon, Garfield, and Angostura irrigation drains prevent saturation of most of the Rincon Valley. Groundwater generally flows towards the Rio Grande and south, down the Rincon Valley towards Mesilla Valley (Anderholm 2002). The future without-project conditions for groundwater resources in the area would remain largely unchanged.

2.4.1.3 Water Quality

In 2004, the New Mexico Environment Department (NMED), Surface Water Quality Bureau (SWQB) conducted a surface water quality survey along the lower Rio Grande, from Elephant Butt Dam to the Texas Border. No sampling site was located near the proposed dam site;

however, sampling sites were located upstream, below the Elephant Butt Dam and near Rincon, downstream of Hatch. The SWQB collected and analyzed samples for metals (dissolved and total), Volatile Organic Compounds (VOC) and Semi-VOCs or SVOCs, bacteria, radionuclides, ambient toxicity, pH, and temperature. Of these tests, only bacteria and radionuclides exceeded New Mexico Water Quality Standards (NMWQCC). The radionuclides exceeded WQCC standards downstream of Hatch near Leasburg Dam and Fort Selden. These exceedances were attributed to a natural source, Radium Hot Springs. Bacterial exceedances were documented from below the Elephant Butt Dam to the Texas Border. Bacteria exceeded both the New Mexico and Texas water quality standards. The Rio Grande is considered biologically impaired from the Texas Border to Percha Dam. Although some impairment was documented by the NMED-SWQB, the future without-project would remain largely unchanged for the quality of water in the project area.

2.4.1.4 Floodplains and Wetlands

EO 11988, *Floodplain Management*, provides Federal guidance for activities within the floodplains of inland and coastal waters. The order requires Federal agencies to take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by floodplains. Historically, agricultural practices and development in and encroachment on the Rio Grande's floodplain has restricted the Rio Grande's floodplain and impeded the movement of flood flows from Spring Canyon to the Rio Grande. The encroachment has included commercial and residential buildings, roads, sidewalks and parking lots in the town of Hatch as agriculture in the surrounding area.

Under existing and future without-project conditions, development within the floodplain could continue to occur through conversion of agricultural lands to residential and commercial uses. Under these conditions, erosion and flood damages could continue within the floodplain. EO 11990. *Protection of Wetlands*, requires the avoidance, to the greatest extent possible, of both long and short-term impacts associated with the destruction, modification, or other disturbance of wetland habitats. Approximately 1.0 acre of riparian habitat exists along Rodey Lateral. However, the indicator status rating for these species are upland (rarely is a hydrophyte, almost always in uplands) and facultative upland (occasionally is a hydrophyte, but usually occurs in uplands). Therefore, since there are no perennial surface water bodies, springs, seeps, or wetlands within the project area the future conditions would remain largely similar to present conditions if no project were built.

2.4.2 Air, Sound and Visual Quality

The Village of Hatch is in New Mexico's Air Quality Control Region No.7 for air quality monitoring and Doña Ana County is "in attainment" (does not exceed State and Federal Environmental Protection Agency air quality standards) for all criteria pollutants (New Mexico Environment Department/Air Quality Bureau 2015). Air quality in the project area is generally good. The closest Class I areas include the Gila Wilderness, approximately 40 miles to the northwest; and the Bosque Del Apache Wilderness, approximately 80 miles to north of the project area. Class I areas are special areas of natural wonder and scenic beauty, such as national parks, national monuments, and wilderness areas, where air quality should be given special protection. Class I areas are subject to maximum limits on air quality degradation.

Background noise levels in the proposed project area are low to moderate and result primarily from vehicular and railroad traffic. Existing noise levels in the Village of Hatch are typical for small communities in New Mexico.

The terrain of the Hatch area is primarily dominated by creosote bush and bare ground. The Sierra de Las Uvas are located to the south of the proposed project area. Adjacent property includes agricultural lands, mobile homes, utilities lines, irrigational canals, a railroad, and open space.

The future without-project conditions for air, sound, and visual qualities in the Village of Hatch would remain largely the same. Air quality would remain in attainment. The future without-project condition for the Class I areas would also remain largely unchanged. Sound/noise will probably slowly increase with urban growth and increased vehicular traffic, but this would occur regardless of whether a project were constructed.

2.4.3 Biological Resources

Surveys of biological resources, including plant, animals and special status species, were conducted by biologists from the USACE and the U.S. Fish and Wildlife Service (USFWS, New Mexico Ecological Services Field Office, Albuquerque) on January 18 and September 11 and 12, 2006. The intensive, pedestrian surveys were conducted in suitable seasons to identify any elements of concern in the project areas. Additional information on biological resources in the study area and common and scientific names of all plants and animals mentioned in this report are contained in the Fish and Wildlife Coordination Act (FWCA) Report (USFWS 2006; see Appendix C - Environmental Resources).

Another site visit to inventory existing conditions was conducted on December 4, 2014 due to observable changes in vegetation over the last eight years. The significant decrease in vegetation and vegetation diversity is the possible result of consecutive drought years. In addition to the on-going drought conditions, a permanent fix to a leaking underground water line, may have contributed to decrease in habitat within the project area (in particular in the area of the footprint of the dam and behind the dam). Figures 11 and 12 show the decrease in vegetation in the project area from 2006 to 2014.

The future without-project condition could result in indirect and direct impacts in the project area. Indirect impacts would be the temporary or permanent loss of the already limited existing upland habitat preventing organisms from returning to the area. Additional impacts from the future without-project condition could range from no significant impact under non-flood events, to minor or significant impacts during flood events, depending on the resulting flow velocities and duration of inundation.

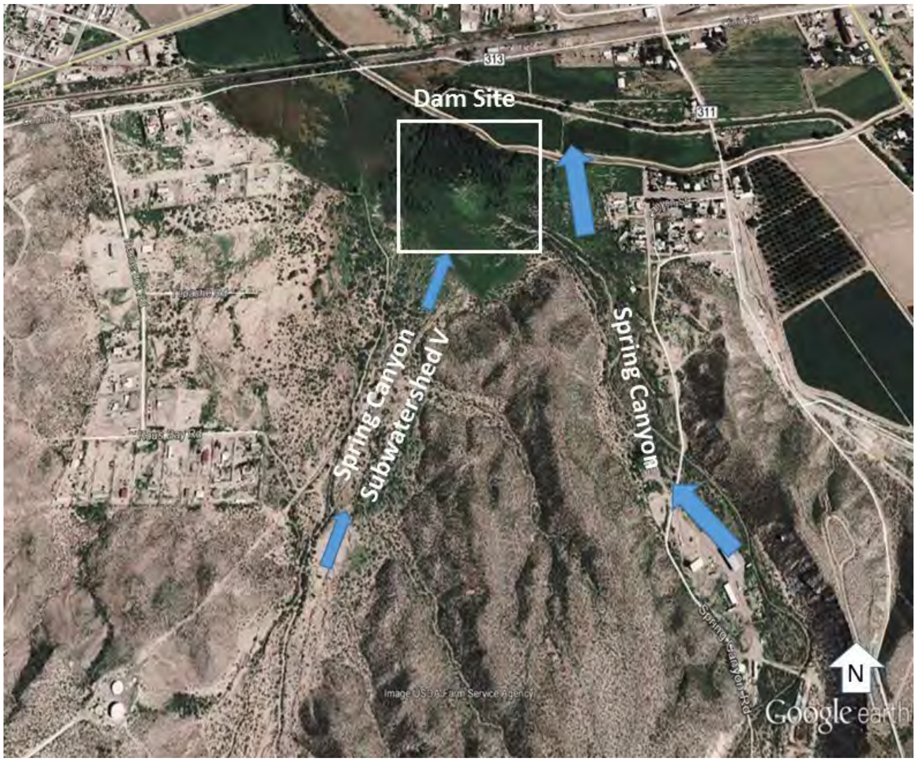


Figure 11 Aerial image of the project area in 2006.

Figure 12 Aerial image of the project area in 2014.

2.4.3.1 Plant Communities

The project lies within the Chihuahuan Desert Scrub biotic community. The Chihuahuan Desert is the largest of the three creosote bush dominated deserts in North America (Brown, 1982). Low moisture, extreme daily and seasonal temperature ranges, and poor soil conditions tend to limit the productiveness of the grasses and shrubs of the understory. Within the dam site area, plant species are scattered throughout the large, open area, including: tansy mustard (*Descurainia pinnata*), honey mesquite (*Prosopis glandulosa*), wolfberry (*Lycium pallidum*), Siberian elm (*Ulmus pumila*), salt cedar (*Tamarix ramosissima*), skeleton plant (*Pyrrhopappus texana*), yellow aster (*Heterotheca villosa*), creosote bush (*Larrea tridentata*), common fleabane (*Erigeron philadelphicus*), prostrate vervain (*Verbena bracteata*), four-wing saltbush (*Atriplex canescens*). Vegetation found within Spring Canyon consists of honey mesquite (*Prosopis glandulosa*), four-wing saltbush (*Atriplex canescens*), creosote bush (*Larrea tridentata*), desert marigold (*Baileya multiradiata*) and spectacle pod (*Dimorphocarpa wislizeni*). Vegetation along Rodey Lateral consists of wolfberry (*Lycium pallidum*), Siberian elm (*Ulmus pumila*), salt cedar (*Tamarix ramosissima*), three leaf sumac (*Rhus trilobata*) and white mulberry (*Morus alba*).

The future without-project condition may affect the existing plant communities in the floodplain as existing and potentially larger flash flood flows in the future would continue degradation within the canyon and therefore threaten vegetation.

2.4.3.2 Animal Communities

A variety of species are known to occur within the Chihuahuan Desert Scrub biotic community. According to Brown (1982) some of these species may include: Desert Pocket Gopher (*Geomys arenarius*), Desert Shrew (*Notiosorex crawfordi*), Desert Bighorn Sheep (*Ovis canadensis mexicana*), Yellow-faced Pocket Gopher (*Pappogeomys castanops*), Desert Pocket Mouse (*Perognathus pencillatus*), Desert Cottontail (*Sylvilagus auduboni*), Black-chinned Sparrow (*Amphispiza bilineata*), Lesser Nighthawk (*Chordeiles acutipennis*), Mourning Dove (*Zenaida macroura*), New Mexico Whiptail (*Cnemidophorus neomexicanus*), Western Diamondback Rattlesnake (*Crotalus atrox*) and Mexican Blackhead Snake (*Tantilla atriceps*). During the USACE site visit on January 18, 2006, the following species were observed: Barn Swallow (*Hirundo rustica*), Killdeer (*Charadrius vociferous*), Western Kingbird (*Tyrannus verticalis)*, Black Phoebe (*Sayornis nigricans*), House Finch (*Carpodacus mexicanus*), Desert Cottontail (*Sylvilagus auduboni*), Mourning Dove (*Zenaida macroura*), Ash-throated Flycatcher (*Myiarchus cinerascens*) and a Black-chinned Hummingbird (*Archilochus alexandri*).

Existing animal communities in the small canyon area may be affected by future without-project conditions, as existing and potentially larger flash flood flows in the future would continue degradation within the canyon and therefore threaten existing wildlife.

2.4.3.3 Special Status Species

Three agencies have primary responsibility for protecting and conserving plant and animal species within the proposed project area. The United States Fish and Wildlife Service (USFWS), under authority of the Endangered Species Act of 1973 (16 U.S.C. 1531), as amended, has the responsibility for Federal listed species. The New Mexico Department of Game and Fish

(NMDGF) is responsible for state-listed wildlife species. The New Mexico State Forestry Division (Energy, Minerals, and Natural Resources Department) is responsible for state-listed plant species. Each agency maintains a continually updated list of species that are classified, or are candidates for classification, as protected based on their present status and potential threats to future survival and recruitment into viable breeding populations. These types of status rankings represent an expression of threat level to a given species survival as a whole and/or within local or discrete populations. Special status species that potentially occur in Doña Ana County and may occur near the proposed project area are listed in Table 7.

The New Mexico State Forestry Division (Energy, Minerals, and Natural Resources Department) lists twenty-one rare plant species with the potential to occur in Doña Ana County. These plant species are listed in Table 7. These plant species are found at elevations or in specific habitats or soil types that do not occur within the proposed construction areas.

There are 24 special status animal species listed by USFWS and New Mexico Department of Game and Fish for Doña Ana County (2016) that might occur near the project area but are not anticipated to occur in the project area (Table 7). No special status animal species or their preferred habitats were observed in the project areas. Future without-project conditions are not anticipated to have an effect on these species.

U.S. Army Corps of Engineers and USFWS biologists conducted surveys for biological resources on January 18 and September 11 and 12, 2006. No Federal or State listed, proposed, or candidate plant or animal species or evidence thereof was observed within the proposed construction areas.

The USACE sent the USFWS a general scoping letter on March 14, 2006. A response letter was received from USFWS on March 21, 2006. Only routine and general comments were received (See Appendix C – Environmental Resources for scoping letter and comments received). Informal consultation and coordination regarding the Endangered Species Act (ESA) will be conducted during the public review period.

Table 7 Special Status Species Listed for Dona Ana County, New Mexico

Common Name	Scientific Name	Federal Status (USFWS)[a]	State of New Mexico status (NMDGF)[b]
Animals			
Bald Eagle	*Haliaeetus leucocephalus*	---	T
Neotropic Cormorant	*Phalacocorax brasilianus*	---	T
Aplomado Falcon	*Falco femoralis septentrionalis*	E	E
Southwestern Willow Flycatcher	*Empidonax traillii extimus*	E/CH	E
Common Black-Hawk	*Buteogallus anthracinus anthracinus*	SC	T
American Peregrine Falcon	*Falco peregrinus anatum*	SC	T
Gray Vireo	*Vireo vicinior*	---	T
Bell's Vireo	*Vireo bellii medius*	SC	T
Baird's Sparrow	*Ammodramus bairdii*	SC	T
Spotted Bat	*Euderma maculatum*	---	T
Mexican Spotted Owl	*Strix occidentalis lucida*	T/CH	---
Least Tern	*Sterna antillarum*	E	E
Common Ground-dove	*Columbina passerina*	---	E
Buff-collared Nightjar	*Caprimulgus ridgwayi*	---	E
Brown Pelican	*Pelecanus occidentalis*	---	E
Desert Bighorn Sheep	*Ovis canadensis nelsoni*	---	E
Broad-billed Hummingbird	*Cynanthus latirostris*	---	T
Costa's Hummingbird	*Calypte costae*	---	T
Violet-crowned Hummingbird	*Amazilia violiceps*	---	T
Organ Mountains Colorado Chipmunk	*Tamias quadrivitattus australis*	SC	T
Doña Ana Talussnail	*Sonorella todseni*	SC	T
Varied Bunting	*Passerina versicolor*	---	T
Yellow-billed Cuckoo	*Coccyzus americanus*	T	---
Arctic Peregrine Falcon	*Falco peregrinus tundrius*	SC	T

(list obtained 12 February 2016)

Table 7 continued

Common Name	**Scientific Name**	**Federal Status (USFWS)[a]**	**State of New Mexico status (NMDGF)[b]**
Plants			
Grayish-white giant hyssop	*Agastache cana*	---	R
Organ Mountains giant hyssop	*Agastache pringlei var. verticillata*	---	R
Castetter's milkvetch	*Astragalus castetteri*	---	R
Organ Mountains paintbrush	*Castilleja organorum*	---	R
Standley's whitlow grass	*Draba standleyi*	---	R
Organ Mountains pincushion cactus	*Escobaria organensis*	---	R
Sandberg pincushion cactus	*Escobaria sandbergii*	---	R
Sneed pincushion cactus	*Escobaria sneedii var. sneedii*	---	R
Villard pincushion cactus	*Escobaria villardii*	---	R
Arizona coralroot	*Hexalectris spicata var. arizonica*	---	R
Vasey's bitterweed	*Hymenoxys vaseyi*	---	R
Organ Mountains evening primrose	*Oenothera organensis*	---	R
Dune pricklypear	*Opuntia arenaria*	---	R
Night-blooming cereus	*Peniocereus gregii var. gregii*	---	R
Alamo beardtongue	*Penstemon alamosensis*	---	R
Nodding cliff daisy	*Perityle cernua*	---	R
New Mexico rock daisy	*Perityle staurophylla var. staurophylla*	---	R
Mescalero milkwort	*Polygala rimulicola var. mescalerorum*	---	R
Supreme sage	*Salvia summa*	---	R
Smooth figwort	*Scrophularia laevis*	---	R
Plank's campion	*Silene plankii*	---	R

[a] **ESA** (as prepared by U.S. Fish and Wildlife Services)

Status: Only Endangered and Threatened species are protected by the ESA.

E= Endangered: any species that is in danger of extinction throughout all or a significant portion of its range.

T= Threatened: any species that is likely to become and endangered species within the foreseeable future throughout all or a significant portion of its range.

C= Candidate: taxa for which the Service has on file sufficient information on biological vulnerability and threat(s) to support proposals to list them as endangered or threatened species.

SC= Species of Concern: taxa for which information now in the possession of the Service indicates that proposing to list as endangered or threatened is possibly appropriate, but for which sufficient data on biological vulnerability and threat are not currently available to support proposed rules.

CH= Critical Habitat: Critical Habitat, as established by the agency.

[b] **State of New Mexico status:**

E= Endangered Animal species whose prospects of survival or recruitment within the state are in jeopardy.

T= Threatened Animal species whose prospects of survival or recruitment within the state are likely to become jeopardized in the foreseeable future.

R=Rare

2.5 Cultural Resources

Regional Cultural History Three major periods of human occupation in the region, the Archaic, the Formative, and the Historic, are represented by sites recorded in the project area. The Archaic Period (ca. 6000 BC to AD 200) is divided into four phases depending on increasing population, associated dates, material culture, and adaptation, with cultigens entering the region towards the end of the period. In general, hunting animals and gathering a wide variety of plants constituted the subsistence strategy during the Archaic Period. Small, mobile, family-based groups moved seasonally through the environmental zones as resources became available. The settlement patterns are poorly defined in this region; however, those resource procurement sites that have been identified tend to correlate with the locally available plants. Such sites in the lower basin were used for processing mesquite and annuals; sites in the foothills of the Sacramento and Franklin Mountains are associated with agave; and the mountains were frequently used for hunting (Kurota 2006:5-6).

There are two primary Formative period (ca. AD 200 to 1400) sequences in southern New Mexico, the Mimbres and Jornada Branches of the Mogollon Culture. The Rio Grande serves as the nominal dividing line between the two. Elements of both occur within the project area given its proximity to the river. The Branches are subdivided into increments of several hundred years depending on the material cultural items recovered. Such factors as pit houses or surface rooms and ceramic assemblages are the primary determinants. Through time in the Mimbres Region, there was a gradual shift from the residential villages in upland settings during the early Pithouse Period to the drainage valleys as year-round residences during the late Pithouse and Pueblo Periods. The Jornada Mogollon land use differs from this pattern in that earlier village sites are found throughout the landscape. Later, as groups were more dependent on agriculture, the residences were closer to the river valleys (Kurota 2006:6-7).

In New Mexico, the Historical Period can be dated from either AD 1540 with the entrance of the Coronado exploratory expedition or AD 1598, the Oñate colonization of northern New Mexico. The initial settlement of the Hatch area by Euro-Americans was not until the mid-nineteenth century; therefore, for the majority of the Historic Period, the Rio Grande Valley served as a transportation corridor. During the seventeenth and eighteenth centuries the major supply and trade route between the Spanish settlements of the Chihuahua mining district and El Paso, and the Spanish colonies of New Mexico was the Camino Real de Tierra Adentro and it passed to the east of Hatch. When New Mexico came under Mexican control in 1821, trade restrictions with the United States were eased and the Santa Fe Trail was opened. This extended trade along the Camino Real to the developing eastern United States. After the United States took control of this area in 1848,several forts and military posts were located in present-day Doña Ana County in part to protect the Camino Real and the California Trail from outlaws and Indians (Kurota 2006:7).

Santa Barbara, the original name for Hatch, was occupied in 1853 when Fort Thorn was located nearby (Wilson et al. 1989: 24-25). The village was abandoned after the fort closed in 1859 and was not reoccupied until 1875 when it was renamed Hatch in honor of General Edward Hatch, the commander of Fort Thorn (Kurota 2006:7; Julyan 1996:162). The lower Rio Grande Valley was increasingly occupied by Hispanic and Anglo settlers after the subjugation of the Indians, especially the Apache. Agriculture became a mainstay, and in 1881 the Atchison, Topeka, and Santa Fe Railroad joined the Southern Pacific in Deming (Myrick 1990). In the 1890s, a diagonal line from Rincon to Deming included a stop in Hatch. Increasing numbers of settlers and increasing agriculture required irrigation, and in 1916 Elephant Butte Dam was completed and construction was initiated on the Percha Diversion Dam to provide irrigation water to the Rincon Valley. Percha Dam was completed in 1918 and canals in the valley were in operation by 1919. By 1935 the irrigation system in and around Hatch was well established (Kurota 2006:7-8).

2.5.1 Site and Survey Data

In April, 2006, archaeologists from the Office of Contract Archeology, University of New Mexico, conducted a review of the State of New Mexico's New Mexico Cultural Resource Information System (NMCRIS) and an intensive or complete inventory survey of the project area for the proposed construction of a FRM dam within the town limits of Hatch, New Mexico. The NMCRIS review of a one-mile radius around the proposed project area found a total of seven known sites, two of which were historic irrigation canals. Only the two irrigation canals are located within the proposed project area.

Following NMCRIS review, the pedestrian survey covered a total of 69.8 ac (28.3 hectares), locating four new archaeological sites, and nine isolated occurrences (single or small clusters of artifacts). The records for the two previously recorded canals were updated. Two sites are scatters of historic and recent trash; the other two are prehistoric artifact scatters. The two prehistoric sites were tested to determine whether subsurface cultural material are present. None of the four new archaeological sites are considered eligible for the National Register of Historic Places (NRHP). The New Mexico State Historic Preservation Officer concurred with the USACE's eligibility recommendations from the 2006 survey on December 5, 2007 (Appendix D). The two canals, the Rodey Lateral and the Colorado Drain, are irrigation ditches that are part of the EBID. Both were previously determined eligible for inclusion in the NRHP.

Site LA 152981, a low-density, prehistoric sherd and lithic artifact scatter associated with the Jornada Mogollon of the Late Formative Period was used for the rapid production of expedient tools probably used in agricultural fields. At LA 152982, two rock features and lithics were found; however, no diagnostic artifacts were recovered, and its age and cultural affiliation are uncertain. One rock feature, which may have been a room, was essentially destroyed by pot hunters and its function remains unknown. The second feature is a concentration of locally available basalt rocks and given its vantage point may have been a hunting blind or a windbreak. A portion of a modern lantern and modern shell casings were scattered around indicating use during the last several decades. The lithics indicate use of the area as a quarry by prehistoric people (Kurota 2006:12-24).

Site LA 152983 is a concentration of historic-period trash dating from 1912 through 1945. Metal, glass, ceramics, corrugated tin roofing, stove parts, milled lumber, and car parts were among the items recorded. Site LA 152984 includes similar material in three discrete piles and may indicate individual trash dumps between 1916 and 1930 (Kurota 2006:25-30).

A small portion of the Rodey Lateral, LA 120285, abuts the project area for approximately 350 m (1148 feet). It was constructed between 1918 and 1922 and is an earthen unlined irrigation ditch starting as a lateral to the Hatch Canal. It parallels the latter for 4.6 miles of its south side and then re-enters the main canal. The Colorado Drain, LA 120284, an unlined earthen ditch, begins in the project area for the collection of rain water. An approximately 100 foot (30.5 m) long, four foot (1.2 m) diameter metal culvert under Rodey Lateral conveys the water in the Colorado Drain. The Colorado Drain, which empties into the Hatch Drain, was constructed in 1923 and is 1.7 miles long (Kurota 2006:30-35).

Included in the inventory of the isolated artifacts were pieces of metal, glass, china, tin cans, barbed wire, three modern camps presumably being used by the homeless or migrant workers, and stone artifacts including flakes, a chopper, a knife, and a partially complete Late Archaic projectile point (Kurota 2006:35-36).

In June 2011, USACE archaeologists conducted an additional pedestrian survey of 12.95 ac (5.24 hectares) in three non-contiguous blocks. The survey was undertaken in order to assess three areas where the proposed dam footprint fell outside of the 2006 inventory area. No archaeological sites were encountered. Two isolated occurrences, both prehistoric stone flakes, were recorded. These isolated occurrences are not considered eligible for the National Register of Historic Places. The New Mexico State Historic Preservation Officer concurred with the USACE's eligibility recommendations from the 2011 survey on July 5, 2011 (Appendix D). Both the 2006 and 2011 archaeological survey reports are included in Appendix D.

2.5.2 State and National Register Listed Properties

Two National Register-listed properties are located within the project area. These properties are two historic irrigation ditches: the Rodey Lateral and the Colorado Drain. Both of these historic properties are listed in the NRHP as contributing elements to the EBID (NR# 97000822).

2.5.3 Traditional Cultural Properties

Consistent with the Department of Defense's American Indian and Alaska Native Policy, signed by Secretary of Defense William S. Cohen on October 20, 1998, Tribes/Pueblos that have indicated they have concerns within Doña Ana County have been contacted regarding the proposed project (Appendix D). Responses were received from the Comanche and Fort Sill Apache Tribes, indicating that both tribes had no cultural or religious concerns with the project. To date, the USACE has received no tribal concerns regarding the study area.

2.5.4 Expected Results of Future Cultural Resource Surveys

At present, the entire project area has been surveyed for cultural resources. Therefore, no future cultural resources surveys are expected within the project area. Additional survey will only be necessary in the event that the scope of the project changes such that the area of potential effect includes areas outside the current surveyed boundaries.

2.6 Indian Trust Assets

Indian Trust Assets (ITA) are a legal interest in assets held in trust by the United States Government for Indian tribes or individuals. The United States has an Indian Trust Responsibility to protect and maintain rights reserved by or granted to Indian tribes or individuals by treaties, statues, EO, and rights further interpreted by the courts. The Secretary of the Department of the Interior (DOI), acting as the trustee, holds many assets in trust. Some examples of ITAs are lands, minerals, water rights, hunting and fishing rights, titles and money. ITAs cannot be sold, leased, or alienated without the express approval of the United States Government. The Indian Trust Responsibility requires that all Federal agencies take all actions reasonably necessary to protect such trust assets. The Department of Defense's American Indian and Alaska Native Policy, signed by Secretary of Defense William S. Cohen on October 20, 1998, and DOI's Secretarial Order 3175 require that the USACE, as the project's Lead Federal Agency, consult with tribes and assess the impacts of its projects on ITAs. If any ITAs are identified and are to be impacted, further consultation on measures to avoid or minimize potential adverse effects will take place. If the project results in adverse impacts, consultation regarding mitigation and/or compensation will take place.

Consistent with the Department of Defense's American Indian and Alaska Native Policy, signed by Secretary of Defense William S. Cohen on October 20, 1998, and based on the State of New Mexico Indian Affairs Department and Historic Preservation Division's 2007 Native American Consultations List, Tribes/Pueblos that have indicated they have concerns within Doña Ana County have been contacted regarding the proposed project (Appendix D). To date, the USACE has received no tribal concerns regarding the study. No specific concerns or ITAs have been brought to the attention of the USACE.

2.7 Hazardous, Toxic and Radioactive Waste

The USACE performed a Phase I Environmental Site Assessment (Phase I ESA) to investigate and identify Recognized Environmental Conditions (REC) associated with a property or site for the property proposed for the dam site. An initial Phase I ESA was finalized in November of 2006. Due to longevity involved in planning, in 2010 EES ordered an additional historical environmental database query of the area, and again in November 2014. In November 2014, an addendum to the initial Phase I ESA was prepared. The initial Phase I ESA was conducted in accordance with the American Society for Testing and Materials (ASTM) standard E1527-00 - *Standard Practice for Environmental Site Assessments*, the Comprehensive Environmental Response, Compensation, and Liability Act Section 120(h) – *Property Transferred by Federal Agencies,* the Corps ER 1165-2-132 - *Hazardous, Toxic, and Radioactive Waste (HTRW) Guidance for Civil Works Projects (Corps, 1992*); and standard industry methodologies. The initial Phase I ESA, the 2010 database query, the 2014 database query, and the Phase I ESA addendum are located in the Environmental Engineering Appendix (Appendix E).

The initial Phase I ESA revealed no evidence of disposal, or release, of hazardous, toxic, radiological wastes or substances, including petroleum products or derivatives on the property. However, the following potential RECs were identified on the property:

- A domestic wastewater leach field system is located on the site. State officials indicated that the leach field had overflowed causing mosquito and health problems. Wastewater samples were collected in late August 2004 and were analyzed for volatile organic compounds (VOCs), metals, and inorganic compounds. The analyses detected trace VOCs including 2-butanone (methyl-ethyl-ketone), toluene, tetra-hydro-furan, ammonia, and organic nitrogen. None of the laboratory results had concentrations of these chemical compounds that exceeded the New Mexico Groundwater Quality Control Commission standards for groundwater. As of November 2014, the leach field is not operational.
- The site reconnaissance identified a dump and debris area just west of the site. The pile consisted of wooden pallets, tires, concrete, and some household trash. No evidence of HTRW including petroleum products was observed.
- A large area of stagnant water was observed near the northwestern corner of the site during the Site reconnaissance. The water had a greenish color, likely from algae or other

> vegetation, and emitted a septic odor. The recent heavy rainfall and flooding in the area had contributed to water pooling. However, overflowing leach lines from septic tanks in the area may have contributed to the water (cited from the initial Phase I ESA).

The initial Phase I ESA recommended a geophysical investigation and groundwater sampling. Since the writing of the initial Phase I ESA, the sponsor of the project/dam has purchased the property. The sponsor is now responsible for any environmental liabilities. This may include the removal the septic system and leach field, mitigating any environmental hazards that may be attributable to the septic system, and/or any contaminated soil or groundwater. However, samples were collected in the vicinity of the leach field in August 2004. No compound exceeded an environmental groundwater quality standard.

The environmental records search did not identify listed facilities within the boundaries of the property. The records search, however, did identify underground storage tanks, aboveground storage tanks, and Resource Conservation and Recovery Act facilities within a 1-mile radius of the site. However, these facilities are all located north of the proposed dam site, across the Atcheson, Topeka and Santa Fe railroad tracks, and are situated topographically lower than the site. Based on regional topography, these facilities appear to be hydrologically down gradient of the site. None of the facilities listed are considered an REC. No evidence of disposal or release of hazardous, toxic, or radiological wastes/ substances, including petroleum products or derivatives, were discovered.

In November 2014, findings of the initial Phase ESA were compared with environmental records queried in 2010, and an addendum to the Phase I ESA was prepared. No additional RECs or potential RECs were discovered. There has been no new development on the property, and there has been no new development encroaching on the property. The initial findings in 2006 Phase I ESA and the findings in November 2014 records review are essentially identical. The future without project, or no action alternative, could result in leach field/septic system remaining. Other than this, the future without project (no action alternative) would have no effect on existing conditions at the site relative to HTRW.

2.8 Geology and Structural Setting

2.8.1 General Geology

The project area is located approximate 0.25 miles southwest of Hatch and about 1 mile south of the Rio Grande. The Village of Hatch resides in two major structural zones, the Rio Grande Rift zone and the Basin and Range Province (Halka Chronic 1996). The Rio Grande Rift formed approximately 30 million years ago. Faulting associated with rifting created step-like plateaus throughout Arizona, New Mexico, Utah and Colorado. Fifteen to 8 million years ago, extensional forces faulted the landscape forming tilted ranges and deep basins. These extensional forces created what is now referred to as the Basin and Range Province and extends throughout much of the southwest, including New Mexico. At about this same time, volcanic activity shattered the landscape on the western side of the Rio Grande Rift zone and spread volcanic ash and rock over New Mexico and bordering states (Halka Chronic 1996). At the time this document was prepared, Halka Chronic (Roadside Geology of New Mexico) was the only reference available for the information noted above.

The Village of Hatch is situated at an elevation of 4,050 feet in the Hatch Basin. The Hatch Basin is just one of many linked basins throughout the Rio Grande Rift zone (NMSHD 1964). During the Tertiary Period, these basins were closed and in-filled with a thick sequence of volcanic and pyroclastic deposits. Evidence of these deposits can be seen on the nearby Rincon Hills where sedimentary rocks are interbedded with rhyolitic rock and tuffaceous sandstone (NMSHD 1964). Subsequent to these volcanic eruptions, additional deposition and in-filling occurred from erosion of the Santa Fe group. The Santa Fe group accumulated thousands of feet in the Hatch Basin through alluvial fan and stream bed deposition. In the Pleistocene Epoch, surface erosion stripped away a channel through these closed basins to form what is now the Rio Grande. The Rio Grande is currently mature in which deposition and erosion are approximately equal.

The geology comprises primarily alluvium (Qa/Qp), which is a mixture of sand, silt, clay and gravel, deposited by tributary arroyos of the Rio Grande. These alluvial deposits are heterogeneous and vary from gravel size grains to clay and were reworked from older beds (parent rock) and transported from higher elevations during flash flooding. On the west side of the Rio Grande, these deposits tend to have a higher percentage of silt and clay rather than sand and gravel because the parent material was that of the Santa Fe group (NMSHD 1964).

There was no information available regarding the depth to bedrock. Therefore, a review of drilling logs was conducted to make a general statement about the thickness of the alluvium and depth to bedrock. The New Mexico Office of the State Engineer (NMOSE) has a database with general information for the depth of wells, and the material a well is screened in. The New Mexico Water Rights Reporting System (NMWRRS) contains this information. Well logs in this database indicate alluvium is at least 100 feet thick, and bedrock rock is greater than100 feet below the ground surface (NMOSE 2014).

The geology of the area would remain the same in the future without-project.

2.8.2 Regional Faulting and Seismicity

Active faults in New Mexico are concentrated within the Rio Grande rift, particularly along its boundaries (Price and Love 2009). Faults that are considered “active” have ruptured during the past 10,000 years (Holocene Period) and are likely the sources of future earthquake activity.

No known active faults are located in the vicinity of the project site. However, the region is seismically active and the site has a moderate seismic hazard associated with potential ground shaking (USACE 2016, Appendix F).

The potential for ground shaking at the project site represents the aggregate earthquake risk associated with all of the potentially active faults in the surrounding region. The potential Peak Ground Acceleration (PGA), associated with the proposed dam site is 0.01-0.014g (USGS 2016)

The largest historic earthquake in New Mexico was probably the 15 November 1906 earthquake near Socorro of estimated M 6.2. The event was felt throughout central New Mexico. Socorro, about 95 miles north of Hatch, is the most seismically active region in New Mexico due to inflation of a magma body at a depth of 12 miles (Price and Love 2009).

2.8.3 Soils

A review of the NRCS, soil datamart at **http://soildatamart.nrcs.usda.gov** was conducted on August 16, 2012 to provide an overview of soil types, including soil characteristics and engineering, chemical and physical properties in the project area (NRCS 2012). There are two soil associations located in the project area. Map units s5318 and s5319 represent six distinct soil series. Map Unit s5318 comprises the Harkey, Glendale, Brazito, Armijo, and Anthony series. Map unit s5319 comprises the Nickel series.

Chemical properties in the soil series associated with Map Unit s5319 have a pH range of 7.4 to 9.6, with the Armijo with the highest pH (9.6). Calcium carbonate and gypsum percentages in these soils are low, if present at all. Sodium ranges from 0 to 16 millimhos per centimeter (mmhos/cm). The pH in the Nickel series ranges from 7.9 to 8.4 with no appreciable amount of calcium carbonate, gypsum, and at most, 2.0 mmhos/cm of sodium. The texture of Nickel series, as defined by the NRCS, can vary with depth. At and near the surface to about 7 feet below ground surface, this soil can be gravelly with fine sandy loam. Gravel, sand and loam are the key grain size associated with this soil series. For Map Unit s5318, grain size distribution is small, ranging from clay to silt to fine sands.

In contrast, the Doña Ana county area soil survey conducted in 1975 broadly classified soils where the dam is proposed as Nickel-Upton. The Nickel-Upton series is classified as a well draining gravelly fine sandy loam located on alluvial fans, terraces, ridges and piedmonts (USDA, 1975). The no action alternative would affect the special distribution of the soils due to periodic flash flooding that would mobilize soils down gradient, but this action would not change the type of soil present at the site. Therefore, the no action alternative would have no effects on the soil type.

2.9 Real Estate

The majority of the lands within the Springs Canyon Arroyo upper watershed belong to either the Bureau of Land Management or the State of New Mexico with scattered parcels of private property.

The lands currently affected by flooding from Springs Canyon Arroyo are primarily privately owned with some property owned by the State of New Mexico, Doña Ana Country or the Village of Hatch. Therefore, it is anticipated that the future without-project would remain largely unchanged and have no effect on existing land ownership conditions at the site.

2.10 Socioeconomics

2.10.1 Environmental Justice and Study Area Demographics

The planning and decision-making process for actions proposed by Federal agencies involves a study of other relevant environmental statutes and regulations, including EO 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, which was issued by President Clinton on February 11, 1994. The essential purpose of EO 12898 is to ensure the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no groups of people, including racial, ethnic, or socioeconomic groups should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of Federal, State, tribal, and local programs and policies. Also included with environmental justice are concerns pursuant to EO 13045, *Protection of Children from Environmental Health Risks and Safety Risks*. This EO directs Federal agencies to identify and assess environmental health and safety risks that may disproportionately affect children under the age of 18. These risks are defined as “risks to health or to safety that are attributable to products or substances that the child is likely to come into contact with or ingest.”

Environmental justice considerations addressed in this assessment involve both population demographics, including ethnic, racial, or national origin characteristics, and persons in poverty, including children under age 18. In order to determine whether environmental impacts affect minority or low-income populations, it is necessary to establish a basis of comparison, referred to as the “region of comparison.” This area consists of the geopolitical units that include the proposed project. Most environmental effects from the proposed action, in this instance, would be expected to occur in Doña Ana County.

EO 12898 requires “to the greatest extent practicable and permitted by law, and consistent with the principles set forth in the report of the National Performance Review, each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies and activities on minority populations and low-income populations…”. Within a half of a mile, the study area is comprised of a mixture of income levels. Field investigation of the areas to be affected by the construction activities did not reveal the presence of community characteristics that would be considered disproportionately minority or low-income neighborhoods. The future without-project conditions are expected to remain largely the same and would have no effect on environmental justice considerations.

2.10.2 Land Use and Classification

Land use in the Spring Canyon watershed is predominantly public land. The development along the main thoroughfares in and around Hatch will continue to be commercial, whereas plans are currently underway for both commercial and residential developments nearby. No significant development is anticipated in the upstream drainage area of Spring Canyon that would increase the volume of stream flows and exacerbate flooding. The future without-project conditions are expected to remain largely unchanged and would have no effect on current land use classifications.

Summary

The Existing and Expected Future Without-Project Condition as described in each subsection above, is synonymous with the “future without-project condition” or No-Action Alternative. Under this alternative, there is no Federal action. It is expected that the future without-project assumptions will be maintained in the project area.

The economic implications of the No-Action Alternative are broadly negative. The investment at risk within the project area is substantial enough that the No-Action Alternative will subject the study area to the possibility of long-term adverse impact on the local economy, and dislocations of residents and industry may even result. In the short term, with an absence of flooding, the current trends in-place for the local economy, tax base, population, and employment may remain intact. However, when major flooding occurs the long term effects are likely to include: business interruptions that could jeopardize workers' jobs and wages, potential losses in population and employment, diminished economic stability, and reductions in the tax base (given net movement out of Hatch) and generally diminished property values.

It is possible that some local initiatives would likely be focused on the engineering reliability measures, such as, minor improvements of local drainages or small detention basins. However, full implementation of the measures as described would not be possible with local budgets alone. This would mean a significant long-term residual risk of food damages and flood risk to life safety.

3 Plan Formulation and Evaluation

3.1 Plan Formulation Rationale

The plan formulation process was used to develop measures used in solving identified problems and ultimately to develop an array of comprehensive alternatives from which a plan is recommended for implementation. Planning studies are required to examine the Federal criteria of completeness, efficiency, effectiveness and acceptability through successive iterations of alternative solutions to the defined problems. Alternative plans were formulated to alleviate identified problems and fulfill study objectives. The process of formulating alternatives and selection of a recommended plan follows the USACE regulation for conducting planning studies, ER 1105-2-100, and predicated on the Federal Principles and Guidelines (P&G) listed in the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*, March 10, 1983. The results of the plan formulation process for the Hatch study is summarized in this report. Additional details of the plan formulation process are in the Plan Formulation Appendix.

This section presents the rationale for the development of a recommended plan. It describes the Corps' iterative six-step planning process specified in ER 1105-2-100 *Planning Guidance Notebook* and used to develop, evaluate, and compare the array of management measures and preliminary alternatives that have been considered. The six steps used in the plan formulation process include:

1. The specific problems and opportunities to be addressed in the study are identified, and the causes of the problems are discussed and documented. Planning objectives are established, and constraints are identified. This has been accomplished for the current study.

2. Existing and future without-project conditions are identified, analyzed, and forecast for a 50-Year Period of Analysis. The existing condition resources, problems, and opportunities critical to plan formulation, impact assessment, and evaluation are characterized and documented. This has been accomplished for the current study stage. A forecast of conditions that will exist for a 50-year period of analysis without a Federal project was used as the baseline.

3. Alternative plans are formulated that address the planning objectives. An initial set of alternatives are developed and evaluated at a preliminary level of detail, and are subsequently screened into a more final array of alternatives. A public involvement program was used to obtain public input to the alternative identification and evaluation process. Each plan is evaluated for its costs, potential effects, and benefits, and is compared with the No Action Alternative for the 50-year period of analysis.

4. Alternative project plans are evaluated for their potential to meet specified objectives and constraints, effectiveness, efficiency, completeness, and acceptability. The impacts of

alternative plans are evaluated using the system of accounts framework (NED, Environmental Quality [EQ], Regional Economic Development [RED], and Other Social Effects [OSE]) specified in the Corps' *Principles and Guidelines* and ER 1105-2-100. This has taken place for the final array of alternatives and recommended plan during this phase of study (see section 3.7.4).

5. Alternative plans are compared with one another and with the No Action Alternative. Results of analyses are presented (e.g., benefits and costs, potential environmental effects, trade-offs, risks and uncertainties) to prioritize and rank FRM alternatives. For the current study thus far, benefits and costs have been evaluated for the final array of alternatives, and a rationale is provided to justify selection of a recommended plan.

6. A plan is selected for recommendation, and related responsibilities and cost allocations are identified for project approval and implementation.

A baseline or future without project condition has been established as in step 2. in order to compare the effectiveness of various alternatives. The major flood problems identified in this DPR/EA are flows from Spring Canyon Arroyo as described in Section 2.2 Hydrology, Hydraulics and Sedimentation, above. This drainage has historically caused flooding. In the last 59 years Spring Canyon Arroyo has flooded Hatch several times.

The following sections describe the development of the various alternatives to meet project objectives. In order to select one alternative for recommendation the entire suite of alternatives is evaluated and screened. Ultimately one alternative is selected for recommendation based on its ability to achieve project objectives and other criteria as presented in the next section.

3.2 Decision Criteria

The measures and alternatives that are developed as part of this study will be evaluated using technical, economic, environmental considerations and other criteria. Alternatives found to be infeasible are removed from further consideration and no further analysis is done with these alternatives. The remaining alternatives are then compared to each other, and to a future in which no action is taken (the No Action Alternative). The focused array of alternatives that remain after these screening steps are compared to determine their ability to meet the project objectives in addition to the criteria listed below.

As described in Section 1.8.4, the objectives, which are derived from the problem and opportunity statements above, guide the plan formulation process. The objectives developed in this study include:

- Reduce the risk of flood hazard to health and human safety within the study area.
- Reduce flood damages to existing properties, infrastructure and agricultural lands in the study are from floods originating in Spring Canyon.
- Reduce damages to existing properties, infrastructure in Hatch from sediment deposition.

The national or Federal objective of water and related land resources planning is to contribute to NED consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable EO, and other Federal planning requirements. Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the nation.

In addition to the Federal objective, the following criteria will be used to screen measures and alternatives.

Evaluation and screening of all measures and alternatives use the following criteria.

- Reductions in flood damages.
- Cost of implementation.
- Potential for induced flooding.
- Unavoidable impacts and significant environmental mitigation requirements.
- Potential impacts to federally listed threatened and endangered Species.
- Compliance with Federal Regulations/USACE Policy.

The focused array of alternatives is compared using these criteria.

- Costs
- Net benefits
- Risk to human life, health, and safety.
- Negative environmental impacts
- Extent of environmental benefits
- Social fairness & acceptability

Selection of the preferred alternative is based on the following criteria

- Costs
- Residual risks
- Net benefits.
- Property risks.
- Compliance with federal/state regulations.

Key Uncertainties

- Hydrologic model variability, accuracy and uncertainty.
- Future weather and climate conditions.
- Subsurface conditions and uncertainties for structural and nonstructural measures.
- Real estate requirements, availability and variability in cost.
- Borrow soil properties.
- Hazardous and toxic waste concerns that may be present but not yet identified.

3.3 Risk Based Analysis of FRM Alternatives

FRM projects can significantly reduce the risk of flooding, but no project or combination of projects can guarantee 100% protection from flooding. Residual risk refers to the amount of risk that remains after a project is completed. While residual risk can be minimized, it can never be eliminated. A zero residual risk does not exist because no project can completely eliminate natural hazards: flooding may occur less frequently, but there is always some residual risk of flooding after implementation of any FRM project.

3.3.1 Flooding from Other Sources

Hatch receives flood flows from two sources, Spring Canyon and Placitas Arroyo. Placitas Arroyo does not impact Hatch until flood flows exceed the channel capacity at approximately a 1% chance exceedance event. The capacity of the Placitas channel is limited by three roadway bridges and heights of levees along the arroyo. Placitas Arroyo also transports significant amounts of sediment that further reduce the capacity of the existing channel between storms. The arroyo flooded in 2006 after the east levee breached. The Village of Hatch has implemented measures to increase the channel capacity and to increase the capacity of road crossings, substantially mitigating flood threats from Placitas Arroyo.

3.3.2 Risk and Uncertainty

For risk and uncertainty analysis, the USACE uses risk-based analysis procedures for formulating and evaluating FRM measures according to guidance in EM 1110-2-1619, *Engineering and Design Risk Based Analysis for Flood Damage Reduction Studies*; and in ER 1105-2-101, *Planning Risk Analysis for Flood Damage Reduction Studies*. For this study, risk is defined as the probability an area will be flooded, resulting in undesirable consequences. Uncertainty is a measure of imprecision of knowledge of parameters and functions used to describe the hydraulic, hydrologic, geotechnical, structural, and economic aspects of a project plan. Risk and uncertainty arise from measurement errors and from the underlying variability of complex natural, social, and economic situations. Flood problems are multi-dimensional, making it difficult to fully understand, document, and model the physical nature of flooding, its magnitude, its probability of occurrence, and its consequences.

In water resource planning for FRM, uncertainties that can have a significant impact on residual damages, benefits, and cost estimates; planning; design; and the reliability of a proposed flood control project may include, but are not limited to:

- In the hydrologic and hydraulic data, estimates of discharges and flood stages, due to issues such as measurement uncertainty and short periods of data records that do not completely capture the range of variation in natural systems.
- In the economic data, uncertainties surround estimates of investment values, beginning damage elevations, and damages with various flood depths.
- In the engineering and design, there are uncertainties in the potential for geotechnical or structural failure of features in an existing flood control project.
- Climate change, through its impact on both precipitation and hydrology, introduces additional sources of uncertainty in estimates of future flood risk.

To offset risk and uncertainty, the analysis considers a range of possible values rather than a single value in its estimates of critical variables. The range of outcomes in some areas of risk and uncertainty can be reasonably described or characterized by a probability distribution. If there is no historical database, the probability distribution of events can be described subjectively, based on best available science and professional judgment.

USACE policy requires projects to explicitly catalog and evaluate risk and uncertainty in all aspects of project planning and execution.

3.4 *Description of Preliminary Alternatives

During plan formulation, management measures were identified that addressed all or part of the problem(s) being addressed. The goal of this step was to cast as wide a net as possible, so that potentially valuable solutions are not subsequently overlooked. The following management measures were developed during plan formulation team meetings.

3.4.1 Nonstructural Measures

Relative Costs of Various Retrofit Measures. The key characteristic of a nonstructural approach is that it modifies susceptibility to flooding, as opposed to simply attempting to control flooding through structural methods such as dams, levees and channels. However, nonstructural approaches may include use of some structural elements. Emergency preparedness plans or flood forecast and warning systems are examples of nonstructural FRM measures that can be implemented. Having a comprehensive emergency preparedness plan or a flood forecast and warning system in place can help avoid confusion, prevent property damage and decrease risks to human health and safety.

Nonstructural alternatives can also involve construction; although they are usually limited to the property being protected (i.e., floodproofing) or can be accomplished through an institutional change. Examples of floodproofing measures include coating the walls or flood prone structures with waterproof membranes, elevating the structures on their foundations above anticipated flood elevations or removing flood prone structures from the floodplain entirely.

Specific measures considered for this study include floodproofing, raising structures; permanent evacuation within the floodplain; floodplain management; and flood forecasting/temporary evacuation. With respect to Hatch, the feasibility of implementing the various floodproofing is based upon a number of factors such as the relative height of the anticipated water level at the structure and the type of construction for those structures.

3.4.1.1 Emergency Preparedness Plans

Having an evacuation plan in place before a flood occurs can help avoid confusion, prevent property damage, and decrease the risks to human health and safety. A thorough evacuation plan should include:
The Doña Ana County Flood Commission has been encouraged to prepare flood response plans for the event of flooding, to include government buildings, community centers, education facilities and housing areas. Flood response plans should include identifying critical equipment, records and supplies prior to the onset of a flood in order to aid the recovery of operations. They should also include specific flood fighting and evacuation plans to enhance the likelihood of success. Implementing these emergency operations is usually the responsibility of management, the homeowner, agency heads, elected officials or other persons with the authority to implement

such plans.

3.4.1.2 Flood Warning System

Important elements in the Nation's program to reduce flood damages include flood warning systems. Timely warnings save lives and aid disaster preparedness, which decreases property damage by an estimated $1 billion annually. A flood warning and preparedness system is often the most cost effective flood mitigation measure comprised of computer hardware, software, technical activities and/or organizational arrangements aimed at decreasing flood hazards. Advanced warning is not generally effective in reducing structural damages outside of sandbagging efforts requiring days to construct. The primary benefits of such a system are credited for providing early evacuation of residents and reduction in damages to vehicles and structure contents. However, since most flooding in the study areas results from localized summer thunderstorms, flood warning lead times are short. A flood warning in Hatch currently provides less than an hours' notice since there are no stream gages in Spring Canyon. Addition of early warning gages in the canyon or rain gages in the upper watersheds could improve warning times by tens of minutes; however, they would not allow for effective reduction of structural damages.

A flood warning system would present benefits by reducing the amount of residential contents subject to flooding. Residential contents represent half the residential flood damages. It is assumed that an effective and understood flood warning system would allow residents to protect structure contents. Removing damageable items from the dwelling or raising them above flood stage would decrease estimated damages by some amount. The high residual damages to properties and to other infrastructure (roads, agriculture, utilities, public and commercial properties) suggests that a flood warning system is ineffective and incomplete on its own.

3.4.1.3 Wet Floodproofing

Per Federal Emergency Management Agency's (FEMA) *Technical Bulletin 7-93*, wet floodproofing can be defined as "Permanent or contingent measures applied to a structure and / or its contents that prevent or provide resistance to damage from flooding by allowing flood water to enter the structure." Generally, this is limited to structures with living spaces above flood stage and crawlspaces, basements, and underground garages that would not sustain damages if flooded. These measures may require the structure be adequately anchored to its foundation, alternation of a structure's design and construction, use of flood-resistant materials, adjustment of building operation and maintenance procedures, and the relocation and treatment of equipment and contents.

Wet floodproofing, in most cases, will require some human intervention when a flood is imminent and so it is extremely important that there be adequate time to execute such actions. This measure also requires some degree of periodic maintenance and inspection to ensure that all components will operate properly under flood conditions. These necessary inspections and maintenance activities must be described in an Inspection and Maintenance plan.

3.4.1.4 Dry Floodproofing

Per FEMA's *Selecting Appropriate Mitigation Measures for Flood prone Structures*, a dry flood proofed structure is made watertight below the level that needs flood protection to prevent floodwaters from entering (Figure 13). Making the structure watertight requires sealing the walls with waterproof coatings, impermeable membranes, or a supplemental layer of masonry or concrete (Figure 14).

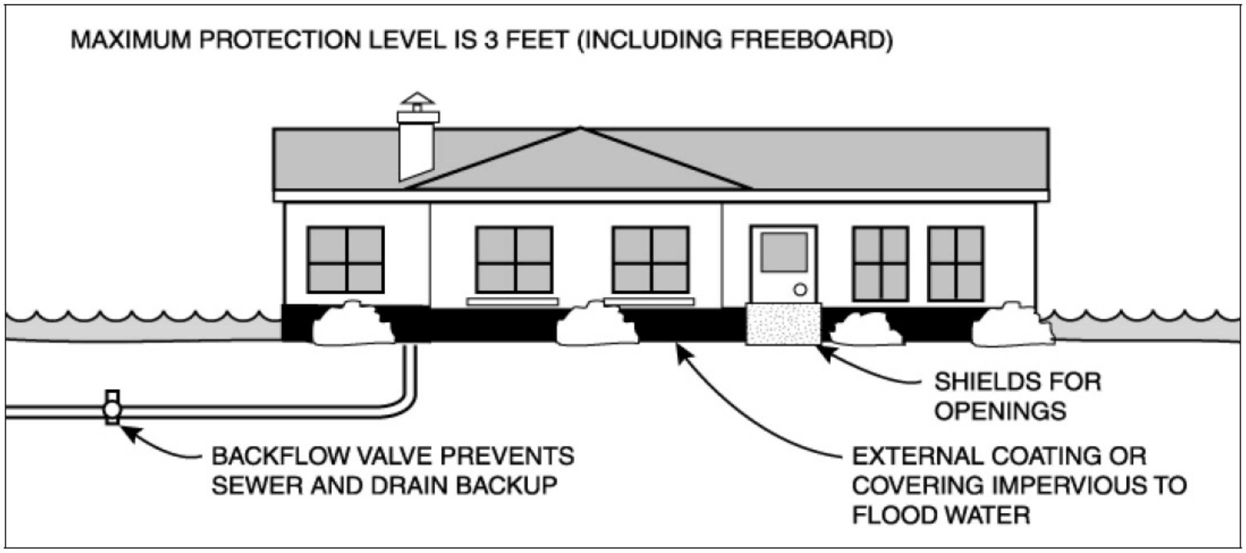


Figure 13 Typical dry floodproofed structure.

This type of floodproofing includes the following:

- Using waterproof membranes or other sealants to prevent water from entering the structure through the walls;
- Installing watertight shields over windows and doors; and,
- Installing measures to prevent sewer backup.

There are technical considerations that must be taken into account in order to accurately determine whether dry floodproofing will be successful. Generally, masonry and masonry veneer walls can usually withstand the water pressures of floods less than 3 feet in depth. Masonry and Masonry veneers are also resistant to moisture damage and can be made watertight with sealants. In flood depths greater than 3 feet, these types of walls require reinforcement.

Dry floodproofing is not recommended when:

- Structure's construction quality is less than good or excellent;
- Structures are located in areas where flood waters may be greater than 3 feet in depth;
- Structures are located in areas where flood waters may stand for days;
- Structure walls are constructed of adobe;
- Structure's foundational soils are very permeable; or,
- The owner is unwilling to implement.

3.4.1.5 Raising Structures In Place

When a structure is properly elevated, the living or commercial area will be above all but the most severe floods (such as the 500-year flood). Several elevation techniques are available. In general, they involve (1) lifting the structure and building a new, or extending the existing, foundation below it or (2) leaving the structure in place and either building an elevated floor within the house or adding a new upper story.

During the elevation process, structures originally built on basement, crawlspace, and open foundations are separated from their foundations, raised on hydraulic jacks, and held by temporary supports while a new or extended foundation is constructed below. The living area is raised and only the foundation remains exposed to flooding. Masonry structures are more difficult to lift, primarily because of their design, construction, and weight, but lifting these homes is possible. For structures with slab-on-grade foundations where the slab forms both the floor of the structure and either all or a major part of the foundation, the structure is left attached to the slab and both are lifted together. After the structure and slab are lifted, a new foundation is constructed below the slab. Raising a slab-on-grade structure is more difficult and more costly.

Raising structures in place is not recommended when:

- Structure's construction quality is less than low cost (i.e. mobile homes and portable buildings), good or excellent;
- Structures are located in areas where flood velocities may be greater than 3 feet/second (foundation walls) or 5 feet/second (posts or fill);
- Structures are located in areas where flood depths may be greater than 6 feet (piers);
- Structure walls are constructed of adobe;
- Structure's foundational soils are very permeable; or,
- The owner is unwilling to implement.

3.4.1.6 Acquisition and / or Relocation of Structures

One method of reducing future damage from floods is for the community to acquire a property and relocate an existing floodprone structure to a new site outside the floodplain. In general, single-story, wood frame structures over a crawlspace or basement foundation are easiest to relocate. Multi-story and solid masonry structures are the most difficult to relocate because their greater size and weight requires additional lifting equipment and makes them more difficult to stabilize during the move. Slab-on-grade foundations complicate the relocation process because they make the installation of lifting equipment more difficult.

Per FEMA's *Scope of Work for Relocation of Floodprone Structures 2005,* the relocation process is complex, expensive, and requires extensive pre-move planning. However, it may be a cheaper alternative than acquiring and demolishing a floodprone structure.

Construction Type	Existing Foundation	Measure	Retrofit	Relative Cost
Frame, Masonry Veneer, or Masonry	Crawlspace or Basement	Wet Floodproofing	Wet floodproof crawlspace to a height of 4 feet above lowest adjacent grade or wet floodproof unfinished basement to a height of 8 feet above basement floor	Lowest
Masonry Veneer or Masonry	Slab-on-Grade or Crawlspace	Dry Floodproofing	Dry floodproof to a maximum height of 3 feet above lowest adjacent grade	
Frame, Masonry Veneer, or Masonry	Basement, Crawlspace, or Open Foundation	Barrier Systems	Levee constructed to 6 feet above grade or floodwall constructed to 4 feet above grade	
Frame, Masonry Veneer, or Masonry	Basement, Crawlspace, or Open Foundation	Elevation	Elevate on continuous foundation walls or open foundation	
Frame, Masonry Veneer, or Masonry	Basement, Crawlspace, or Open Foundation	Relocation	Elevate on continuous foundation walls or open foundation	
Frame, Masonry Veneer, or Masonry	Slab-on-Grade	Elevation	Elevate on continuous foundation walls or open foundation	
Frame, Masonry Veneer, or Masonry	Slab-on-Grade	Relocation	Elevate on continuous foundation walls or open foundation	Highest
Frame, Masonry Veneer, or Masonry	Slab-on-Grade, Crawlspace, Base-ment, or Open Foundation	Demolition	Demolish existing building and buy or build a home elsewhere	Varies

Figure 14 Relative Costs of Various Retrofit Measures

3.4.1.7 Nonstructural considerations

Nonstructural alternatives were considered in the initial screening of measures. Additional local nonstructural measures were identified that could be implemented by the Village of Hatch:

- Implementation of subdivision regulations restricting drainage in the developing watershed.
- Development of new building codes that could specify building design and materials for both new buildings and repair of flood-damaged structures.
- Flood forecasting and temporary evacuation plans which will be developed in conjunction with the structural alternatives.
- Sponsor's participation in the National Flood Insurance Program which can also be developed in conjunction with structural alternatives.

3.4.2 Structural Measures

Structural alternatives were identified in coordination with the sponsor and the Village of Hatch. Structural measures consist of structures designed to convey, exclude or detain damaging flows from reaching flood-prone areas to reduce damages to property and hazard to life or public health. The initial analyses included floodwalls, levees, channel improvements and earthen dams. Several of these alternatives were eliminated for technical, economic, environmental considerations. Others would present an incomplete or ineffective solution.

3.4.2.1 Localized Levees or Floodwalls

Ring levees or floodwalls can be built to protect single or small groups of structures. Ring levees are earthen embankments with stable or protected side slopes and a wide top. Floodwalls are generally constructed of masonry or concrete and are designed to withstand varying heights of floodwaters and hydrostatic pressure. Closures (e.g., for driveway access) are typically manually operated based on flood forecasting and prediction that would alert the operator. While this solution may be practical for buildings with adequate space and lower floodwater depths, the floodwater depth associated with many structures make berms impossible due to the land area required and impractical for floodwalls due to the high costs of floodwalls.

3.4.2.2 Channel Improvements

Flood flows can be conveyed through or around flood prone areas using improved channels. Channels can be open earthen or concrete lined or enclosed in conduits or culverts. The channels must be sized to carry the design flow events without spilling. In high sediment systems such as Spring Canyon Arroyo a sediment management basin is constructed at the upstream channel inlet to prevent sediment from entering and blocking the channel.

3.4.2.3 Open Concrete Lined Channel

This management measure is a concrete-lined channel that would follow a narrow transportation and utility corridor. This channel would consist of pre-built, three-sided concrete box culverts for 2.29 miles (Figure 15). The channel alignment follows the right of way between highway 154 and the Burlington Northern – Santa Fe Railroad (BNSF). Additional crossing structures would be required to address multiple road and irrigation infrastructure crossings. Two irrigation pipeline crossings, three gravel roads, three paved roads, and two large irrigation return drains cross this channel alignment. Real estate actions would be required (permission, rights-of-way and permanent easements) with the Burlington Northern – Santa Fe Railroad, the NM Department of Transportation and at least one utility.

3.4.2.4 Open Earthen Channel

This channel would consist of an open, earthen trapezoidal channel with riprap-reinforced sides for 3.62 miles (Figure 15). The channel would follow the alignment of the Colorado Drain for much of its length but would require additional lands to accommodate a significantly wider footprint. Crossing structures would be required to address two irrigation pipeline crossings, one gravel road crossing, eight paved road crossings, and three large irrigation return drains.

Figure 15 Map of open channel alternatives.

3.4.2.5 Earthen Detention Structure

Earthen Dams have been used effectively to capture large flood events and slowly release impounded flood waters at discharge rates that do not threaten downstream structures and populations. Flood flows are captured in a basin or behind a dam using the detention method and released slowly through restricted outlets. Discharges from the detention structures would be reduced to the extent that flood damages are reduced in the study area. For this project a detention structure would consist of an earthen embankment dam with appurtenant features such as a spillway, intake tower and outlet conduit. A dry detention structure holds flood flows for short durations (days or weeks) and is dry the majority of the time.

Earthen dams have been used effectively to capture large flood events and slowly release the flood waters in non-damaging amounts. The earthen dam is designed with a Roller Compacted Concrete (RCC) spillway and an overflow stilling basin made of RCC with wire wrapped rip rap apron just downstream of the basin to protect against scour. A gate well structure is designed to be located at the upstream toe of the dam to provide for a way to drain the dam for maintenance. A 36 inch diameter, concrete encased, steel conduit conveys flow from the gate well structure to the stilling basin. The outlet structure is sized to completely evacuate water from the detention basin in 96 hours per New Mexico state law.

The primary considerations relative to the design of a dam in this situation is that any dam meet safely pass the 1 in 10,000 year hydrologic event and meet appropriate seismic loading conditions for the design earthquake. For any dam with life loss potential due to failure, the design earthquake is the probabilistic seismic hazard with a return frequency of 10,000 years.

The site for the proposed earthen dam is located at the mouth of Spring Canyon adjacent approximately a half mile south of the BNSF railroad tracks near the head of the Colorado Drain (Figure 2). The proposed dam site was attractive for four reasons:

1. The Village of Hatch owns the property.

2. The retention basin area is an existing ponding site that collects flows from Spring Canyon Arroyo.

3. The site has an existing outfall (Colorado Drain) for controlled outflows from the dam.

4. The downstream location captures flows from the majority of the watershed.

Figure 8 shows the watersheds relative to the proposed dam location. The site intercepts flows from both the V and the IVA sub-basins. Flows from sub-basin V would not be caught ifthe dam is located further upstream in Spring Canyon Arroyo.

3.5 Evaluation of Preliminary Alternatives

3.5.1 System of Accounts Evaluation

The Economic and Environmental Principles for Water and Related Land Resources Implementation Studies (Water Resources Planning Act 1965, as amended 42 U.S.C. 1962a-2 and d-1) establish a system of four accounts for evaluation of alternative plans. The first of these accounts, NED, evaluates the changes in the economic value of the national output of goods and services and is measured by the economic benefit, or reduced damages, resulting from the alternative plan, discussed previously. The remaining three accounts are:

- Environmental Quality (EQ). The non-monetary effects on significant natural and cultural resources.
- Regional Economic Development (RED). Changes in the distribution of regional

economic activity that result from the plan.
- Other Social Effects (OSE). Plan effects from perspectives relevant to the planning process that are reflected in the other accounts.

USACE and the sponsor conducted a preliminary screening of FRM measures to evaluate the applicability of each measure and the potential for each measure to contribute to the planning objectives consistent with planning constraints.

All alternatives were evaluated based on their performance over a 50-year period of analysis. The alternatives that were eliminated were found to be of very limited applicability, had a very high associated cost, may have extensive environmental effects, or did not address the established goals and objectives.

3.5.2 Nonstructural Measures

3.5.2.1 Emergency Preparedness

Relative to other measures presented, emergency preparedness provides high life safety risk reduction but minor reduction in monetary damages. Some damages to vehicles and structure contents would be prevented through this measure, however, it is by itself an incomplete solution. **This measure is carried forward for consideration in combination with other measures**. The Doña Ana County Flood Commission should collaborate with their county emergency managers, the New Mexico Department of Homeland Security and Emergency Management and SPA's Flood Plain Manager to create a seamless Flood Response Plan prior to completion of project construction.

3.5.2.2 Flood Forecast and Warning

The high residual damages suggest that a flood warning system is ineffective and incomplete on its own. Storm flows from the Spring Canyon Arroyo are flashy and reach the ponding area that is the Village of Hatch, very quickly. Installation of stream gaging stations would only increase warning times by minutes. Some damages and a reduction of life safety risk would be accomplished however, it is by itself an incomplete solution.

This measure is effective in combination with a detention structure, however, so long as gauges are installed in the detention basin. Automated gages could warn emergency mangers of remaining detention basin capacity and impending overtopping events. **This measure is carried forward for consideration in combination with other measures.**

3.5.2.3 Wet Floodproofing

Few of the structures located within the 0.2% USACE floodplain meet the requirements for wet floodproofing, e.g. not recommended for frame construction and located in an area where flood flows rise slowly. Floodproofing does nothing to remove agriculture or transportation infrastructure from the floodplain and therefore would represent an incomplete solution to the flood problem. **Due to the incomplete nature and limited applicability of this floodproofing method, it was not carried forward for alternative evaluation.**

3.5.2.4 Dry Floodproofing

Few of the structures located within the 0.2% USACE floodplain meet the requirements for dry floodproofing, e.g. areas where floodwaters may stand for days. This technique is not applicable in areas subject to flash flooding (less than one hour) or where flow velocities are greater than three (3) feet per second. It would also not be applicable to mobile homes, due to the type of construction and typical lack of anchoring to a foundation.

Aside from the cost, dry flood proofed homes and businesses can still suffer flood damages due to the potentially incomplete nature of the solution. Enclosures for windows and doors require human intervention in order to fully implement the solution and, this action would have to occur in a very short time frame. Once again, floodproofing does nothing to remove agriculture or transportation infrastructure from the floodplain and therefore would represent an incomplete solution to the flood problem. **Due to the incomplete nature and limited applicability of this floodproofing method, it was not carried forward for alternative evaluation.**

3.5.2.5 Acquisition and/or Relocation

Per FEMA's Scope of Work for Relocation of Floodprone Structures 2005, the relocation process is complex, expensive, and requires extensive pre-move planning. FEMA estimates relocation costs between $99 and $116 per square foot (1999 dollars), which exceeds the depreciated replacement costs of just about every structure in the Spring Canyon floodplain (FEMA, 2009:3-28, Table 3-9). **Due to the incomplete nature and inefficiency of this floodproofing method, it was not carried forward for alternative evaluation.**

Acquisition requires the purchase of the flood prone property and structure; demolition of the structure; relocation assistance; and applicable compensation required under Federal and State law. This alternative typically requires voluntary relocation by the property owners and/or eminent domain rights exercised by the non-Federal sponsor. This technique is more costly than relocation and therefore is uneconomical. As with relocations, acquiring properties in a floodplain has limited utility. Repurposing land for a public good like a park is also infeasible, as it would represent an incomplete solution to the flood problem.

3.5.3 Structural Measures

3.5.3.1 Localized Levees or Floodwalls

The disadvantages of levees or berms are that they: 1) can impede or divert the flow of water in a floodplain; 2) can block natural drainage; 3) are susceptible to scour and erosion; 4) give a false sense of security; and 5) take up valuable property space. The disadvantages of floodwalls are: 1) high cost; 2) closures for openings required; and 3) give a false sense of security. While this solution may be practical for buildings with adequate space and lower floodwater depths, the floodwater depth associated with many structures make berms impossible due to the land area required and impractical for floodwalls due to the high cost of floodwalls. Ring levees or floodwalls do nothing to remove agriculture from the floodplain and therefore would represent an incomplete solution to the flood problem. **Due to the incomplete nature and limited applicability of this floodproofing method, it was not carried forward for alternative**

evaluation.

3.5.3.2 Open Concrete Lined Channel

This alternative was removed from further consideration given that a preliminary and incomplete project construction cost of $27 million is more than twice that of the most expensive dam alternative. A more detailed cost estimate for this alternative would only show an increase in currently uncaptured costs. This alternative would not reasonably maximize net benefits. Further, this alternative resulted in a large disturbance along its 2.3 mile long footprint. **This alternative was removed from further consideration.**

3.5.3.3 Open Earthen Channel

This alternative was removed from further consideration given that the initial project construction cost of $18 million is more than half again as costly as the most expensive dam alternative, and would not reasonably maximize net benefits. A more detailed cost estimate for this alternative would only show an increase in currently uncaptured costs. Further, this alternative resulted in a large disturbance along its 3.6 mile long footprint. **This alternative was removed from further consideration.**

3.5.3.4 Earthen Detention Structures

Earthen detention structures were retained for further analysis since they have been used successfully to reduce flood risk on tributaries up and down the Rio Grande. There are adequate locations and conditions for construction of a detention dam upstream of Hatch. Preliminary costs estimates demonstrated that the alternative would be feasible and provide an efficient method for reducing flood risk.

Table 8 Results of initial screening of alternatives.

Measure	Meeting Goals and Objectives	Comparative Cost Range	Environmental Effects	Socio-Economic Effects	Cost Effectiveness	Status
NONSTRUCTURAL						
Raise/Flood-Proof Structures	Minimal	High	Minimal	High	Low	Eliminated
Relocate Structures	Minimal	High	Extensive	High	Low	Eliminated
Flood Warning System	Minimal	Low	Minimal	Low	High	Retained
Emergency Preparedness	Moderate	Low	Minimal	Medium	Medium	Retained
STRUCTURAL						
Levees and Flood Walls	Minimal	High	Moderate	High	Low	Eliminated
Channel Improvements	Moderate	High	Moderate	Low	Low	Eliminated
Earthen Storage/ Detention Structure	High	Moderate	Moderate	Low	High	Retained
NO-ACTION ALTERNATIVE						
	Low	Low	Minimal	High	N/A	Eliminated

After screening of alternatives (Table 8) the remaining measures are flood warning system, emergency preparedness, and detention structures. These three measures complement each other well and can be combined into a single alternative. This alternative centers on a single detention dam at the mouth of Spring Canyon. In addition to the dam, a flood warning system would be developed along with emergency preparedness.

3.6 * Focused Array of Alternatives

This section describes the analysis of remaining alternatives that address the planning objectives, the comparison of those alternatives, and the identification of the recommended plan. A detailed analysis of the environmental impacts from these alternatives is presented in Chapter 4. The focused array is as follows:

3.6.1 No Action Alternative (Future Without Project Condition)

In accordance with current policy, it is necessary to evaluate the No-Action Alternative for purposes of comparison to other alternatives and the future with-project conditions. Evaluation of the No-Action Alternative is synonymous with the “future without-project condition” described in Section 2*Existing and Expected Future Without-Project Conditions, above. Under this alternative, there is no Federal action. It is expected that the future without-project assumptions will be maintained in the project area. No additional FRM would be provided under the No-Action Alternative.

The No-Action Alternative does not address the established objectives for the study area. The economic implications of the No-Action Alternative are broadly negative. The investment at risk within the project area is substantial enough that the No-Action Alternative will subject the study area to the possibility of long-term adverse impact on the local economy, and dislocations of residents and industry may even result. In the short term, with an absence of flooding, the current trends in-place for the local economy, tax base, population, and employment may remain intact. However, when major flooding occurs the long term effects are likely to include: business interruptions that could jeopardize workers' jobs and wages, potential losses in population and employment, diminished economic stability, and reductions in the tax base (given net movement out of Hatch) and generally diminished property values.

It is possible that some local initiatives would likely be focused on the engineering reliability measures, such as, minor improvements of local drainages or small detention basins. However, full implementation of the measures as described would not be possible with local budgets alone. This would mean a significant long-term residual risk.

3.6.2 Earthen Detention Basin and Warning System.

As mentioned in Section 3.5, a flood warning system and emergency preparedness are both measures that were retained, however, they would be considered in combination with the earthen embankment structures. The emergency preparedness plan is developed and implemented by the local floodplain managers. The flood warning system is a way to trigger the action plan to respond to an impending flood to reduce life safety risk. The earthen dam could be instrumented to warn emergency responders in Hatch of the water levels being captured behind the dam.

Responders and floodplain managers would be able to monitor the flood event and in the case of exceedance of the reservoir capacity, would activate the emergency preparedness plan. Four alternatives were developed around an earthen dam of four distinct sizes.

3.6.2.1 Determination of Alternative Dam Sizes

The last step in evaluating the earthen storage/detention basin alternative is determining the appropriate size of detention structure. The following sections describe the evaluation of different sizes of dams using the project objectives, and Federal criteria for determining the recommended plan.

The four dam sizes evaluated are essentially the same structure design with changes made to the height of the structure to protect against different frequency flood events. This means that the dam sizes analyzed vary mainly in the amount of excavated and fill material needed to build each of the structures (Table 9). The spillway size for all dams would be designed to pass the probable maximum flood per Federal and state dam safety regulations. Therefore, the spillways for each size dam are the same width and only differ slightly in the amount of slope requiring protection with each structure height. Other features of the project such as the inlet, diversion channel, utility removals and relocations and outlet structure do not vary between the different sized dams.

Earthen material used for the dam fill is assumed to come from the excavation of the retention basin immediately upstream of the alignment of the earthen embankment. The material to be excavated is assumed suitable material for dam construction. The intention in the design is to balance the cut and fill for the project, however, an estimated 10% of the excavated material would be unsuitable for placement in the embankment dam (large rocks, organic material). Unsuitable material will be disposed of offsite at an approved facility. The estimate assumes there would not be a significant amount of borrow needed or waste to be disposed of offsite. Detailed comparison of the dam sizes consisted of analyzing the cost of each dam compared to the performance or damages prevented. Each dam size will address floods associated with different design flood frequencies described as follows:

- Dam A is sized to address the 4% chance exceedance event.
- Dam B is sized to address the 1% chance exceedance event.
- Dam C is sized to address the 0.2% chance exceedance event.
- Dam D is sized to contain flows greater than the 0.2% chance exceedance event.

The following features are common to all dam alternatives:

- Earthen embankment.
- Roller compacted concrete spillway.
- Utility removals and relocations.
- Concrete outlet structure.
- Excavation of approximately 50 ac in the dam retention basin area.
- Same location of staging area and access roads.
- Same future operation & maintenance activities.

Table 9 Quantities of variaous materials for each of the dam sizes.

Item	Dam A	Dam B	Dam C	Spring Canyon Channel
DAM				
Random Fill (General)	65,919.8	71,699.4	99,435.1	2,468.6
Random Fill (Key Trench)	11,122.5	11,275.3	11,816.7	
Random Fill (SC Key)	6,347.0	6,485.0	6,756.2	
Semi-Imp Fill	10,901.0	11,364.8	14,719.4	
Gravel Material (6" thick)	2,201.5	2,228.4	2,713.2	
Soil Cement (SC)	18,939.5	19,377.1	22,552.9	4,725.0
RCC	1,972.0	2,144.9	2,730.4	605.0
Rip Rap (2' thick)				1,302.4
Bedding Material (6" thick)				351.0
Concrete Box Culvert (CBC)				126.7
Filter Fabric (sq. yards)				2,355.9
Dam-Channel Exc (general)	10,578.3	10,808.4	11,260.3	11,460.2
Dam Excav. (Key Trench)	11,122.5	11,275.3	11,816.7	
Reservoir Exc. (RE) (Model)	158,422.4	156,178.1	149,407.7	
Reservoir Fill	524.4	490.6	1,698.0	
Clear & Grubb (part of RE)	9,000.0	9,000.0	9,000.0	
Extra Reservoir Storage Above Design Cap (acre-feet)	3.8	13.8	22.1	
Extra Reservoir Stor. Above Design Cap (cubic yards)	6,130.7	22,264.0	35,654.7	
Reservoir Exc. (Design Cap)	152,291.7	133,914.1	113,753.0	
Fill between Rodey Lateral and Dam	9,898.5	8,605.8	8,378.8	

Spillway crest elevations were determined using a HEC-HMS model. Initially only three dam heights were evaluated. The Dam D was developed to determine if a larger dam would be more efficient. The 4%, 1%, and 0.2% chance exceedance events were routed through the proposed dam. The spillway crest elevation was set equal to the maximum computed water surface elevation for the three floods. The PMF discharge of the spillway is 8300 cfs. The discharge versus stage relationship (rating table) for the PMF Spillway (Dam C elevation = 4067.7 feet) is shown in Table 10.

Table 10 Probable maximum flood spillway rating table.

Water Surface Elevation (feet)	4067.7	4069	4070	4071	4072.1	4073	4075.1
Discharge (cfs)	0	1364	3210	5518	8495	11231	18530

All earthen dams analyzed had a semi-impervious core with random fill outer shell. Each dam embankment would have the same alignment and therefore the same foundation properties. The overflow spillway for each alternative would be constructed of roller compacted concrete with reinforced training walls. A wire-wrapped riprap stilling basin would be placed at the downstream toe. An outlet would be provided by a cast in place concrete conduit with a removable flow reducer. The intake tower would be reinforced concrete with horizontal metal trash racks. It could be uncontrolled or gated. Random borrow material would be used in the embankment varying between 117,744 cubic yards and 181,786 cubic yards depending on the height. The volume of concrete calculated for the construction of structures varies between 2,300 cubic yards and 3000 cubic yards. Each structure would require approximately 4,000 cubic yards of wire-wrapped riprap. Semi-impervious material is available on site. Subsurface investigations, sampling in the proposed retention basin upstream of the dam location, classified the material as suitable for use as a semi-impervious material.

Since the detention basin is adjacent but not on Spring Canyon arroyo, a diversion channel would bring flood flows into the detentions basin. Flows in excess of the design event would be excluded from entering the basin and would continue to flow down Spring Canyon Arroyo into the valley including the Village of Hatch.

The dimensions of the diversion channel are sized to accommodate the design flood event of each dam size respectively. Hydraulic dimensions for the 4%, the 1%, and the 0.2% chance exceedance events trapezoidal channels were determined using the HEC-RAS model. Culverts integrated into the diversion channel would at as restrictions only allowing the design flows in to the basin. For instance the 0.2% chance exceedance event channel has a design discharge of 870 cfs. Any flow larger than this would be excluded from entering the basin. See further discussion in Section 3.8.8.1 and Figure 22.

3.6.3 Borrow and Disposal Sites

Earthen material (borrow) needed for any of the dam alternatives would come from the excavation of the retention basin immediately upstream of the alignment of the earthen embankment. The material to be excavated is assumed suitable material for dam construction. The intention in the design is to balance the cut and fill for the project, so the estimate assumes there would not be a significant amount of borrow needed or waste to be disposed of offsite. However, if there is any waste, it would be taken to an offsite, preapproved area.

3.6.4 Access Roads and Staging Areas

Only existing roads would be used for access (See Appendix F). Tepache Road terminates at the entrance of the proposed project site. One staging area has been identified for the proposed project construction. It is located within the retention basin immediately upstream of the alignment of the earthen embankment.

3.6.5 Operation and Maintenance

Future Operation and Maintenance (O&M) activities would include the following: vegetation removal from the dam slope and vegetation free zone (ETL 1110-2-583), replacement of stone protection (rip-rap) on the dam slope, and the removal of sediment needed to maintain retention capability.

3.7 Economic Analysis

Project construction costs were used to compare all dam sizes except Dam D. Once Dams A through C were developed Dam D was developed to determine if a larger dam would be more efficient. Although full costs were not developed for Dam D, it was determined that Dam D would not be economically feasible for the following reasons:

- Costs for Dam C used the existing borrow from its retention basin for dam construction material. Dam D would require the purchase and transport of additional material beyond what could be obtained from the proposed retention basin.
- Costs, such as real estate and mitigation costs increase substantially as Dam D’s footprint increases above that of Dam C.
- Dam C captures over 79% of Equivalent Annual Damages (EAD) and most of the remaining damages are from the uncontrolled portion of the watershed downstream of the dam site. Additional costs for a larger dam are expected to increase substantially faster than the remaining benefits.

3.7.1 Average Annual Cost

Table 11 shows costs for the three alternative dam sizes A-C. The period of construction is assumed to be 12 months with equal mid-monthly payments and no project benefits until the project phase is complete. All three dam sizes are expected to be completed within a year; therefore no interest during construction was calculated.

Preliminary costs presented in Table 11 were used to compare the alternative dam sizes to each other. Further refinement of the cost for the recommended plan are shown in Table 16. The Federal interest rate of 2.75% (FY 2018) was used to further refine the cost of the selected plan.

3.7.2 Average Annual Benefits

Equivalent annual residual damage and benefit computations for the flood control alternatives considered are depicted in Tables B-8A – B-8C of the Economics Appendix. Table B-10 of the Economics Appendix shows the expected net benefits to structures and contents. Benefit determination for the post project condition was computed by changing the event-flow relationship to remove damaging flows from lesser magnitude events. Table B-11 of the Economics Appendix shows the expected B/C ratio for the proposed alternatives.

3.7.3 Benefit-Cost Comparisons and Plan Selection

Table 11displays annualized equivalent annual benefit and cost information, discounting future benefits of flood control (which remains the same due to unchanging hydrology and hydraulic conditions, and economic growth assumptions) and amortizing those benefits over the project life.

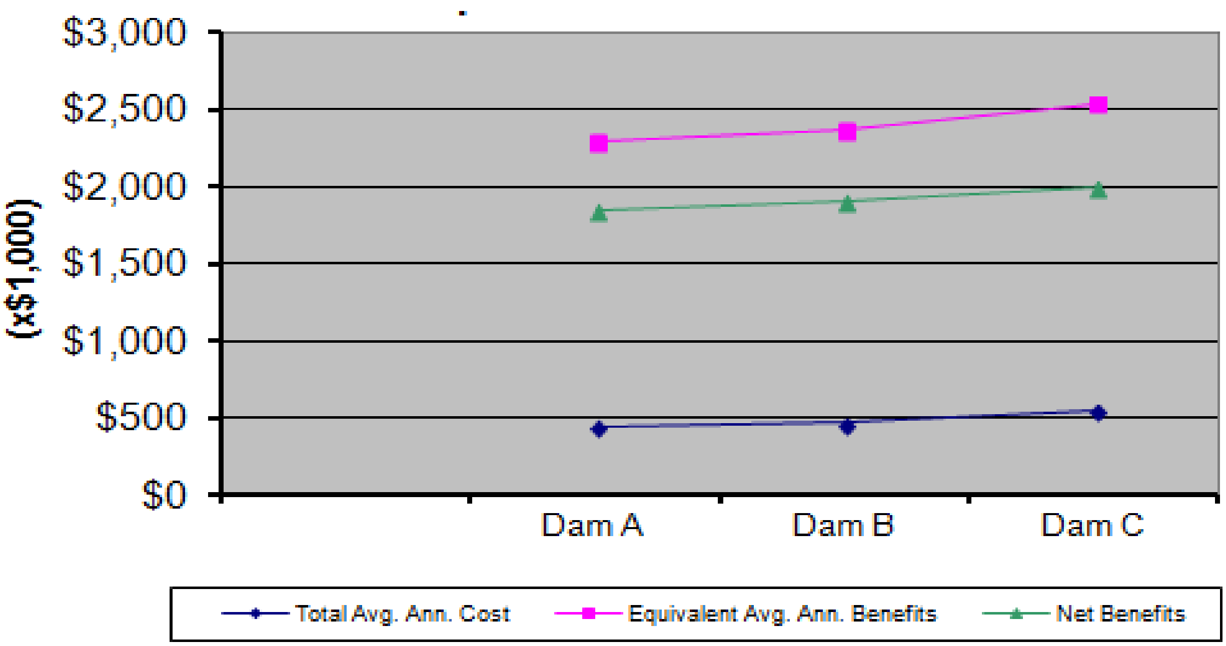
Table 11 Comparison of costs and equivalent annual damages by dam size.

Comparison of Costs and Equivalent Annual Benefits for Alternatives Aug 2014 price levels @ 3.5% interest rate			
(X $1,000)	Dam A	Dam B	Dam C
Construction Cost	$ 8,494	$ 8,344	$ 9,111
Env Mitigation	$ -	$ -	$ -
Real Estate	$ 350	$ 350	$ 350
PED	$ 901	$ 901	$ 901
Total First Cost	$ 10,046	$ 9,895	$ 10,662
IDC, Construction	$ -	$ -	$ -
Total Investment	$ 10,046	$ 9,895	$ 10,662
Avg. Ann. Cost	$ 428	$ 422	$ 455
OMRR&R	$ 23	$ 23	$ 23
Total Avg. Ann. Cost	$ 451	$ 444	$ 477
Equivalent Avg. Ann. Benefits	$ 2,192	$ 2,273	$ 2,432
Benefit/Cost Ratio	4.9	5.1	5.1
Net Benefits	$ 1,741	$ 1,829	$ 1,955

*OMRR&R = operation, maintenance, repair, replacement, and rehabilitation.

Estimates in Table 11 used to compare alternatives differ from the cost shown for the recommended plan in the narrative and in Table 12. The costs shown in Table 12 and presented in the narrative are a result of refined design and updated to Oct. 2019 price levels.

Table 11 shows the benefits and costs for the three dam alternatives considered. Dam A is slightly more expensive than Dam B because it will require disposal of excess material excavated from the reservoir pool. The plan that maximizes net benefits is Dam C. With refinement of the design and cost estimates, the current benefit/cost ratio is 4.8, first cost of $12,735,000 resulting in $1,925,840 in net benefits (Oct 2018 price level). Figure 16 below, displays the optimization curve for Dams A-C. The graph shows that both benefits and costs continue to rise with larger dams. As discussed earlier, a larger dam was evaluated (Dam D) to determine if it would be more efficient. Dam D would not be economically feasible due to additional costs for importing soil for dam construction, mitigation for increased dam footprint and a lack of remaining benefits to offset increases in cost.



Due to the fact that Dam C is the NED plan and coincidently the largest dam analyzed, developed one larger sized dam (D). It was determined that the larger Dam D would not be economically feasible since expected to increase substantially faster than the remaining benefit.

Figure 16 Optimization curve for Dams A-C.

From the information in Table 11 it can be concluded that the alternative that maximized net benefits (NED plan) is Dam C. Implementation costs for this option have been computed using the Micro-Computer Aided Cost Estimating System format and are included with this report in Appendix K - Cost Engineering. The NED plan meets the established planning objectives for the study area, and further Federal involvement is warranted. Please refer to Appendix B - Economics for further details on how the NED analysis was conducted.

3.7.4 System of Accounts Evaluation

As stated in Section 3.7.4, the four accounts used to compare proposed water resource development plans are the National Economic Development (NED), Environmental Quality (EQ), Regional Economic Development (RED), and other social effects (OSE) accounts. These accounts are discussed below.

3.7.4.1 National Economic Development (NED)

Because the purpose of this study is to reduce risk of flooding, the plan formulation and selection process for this reevaluation study is primarily driven by NED plan selection criteria. As shown, the alternative plan that maximizes net benefits is Dam C. Implementation of each dam alternative has an economic benefit to the nation as described in Table 11.

3.7.4.2 Environmental Quality (EQ)

The EQ account is another means of evaluating the alternatives to assist in making a plan recommendation. The EQ account is intended to display the long-term effects that the alternative plans may have on significant environmental resources. Significant environmental resources are defined by the U.S. Water Resources Council (USWRC) as those components of the ecological, cultural, and aesthetic environments, which, if affected by the alternative plans, could have a material bearing on the decision-making process. The final array of alternatives were formulated to avoid or minimize negative impacts to the environment while meeting the goals of reducing flood risk to the community of Hatch. Section 4 provides a detailed discussion of impacts to environmental resources.

3.7.4.3 Regional Economic Development (RED)

The RED account is intended to illustrate the effects that the proposed plans would have on regional economic activity, specifically regional income and regional employment.

Any proposed Federal project would benefit the local and regional economy though employment and purchase of materials such as riprap, bentonite and fuel for construction equipment during the period of construction. The increased construction-related employment would have a corresponding beneficial effect on the local economy. Increases would tend to be focused in lower specialization sector. The regional benefit would be proportional to the size or cost of the alternative project.

3.7.4.4 Other Social Effects (OSE)

The OSE account typically includes long-term community impacts in the areas of public facilities and services, transportation and traffic, and man-made and natural resources.

The existing floodplain includes a large portion of Hatch. In the event of a flood, warning times would not be sufficient for effective evacuation of residences and businesses, flood velocities are not expected to be sufficient to dislodge vehicles using local roads; however, flood depth in portions of the floodplain would be very hazardous. Most flood fatalities occur in vehicles moving through the floodplain.
(http://www.nws.noaa.gov/oh/hic/flood_stats/recent_individual_deaths.shtml, accessed 4/5/12).

Each of the dam alternatives reduces the impacts from flooding to the study area at varying degrees. Each alternative would contribute to the OSE account through a reduced life safety risk. Since net economic benefits are derived from a reduction of flood depth or extent to residences and buildings in the floodplain, reductions in life safety could be proportionately similar relative to each alternative.

3.8 *Description of the Recommended Alternative

Dam C is the recommended alternative and represents the NED plan (Figure 16). Dam C is sized for a 0.2% chance exceedance event which would detain a storage capacity of 283 AF. This storage capacity consists of a 30 AF sediment pool and up to 253 AF of water with flows being routed through Dam C at a maximum discharge rate of 300 cfs. The majority of the random fill material needed for the construction of the Dam C would come from borrow located within the dam's retention basin. New grades within the dam's retention basin area have a low point (approximate elevation 4053) adjacent to the outlet works intake tower and slope upward (at approximately 1%) into the retention basin in a radial fashion for a distance of approximately 900 feet. Some select fill material would have to be trucked in to accommodate project construction. It is estimated that approximately 2 to 21% of the fill needed to construct this project would be imported from commercial quarries or gravel mining pits nearby. The maximum height of embankment for Dam C is 22.6 feet and the dam includes a roller compacted concrete spillway and concrete outlet works with gate and tower. Dam C is approximately 4,191 feet in length.

Access roads would be required on both sides of the dam and ramps also would be constructed to access the top of the dam. Fencing would enclose the retention basin and gates would be provided as needed for access to the dam. A new trapezoidal channel would transport runoff from nearby Spring Canyon into the retention basin of Dam C. A new storm drain line would be provided to collect and remove standing water located outside the proposed dam area. The proposed project area, including the dam site and retention basin, access roads and staging area is approximately 61 ac (Figure 18). Drawings illustrating the Dam C project features are included as Exhibit A in Appendix J – General Engineering and in Appendix L – Structural Engineering, and the features are described in Table 13.

3.8.1 General Project Features

The proposed embankment dam and appurtenant structures (i.e., spillway, outlet works, and diversion structure) consist of a rolled, zoned earth fill dam; a notched, stepped, trapezoidal roller compacted concrete overflow emergency spillway; a gated outlet works intake structure with trash rack; a 3 x 5-foot reinforced concrete conduit; and a trapezoidal roller compacted concrete and soil cement diversion channel with two 5 x 9-foot box culverts through the dam.

Table 12 shows the recommended plan after refinement of the cost estimate and updated to October 2018 price levels. This differs slightly from the cost shown in Table 11 due to refinement of costs for the recommended plan and escalation to current year price levels.

Table 12 Refined cost estimate for recommended plan

Current Dam C –Cost Oct 2019 price levels and @ 2.875% interest rate ($1,000)	
Construction Cost	$10,323
Environmental Mitigation	$ -
Real Estate	$693
PED	$1,094
Construction Management	$625
Total Project First Cost	$12,735
Avg. Ann. Cost	$483
OMRR&R	$23
Total Avg. Ann. Cost	$506
Equivalent Avg. Ann. Benefits	$2,432
Benefit/Cost Ratio	4.8
Net Benefits	$1,926

3.8.2 Embankment Dam Design

The proposed dam consists of a rolled, zoned earthfill embankment structure having a 20-foot wide dam crest, a length of 4,191 feet, a maximum height of 22.6 feet, and 1V on 3H upstream and downstream slopes . The zoned earth fill dam consists of upstream and downstream random fill shells for structural stability; a central semi-impervious core; a 5-foot deep by 10-foot wide trapezoidal semi-impervious partial cutoff trench (inspection trench); a downstream toe drain provided for seepage control (reduce seepage gradients); a 3-foot thick downstream horizontal drainage blanket (provided as an internal filter zone for positive seepage control); and a 9.5-foot wide upstream soil cement cap and a 6-inch thick downstream gravel layer provided on the upstream slope and downstream slope, respectively, for erosion protection. Typical cross sections of the proposed dam are shown on the drawings in Appendix J, Exhibit A – Dam Feasibility Drawings.

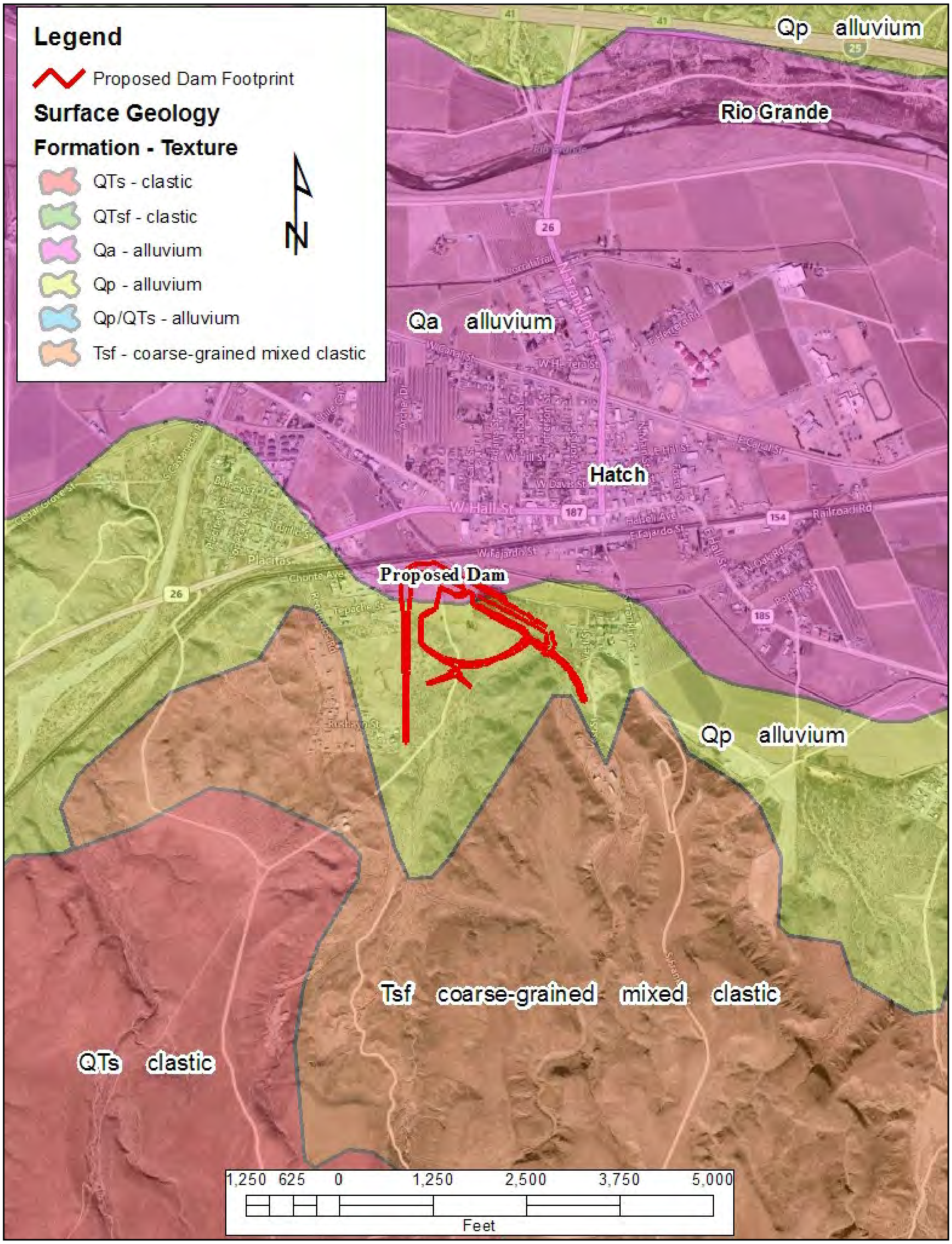


Figure 17 Surface geology for the project area.

Source: USGS Open-File Report 2005-1351 (digital Data Map, 2007)

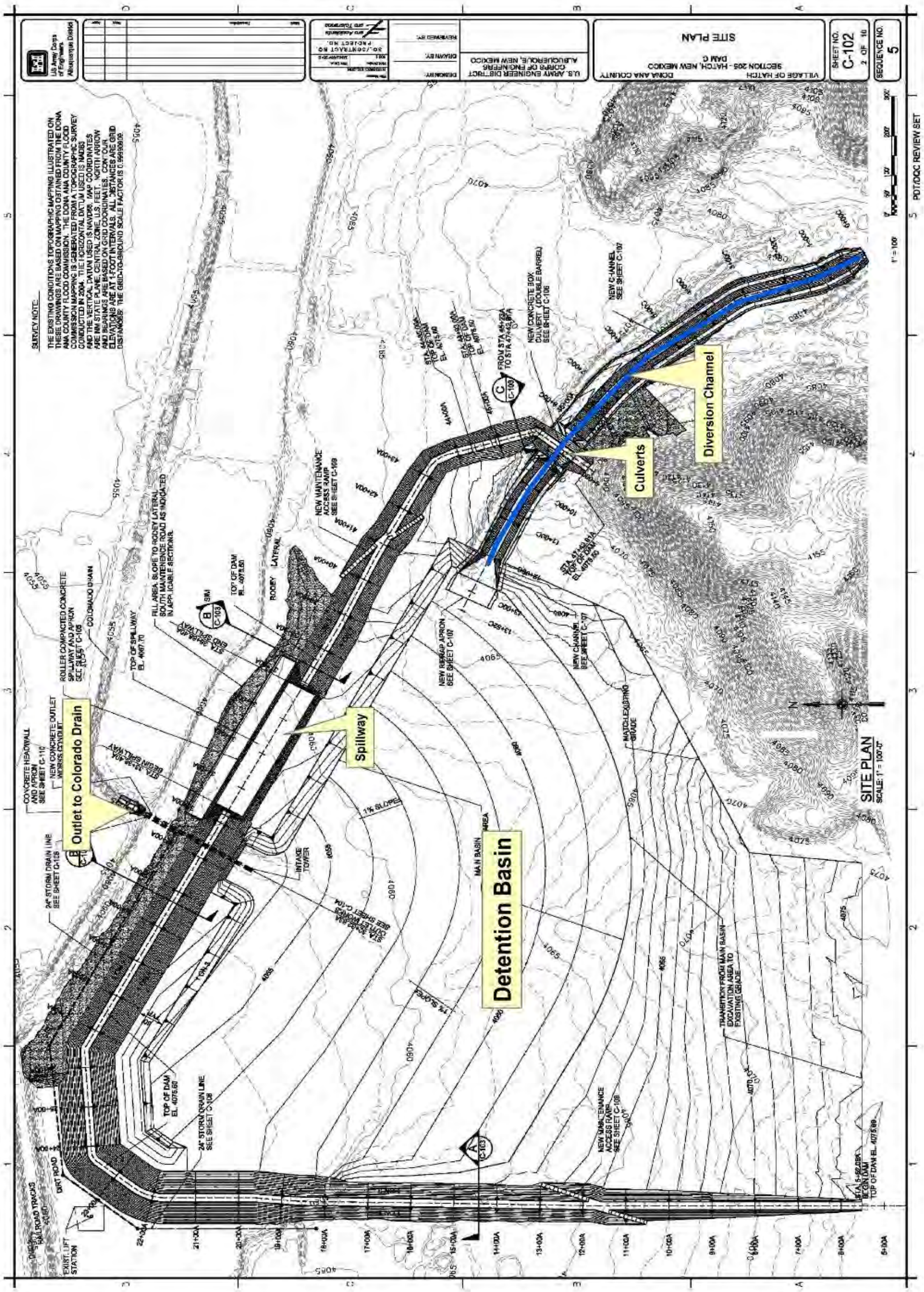


Figure 18 Site plan for the recommended plan.

Table 13 Summary of characteristics of Dam C.

Dam C Features	
Spillway	
Maximum capacity at spillway crest	283 AF (456,573 cu yd)
Spillway Cross Section	Trapezoidal
Construction	Roller Compacted Concrete
Spillway Length (parallel to dam alignment)	350 feet
Spillway Crest Width (perpendicular to dam alignment)	74 feet
Spillway Width (including downstream apron)	111.9 feet
Spillway crest elevation	4,067.7
Embankments	
Length of Dam Embankment	4,191 feet
Embankment Crest Width	20 feet
Side Slopes – Exterior Embankment Slopes	3H:1V
Maximum Height of Embankment	22.6 feet
Maximum Width of Dam at Base	147 feet
Typical Top of Dam Elevation (top of 6 inch soil cement cap)	4,075.60 feet
Toe of Dam Elevation	Varies
Sediment Pool Capacity	30 AF
Water Pool Capacity	253 AF
Random Fill Volume For Dam Embankment	118,008 cu yd
Semi-Impervious Fill Volume For Dam Embankment	14,720 cu yd
Soil Cement Fill Volume For Dam Embankment	22,553 cu yd
RCC Fill Volume (at spillway)	2,731 cu yd
Gravel Slope Protection Fill Volume For Dam Embankment	2,714 cu yd
Excavation Volume For Dam Embankment	23,077 cu yd
Outlet Works	
Outlet Conduit Size (average outside dimensions)	5.0 x 8.0 foot
Outlet Conduit Size (inside dimensions)	3.0 x 5.0 foot
Intake Tower Rim Elevation	4,064.0 feet
Intake Tower Invert Elevation	4,053.0 feet
Conduit Length	306.9 feet
Gatewell Structure Conduit Size (at gate)	3.0 x 7.0 foot
Excavation Volume For Dam Outlet Works	3,218 cu yd
Random Fill Volume For Dam Outlet Works	1,086 cu yd

Table 12 continued

Channel (at Spring Canyon)	
Length of Channel (including portion within dam)	1,319 feet
Channel Bottom Width (upstream of dam)	10 feet
Channel Bottom Width (downstream of dam)	20 feet
Top of Channel Width	Varies
Channel Side Slopes - Cut Slopes	3H:1V
Riprap Apron Dimension (at downstream of channel within dam)	100’W x 50’L
Design Channel Capacity (minimum)	870 cfs
Random Fill Volume For Channel Section	2,469 cu yd
Soil Cement Fill Volume For Channel Section	4,725 cu yd
RCC Fill Volume For Channel Section (at upstream end)	605 cu yd
Riprap Fill Volume for Channel Section (at downstream end and at apron)	1, 303 cu yd
Excavation Volume For Channel	11,461 cu yd
Fill Area Between Rodey Lateral and Dam	
Fill Area Volume	8,379 cu yd
Retention basin Grading	
Excavation Volume For Dam Retention Basin (at 283 AF storage)	113,753 cu yd
Maximum Excavation Volume For Dam Retention Basin (at 305 AF storage)	149,408 cu yd
Random Fill Volume For Dam Retention Basin	1,698 cu yd
Storm Drain Line	
Length Of Storm Drain Line	1,684 feet
Storm Drain Line Pipe Diameter	24 in
Number Of Manholes/Inlets	6
Excavation Volume For Storm Drain Line	4,440 cu yd
Random Fill Volume For Storm Drain Line	4,240 cu yd

3.8.3 Construction Materials

Suitable materials required for construction of the upstream and downstream random fill shells of the earth fill embankment and semi-impervious fill material for the core and inspection trench should be available from the retention basin borrow area and required foundation excavation. Filter materials for the downstream drainage blanket, toe drain, and aggregates for soil cement and roller compacted concrete are anticipated to be obtained from local commercial sources. Random fill and semi-impervious fill embankment materials will consist of fine and coarse grained materials from the retention basin borrow area and required excavations (See Appendix F).

3.8.4 Description of Site

The dam axis is an earthen embankment structure in the shape of a horseshoe and is situated at the west end of Spring Canyon located southwest of Hatch, NM. An inlet structure located in Spring Canyon proper will divert water to the dam via a 1,319 feet long concrete lined channel. The left abutment of the earthen embankment structure is founded upon fat and lean clays with some layers of silty sands, underlain primarily by poorly graded sands (See Appendix F). The right abutment of the earthen embankment structure intercepts high ground on the west side of Spring Canyon and is founded upon similar materials as the left abutment.

3.8.5 Subsurface Investigation

An exploration characterized the foundation materials in the general area of the proposed flood control structure. This investigation included drilling 16 soil borings, visual logging of retrieved soil/rock, sampling and laboratory testing of representative soil. The preliminary drilling indicates that the general area of the proposed dam site location is predominately underlain by silty sands, poorly graded sands, and fat clays with sand. Groundwater was encountered during drilling from 5 to 15 feet below ground surface. The locations and spacing of the borings drilled were performed to get a general idea of subsurface soil conditions and were not ideal for design purposes.

The 2011 subsurface exploration included 16 drilling locations. Seven locations are within the general footprint of the proposed dam, six locations are in the proposed borrow location, and three locations are located near the toe of the proposed dam. Depth of drilling varied from 10 feet to 40 feet. Samples were collected in accordance with ASTM D-1589, with an 2-foot split spoon sampler, at 2.5 foot intervals from 0 to 20 feet below the ground surface. At 20 feet the sampling interval was every 5 feet thereafter. Samples were visually logged and sent to a laboratory for testing grain size distribution, Atterberg limits, and hydraulic conductivity. Test results are located in the Geotechnical Appendix (Appendix F).

The depth of the drilling corresponds to approximately two times the height of the embankment for the locations within the proposed dam. Drilling in the proposed borrow area indicates there is enough suitable material for embankment construction prior to encountering the water table or unsuitable material. An analysis of the drilling data using Groundwater Modeling System (version 7.1) is presented in Appendix F of this report. The future without-project conditions would remain unchanged and have no effect on subsurface soils.

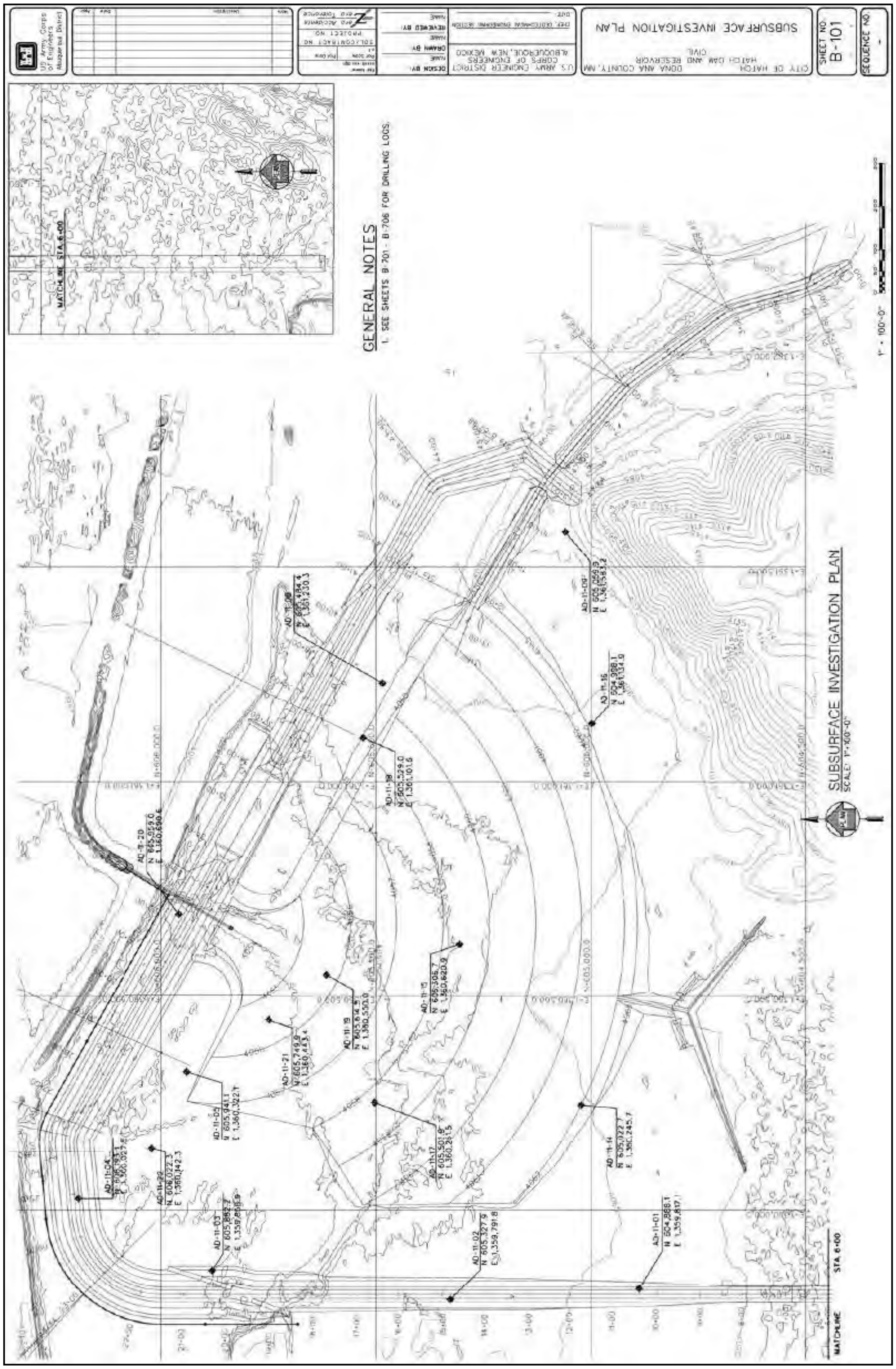


Figure 19 Map of 2011 subsurface investigation borehole locations.

3.8.6 Hydrologic Analysis

The purpose of the hydrologic analysis is to determine new peak discharge frequency relationships and design hydrographs for the Spring Canyon drainage area. This study establishes peak discharge frequency and flood hydrographs for eight events (50%, 20%, 10%, 4%, 2%, 1%, 0.5%, and 0.2% exceedance frequency events) specifically for future conditions with the proposed dam in place for Spring Canyon.

Development is not anticipated in the Spring Canyon watershed; consequently, future condition hydrology upstream of the proposed dam is the same as the existing condition hydrology. Probable maximum flood (PMF) hydrographs were also developed for the purposes of dam safety design and are discussed below in Section 3.8.7.

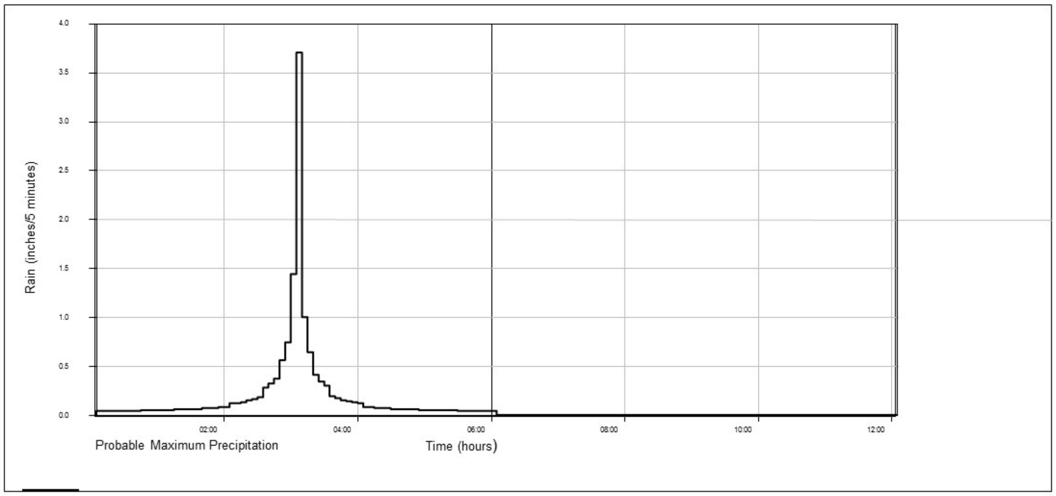
3.8.7 Development of the Probable Maximum Flood (PMF)

The PMF was developed for Dam C for purposes of ensuring compliance with dam safety laws and regulation. The probable maximum precipitation (PMP) was developed using the guidance in *HMR 55A - PMP Estimates between the Continental Divide and the 103rd Meridian*, NOAA (June 1988). Total rain for the watershed is 14.47 inches for a six hour storm. The hyetograph is shown in Figure 20. Both the existing Spring Canyon Dam and proposed Dam C were assumed full to spillway crest at the start of the PMF and the low level outlet was assumed plugged.

Spillway Capacity

Dam C is located on the flow path of the smaller sub-watershed V shown in Figure 22. All flows from this watershed are captured in the detention basin. The diversion channel leading from the Spring Canyon arroyo was configured to divert the entire 0.2% chance exceedance event into the detention basin but exclude larger flows. The diversion channel passes through an earthen berm via two 9 x 5-foot culverts to prevent most of the PMF from entering the basin. Figure 21 shows the portion of the PMF at the Spring Canyon diversion channel that will bypass the diversion channel and not enter the detention basin. Due to the depth of the PMF and the freeboard for the diversion channel, the peak discharge of the PMF that enters the retention basin through the two 9 x 5-foot culverts is larger than the 0.2% exceedance event flow. The excess flow from Spring Canyon as well as the PMF from sub basin V pass over the dam through the emergency spillway. The peak discharge of the PMF upstream of the diversion channel is 26,700 cfs. Of this, 25,200 cfs is diverted away from Dam C. See inflow distribution from Spring Canyon into Dam C (Figure 22 and Figure 23). The downstream face of the right abutment will be treated with soil cement revetment to protect the embankment from erosion. The top of the right abutment will be elevated to prevent overtopping of the embankment by the Spring Canyon PMF.

Because there are uncontrolled drainage areas that are directly tributary to the retention basin of Dam C, a PMF spillway is still necessary.



Values are rainfall in inches per five minute period.

Figure 20 Hyetograph of the probable maximum precipitation

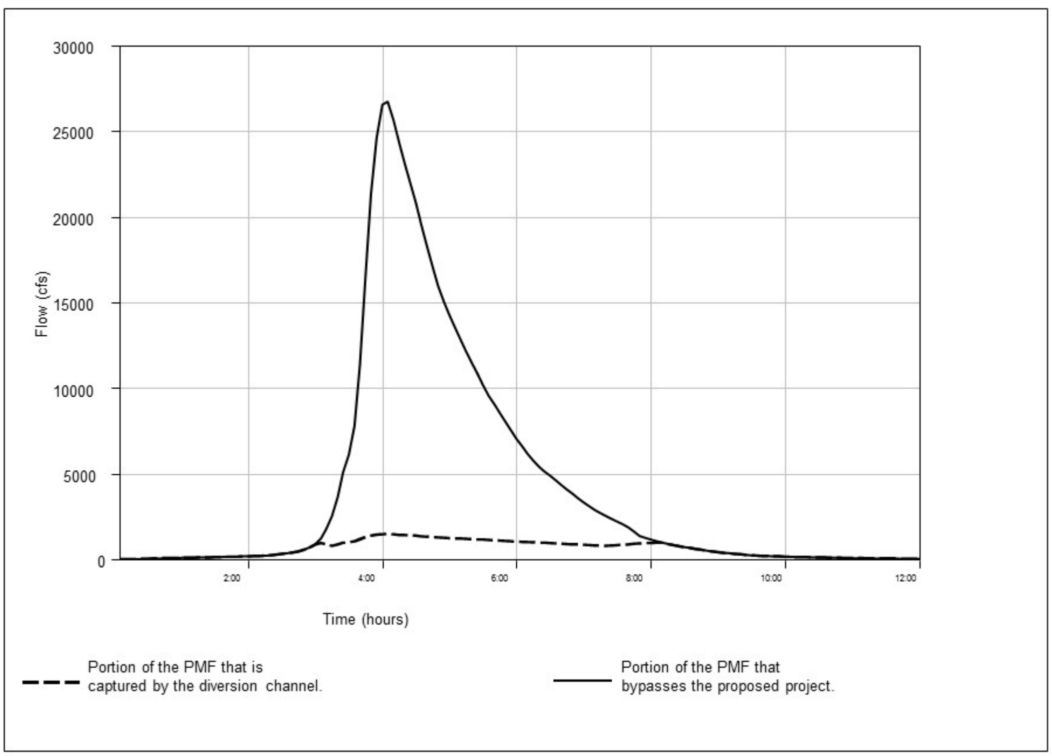


Figure 21 Probable maximum flood hydrographs at Spring Canyon diversion channel

Hydraulic Design

3.8.7.1 Hydraulic Design of the Diversion Channel

Flood flows from Spring Canyon will be diverted into the retention basin by an entrenched diversion channel. An existing training dike will be removed and replaced with the diversion channel. Figure 22 shows the flow distribution of the 0.2% exceedance (500-year frequency) event through the watershed. The 0.2% chance exceedance event channel has a design discharge of 870 cfs with a channel slope of 0.0117 feet. It has an average bottom width of 10 feet and an average depth of 5.5 feet. The channel will be lined with roller compacted concrete transitioning to soil cement and rip-rap with side slopes of 1 vertical to 3 horizontal (1:3 slope).

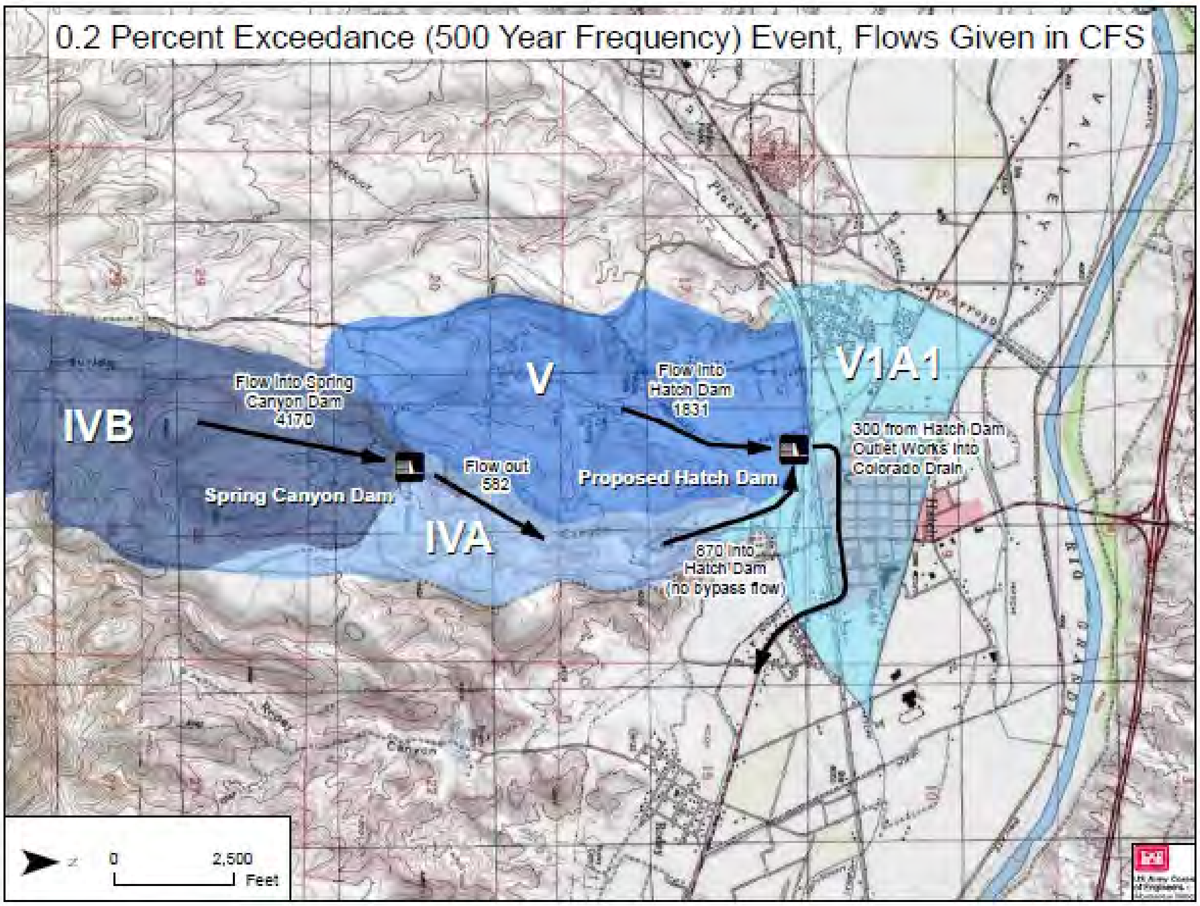


Figure 22 Flow distribution for the 0.2% chance exceedance event.

3.8.7.2 Hydraulic Design of the Spring Canyon Inlet

The Spring Canyon diversion channel was designed to divert the selected frequency flood into the retention basin area. Flow in excess of the design frequency, including the PMF, will continue down Spring Canyon and not be completely diverted into the retention basin.

Since significant cost savings would be realized if the size of the spillway for Dam C could be reduced, measures were taken to prevent most of the PMF from getting into the retention basin. The east, or right abutment of the proposed dam was extended across the downstream end of the diversion channel, and the diversion was extended into the retention basin through two 5 x 9-foot box culverts.

This has the effect of diverting the 0.2% exceedance event into the retention basin, but preventing most of the PMF from getting into the retention basin. The downstream face of the right abutment will be treated with soil cement revetment to protect the embankment from erosion. The top of the right abutment will be elevated to prevent overtopping of the embankment by the Spring Canyon PMF. The Spring Canyon PMF water surface elevations and velocities were determined using a HEC-RAS model (Figure 23).

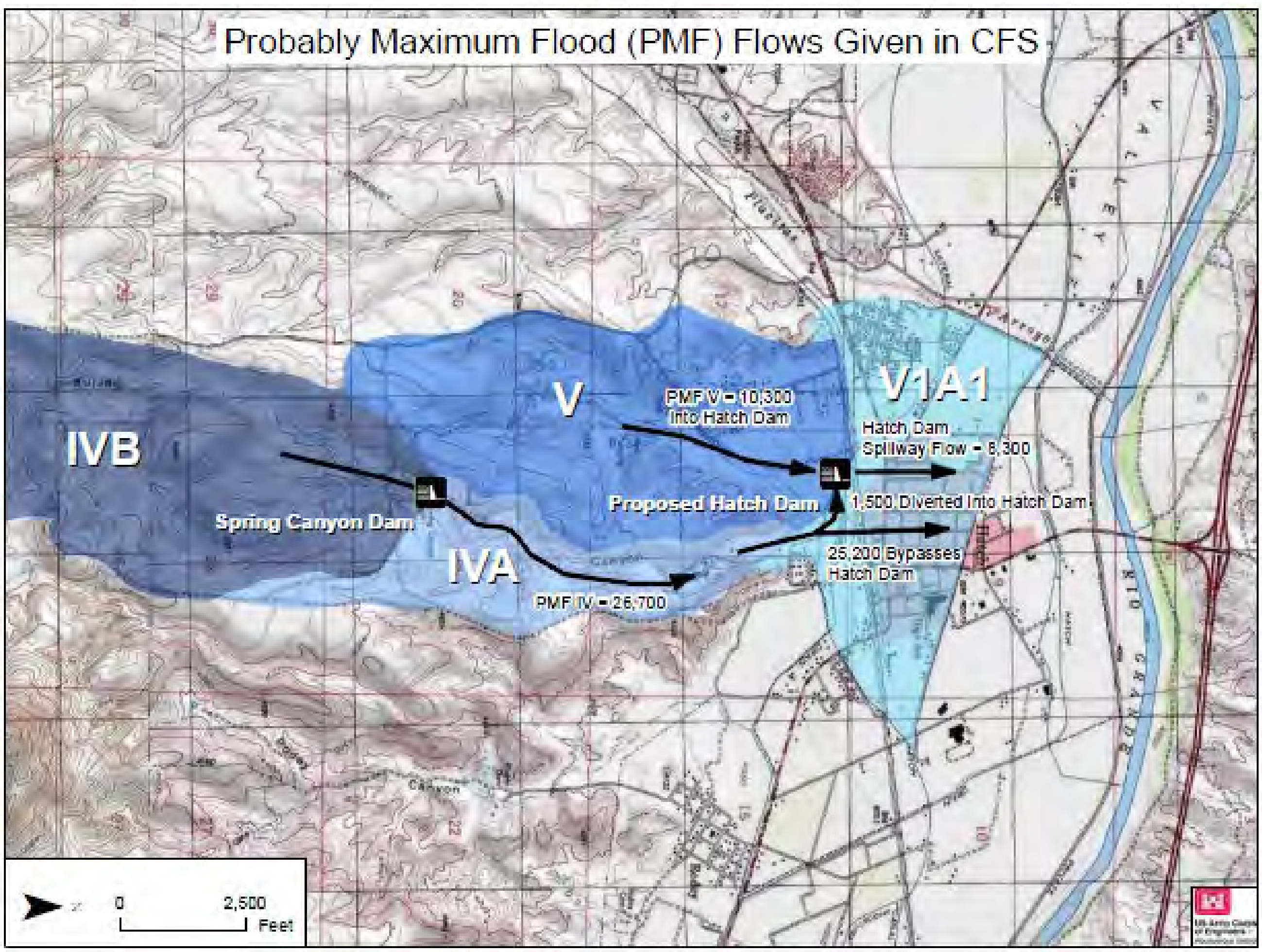


Figure 23 Flow distribution for the PMF event.

3.8.7.3 Colorado Drain Capacity

The capacity of Colorado Drain was determined with the application of a HEC-RAS model. Hydraulic dimensions and elevations of the drain were surveyed by the Doña Ana County Flood

Commission. The entire 3.7 miles was modeled, from the Rio Grande levee gates to the upstream crossing of Rodey Lateral.

The model showed that there are currently several crossing structures that restrict flow in the Colorado Drain between the project and the outfall to the Rio Grande to less than the 300 cfs channel capacity of the Colorado Drain. Within the Village of Hatch there is only one crossing that restricts flow to less than 300 cfs. This is a second crossing of the Rodey Lateral, which limits the flow allowed to exit Hatch to 250 cfs without overtopping the channel. At this location, the Colorado Drain crosses under the Rodey Lateral in a 4 foot high by 6 foot wide reinforced concrete box. These capacity issues associated with the Colorado Drain were identified early in the project scoping process and have been discussed with the sponsor, Village of Hatch and EBID, which operates and maintains the Colorado Drain. They have expressed a desire to work together toward resolving the Colorado Drain capacity issues. The capacity of the Colorado Drain continues to be a limiting factor; however, the outlet capacity of Dam C allows for controlled flows, as discussed below.

3.8.7.4 Determination of Outlet Capacity

The outlet capacity of Dam C was limited to 300 cfs prior to overtopping the spillway. Dam C will include an intake tower and gated outlet that will provide flexibility to operate and maintain the facility and would not exacerbate the capacity limitations of Colorado Drain. The flow rate could be reduced to limit the discharges to available downstream capacity of the Colorado Drain until the Sponsor and stakeholders resolve the capacity issues. The outlet rating table was calculated using the orifice equation and modeled in HEC-HMS using an opening of 15 ft^2. Since the proposed dam embankment is located just upstream of Rodey Lateral, the outlet must pass under Rodey Lateral to convey flood waters to Colorado Drain. This constrains the elevation and dimensions of the outlet.

3.8.7.5 Hydraulic Design of the Spillway

The spillway is trapezoidal in cross section with 3:1 side slopes. The approach and downstream chute were modeled with 3:1 slopes also. The stage-discharge relationship of the spillway was determined using the weir equation. Various depths of flow were calculated to determine the spillway rating table with the Dam C weir length of 350 feet and using a weir coefficient of 2.63. The computed stage-discharge relationship was then used to determine top of dam elevations as explained below.

3.8.7.6 Determination of Top of Dam Elevations

Top of dam elevations for the three alternatives were determined by adding three feet of freeboard to the calculated water surface elevations of the PMF flow over the spillways using the weir equation as described in the previous section.

Both the existing Spring Canyon Dam and the proposed projects were assumed full to spillway crest at the start of the flood. For the proposed dams, the PMF was routed through the dam with a starting water surface elevation equal to the proposed 4% chance, 1% chance, and 0.2% chance spillway crest elevations. The outlet for the proposed dam was assumed to be plugged.

Routing the PMF through the proposed dam under these assumptions yielded conservative water surface elevations for all proposed dam alternatives. The top of dam elevations were then set to provide a minimum of three feet of freeboard to the computed PMF water surface elevation.

3.8.8 Appurtenant Features

The west, abutment will be extended 600 feet upstream to tie into high ground to prevent the PMF from flanking the embankment on the west side. A gradual slope will be placed in the retention basin area to prevent headcutting. A 24 inch diameter pipe along the downstream toe of the left or west portion of the embankment will convey nuisance waters from a low area to the retention basin and avoid saturation of the toe of the embankment.

3.8.8.1 Retention Basin Sediment Deposition

Based on observed deposition rates in the upstream Spring Canyon Dam and on regional soil loss factors, an average annual deposition rate of 0.6 AF per year was used. A trap efficiency of 100% was assumed for the proposed dam. For a design life of 50-years, 30 AF of sediment can be expected to be deposited in the retention basin. All three dam alternatives included an additional 30 AF of storage for the proposed retention basin volume to account for sediment accumulation over the life of the project.

The proposed project will reduce the amount of sediment that currently enters the Colorado Drain from Spring Canyon and subsequently reduce routine maintenance of the drain by the EBID. Since any of the alternative dams discharge directly into the Colorado Drain, energy dissipation and scour protection is required at the outlet and spillway as described in 3.4.2 Structural Measures; E. Earthen Detention Structure. No scour would be expected downstream of these facilities since the slope of the drain is generally less than 0.1%.

3.8.9 Geotechnical Site Conditions

Investigation of the proposed dam site consisted of a review of publically available site information (desk-top study), a subsurface investigation of the site to determine ground conditions, and laboratory testing of recovered soil samples to determine soil properties. Detailed discussion can be found in *Appendix F Geotechnical Engineering*.

Subsurface investigations of the site were completed in 2000 and in 2011. The two investigations combined produced a total of 30 boreholes in the project area with borehole depths ranging from 10 feet to 50.5 feet below ground surface. Results of these investigations indicate that the subsurface soils consist primarily of a 5 feet to 10 feet thick layer of silty sands (SM), fat clays (CH), and lean clays (CL), underlain by poorly graded sands (SP). Groundwater was encountered between 10 feet to 20 feet below ground surface. Standard penetration test (SPT) N-values obtained from drilling indicate that the in-situ soil is of loose to medium density when sandy and medium to stiff when clayey.

Additional subsurface investigations, including field and laboratory tests, will be required during the design and implementation phase for this project in order to verify estimated shear strengths and permeabilities used in the model for slope stability and seepage analyses and to verify extents of allowable over-excavation in the reservoir area for borrow.

3.8.10 Dam Foundation

The length of the proposed dam will be primarily founded on the poorly graded sands found at a depth of 5 to 10 feet below existing ground surface. The upper 5 to 10 feet of clays and silts, found throughout the project site, will be over excavated in order to provide a suitable base free from swelling and consolidation for the embankment to be constructed upon.

Due to the porous and sandy nature of the foundation significant seepage could be observed downstream of the embankment during events in which the dam impounds water for a significant duration. To minimize these effects a drainage blanket and toe drain along the downstream toe of the embankment is provided for safe seepage collection and discharge. A more detailed discussion on the dam foundation can be found in *Appendix F Geotechnical Engineering.*

3.8.11 Dam Embankment

The dam embankment is composed of on-site materials excavated from within the reservoir area. These available materials consist of clays, silts, and sands which are blended for use in the random fill section of the embankment. The semi-pervious core of the dam is composed of select finer grained materials.

Design features of the zoned earthen dam consists of upstream and downstream random fill shells for structural stability, a central semi-pervious core for seepage control, a trapezoidal semi-pervious partial cutoff trench, and a downstream toe drain and drainage blanket provided for seepage control and discharge. Slope protection consists of an upstream soil cement cap and a downstream gravel layer. Materials for the construction of the drainage blanket and soil cement cap are anticipated to be obtained from local commercial sourced. Typical cross sections of the proposed dam are shown in Figure 24 and on the drawings in *Appendix J, Exhibit A – Dam Feasibility Drawings.* A more detailed discussion on the dam embankment can be found in *Appendix F Geotechnical Engineering.*

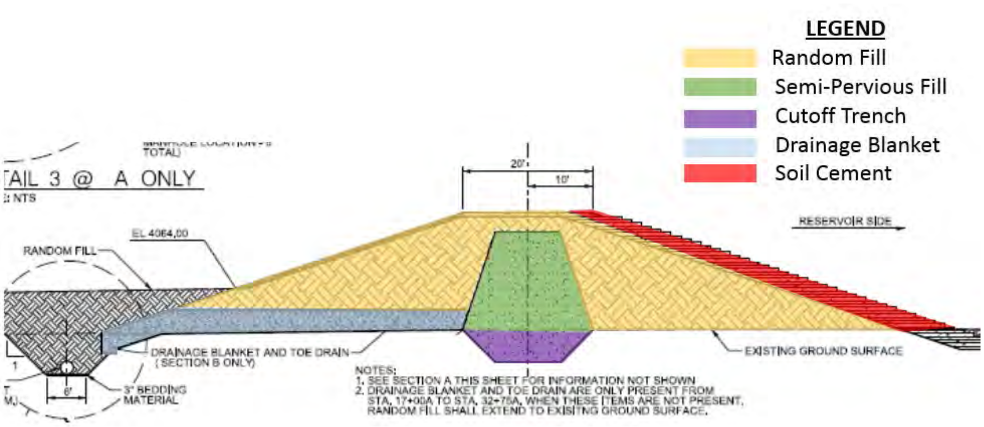


Figure 24 Typical embankment section

3.8.12 Outlet Works

The primary outlet works for the earthen embankment dam consists of a reinforced concrete conduit incised into the existing overburden of the dam. The conduit discharges into the Colorado Drain. Waterstops between conduit joints are required to prevent joint leakage into the embankment. Drainage material placed around the conduit is utilized to prevent seepage and erosion along the length of the conduit. Additional features such as flexible joints between the gatewell and conduit section may also be required based on future geotechnical analysis and detailed design. A more detailed discussion on the outlet works can be found in *Appendix F Geotechnical Engineering.*

The emergency spillway consists of a roller compacted concrete structure. The embankment drainage blanket continues beneath the spillway in order to provide seepage and internal erosion control beneath the structure. Additional features that are not selective between alternatives but will be required before construction include; spillway slope protection with a stilling basin and end sill with cut off wall to dissipate energy and mitigate erosion or head cutting of the spillway.

Further analysis is required during design and implementation in order to determine the outlet works and spillways foundation preparation, footing size, conduit reinforcement, bearing capacity, and slab thickness; and in order to limit settlement and any deleterious effect to the structures. Some uncertainty exists with respect to the properties of existing soils at the project site due to limited geotechnical survey and testing performed at this stage of the study. Detailed design prior to project construction will be performed based on detailed and targeted geotechnical survey, testing and analysis. Results of these analysis could include thicker concrete or using reinforced concrete instead of roller compacted concrete.

3.8.13 Additional Investigation and Analysis

In addition to a detailed design and dam safety analysis, additional subsurface investigations, including field and laboratory testing of foundation and proposed embankment materials, will be required during the design and implementation phase of this project. Additional subsurface investigations will include test pits, drilling, sampling, in-situ permeability testing, geophysical testing, and soil and rock testing to determine engineering properties for design. Foundation materials will be assessed for in-situ shear strength and density to determine their suitability beneath the embankment structure and to determine what seepage control measures, if any, need to be incorporated into the project. Triaxial testing will be required to establish strength parameters for the embankment utilizing unconsolidated-undrained and consolidated-undrained triaxial testing for the semi-pervious material and undrained triaxial testing for the pervious random fill material. Geologic mapping of the dam site and site-specific seismologic studies of the project site may be required for site-specific seismic analyses.

Slope stability and seepage analyses for static loading conditions including the use of both drained and undrained soil conditions (i.e. end of construction, steady seepage, and sudden drawdown) will be performed for detailed geotechnical design of the dam. Geologic mapping of the dam site and site specific seismologic studies of the project site may be required for site specific seismic analyses.

3.8.13.1 Seismic Design Considerations

As discussed in Section 2.6, Geology and Structural Setting, there are numerous faults of Quaternary and Tertiary age in the general vicinity of the proposed dam that are most likely associated with the Rio Grande rift, many of which there is little information. U.S. Army Corps of Engineers design guidelines utilize an operating basis earthquake and a maximum credible earthquake (MCE). The operating basis earthquake is considered to be an earthquake that has a 50% probability of being exceeded in 100 years (or a 144-year return period). The MCE is defined as the greatest earthquake magnitude that can reasonably be expected to be generated by a specific source based on seismological and geological evidence. For the purposes of this semi-quantitative risk assessment, a range of probabilistic loadings was considered. The seismic hazard curve was generated using the U.S. Geological Survey (USGS) Hazard Curve web application, which is based on 2008 mapping data. Based on USGS (2008) data, the peak horizontal ground acceleration for the operating basis earthquake is 0.016g, and the peak

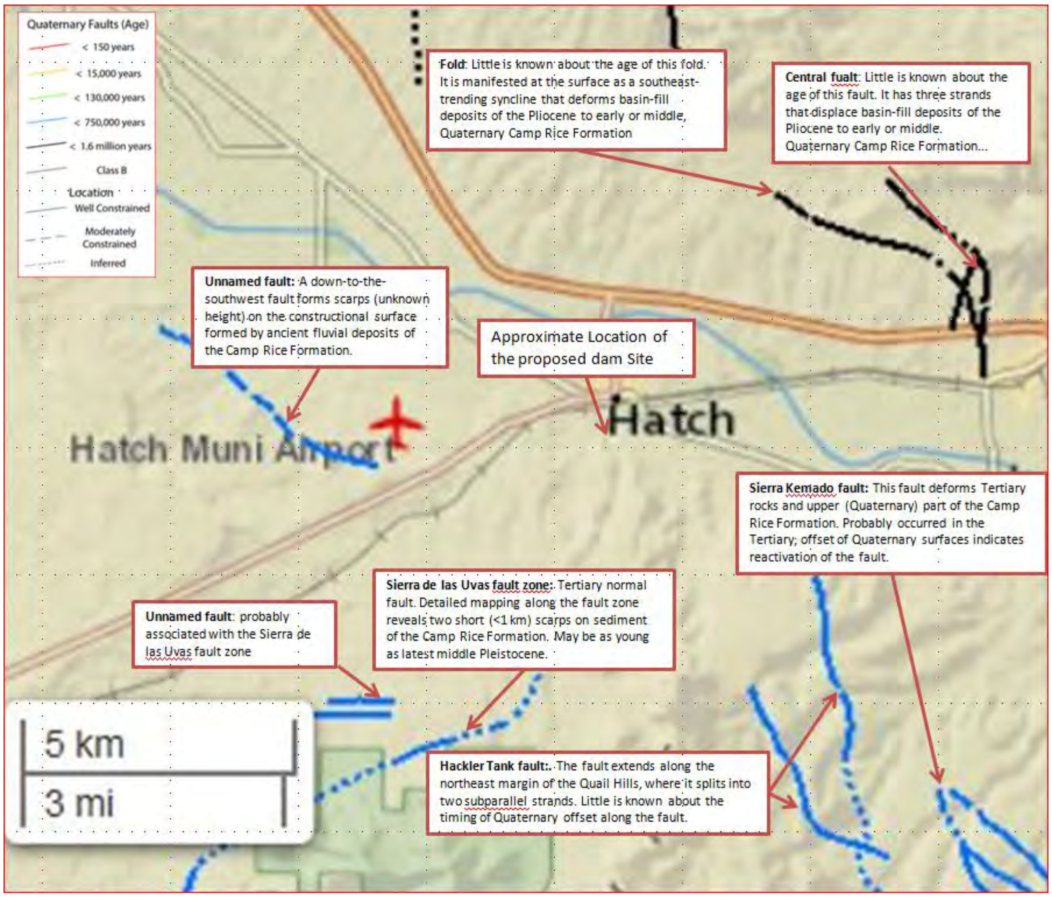


Figure 25 Local Quaternary and Tertiary faults near the project area.
Source: ***http://geohazards.usgs.gov***

horizontal ground acceleration for an earthquake with an annual exceedance probability (AEP) of 1/10,000 is 0.242g. This provides a basis for the general loading level. A site-specific seismic study has not been performed for this project. During the detailed design stage for this project, site specific seismic analyses of the project site will be required to evaluate the seismic performance of the proposed dam embankment and foundation during the design earthquake.

Additional studies and analyses, including subsurface investigations, seismologic studies, and seismic analyses, including potential liquefaction analysis, will also be required.

3.8.13.1 Earthquake and Seismic Analysis

The study area is located at 32.662623 north, −107.158588 west (lat/long) in New Mexico, United States, to the southwest of Hatch. There are numerous faults of Quaternary and Tertiary age in the general vicinity of the proposed dam that are most likely associated with the Rio Grande rift. For many of these faults, there is little information.

Figure **25** identifies local faults and shows their location in relation to the proposed dam. Some of the named faults are the Sierra Kemado fault, the Hanker fault, the Central fault, and the Sierra de la Uvas fault zone.

Figure 26 is a regional map showing locations of seismic hazards. The Caballo fault zone is approximately 30 kilometers to the north of Hatch and has probability of 1% of becoming active, causing a moment magnitude (Mw) 6.5 to 6.7 earthquake. The San Andres Mountains fault is approximately 18 mi east of Hatch with a probability of 1% of becoming active, causing a Mw 6.5 to 7.5 earthquake (USGS 2014 National Seismic Hazard Map, **http://geohazards.usgs.gov)**

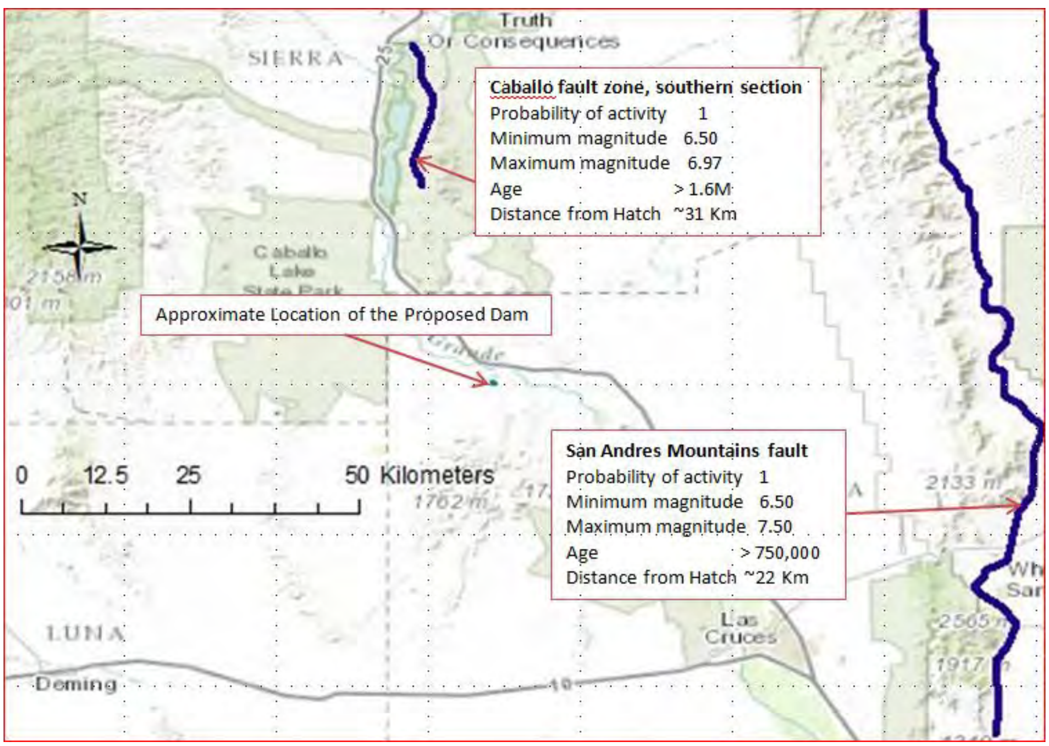


Figure 26 Seismic hazards near the project area.

Source: http://geohazards.usgs.gov

The future without-project conditions would remain unchanged and have no effect on the existing earthquake or seismic hazards conditions.

3.8.13.2 Seismic Hazard Curve

The proposed detention dam is considered a high hazard dam since it detains a large pool of water upstream of a populated area. To meet Federal and state guidelines for design of high hazard dams seismic conditions are incorporated into the design of the proposed dam. The USACE design guidelines utilize an Operating Basis Earthquake (OBE) and a MCE. The OBE is considered to be an earthquake that has a 50% probability of being exceeded in 100 years (or a 144-year return period). The MCE is defined as the greatest earthquake magnitude that can reasonably be expected to be generated by a specific source based on seismological and geological evidence. However, the attenuation functions and percentile ground motions used to generate the MCE loadings are seldom the greatest that can be reasonably be expected. Thus, the MCE ground motions should not be considered maximum. The OBE is determined by a probabilistic seismic hazard analysis, while the MCE is a deterministic seismic hazard analysis.

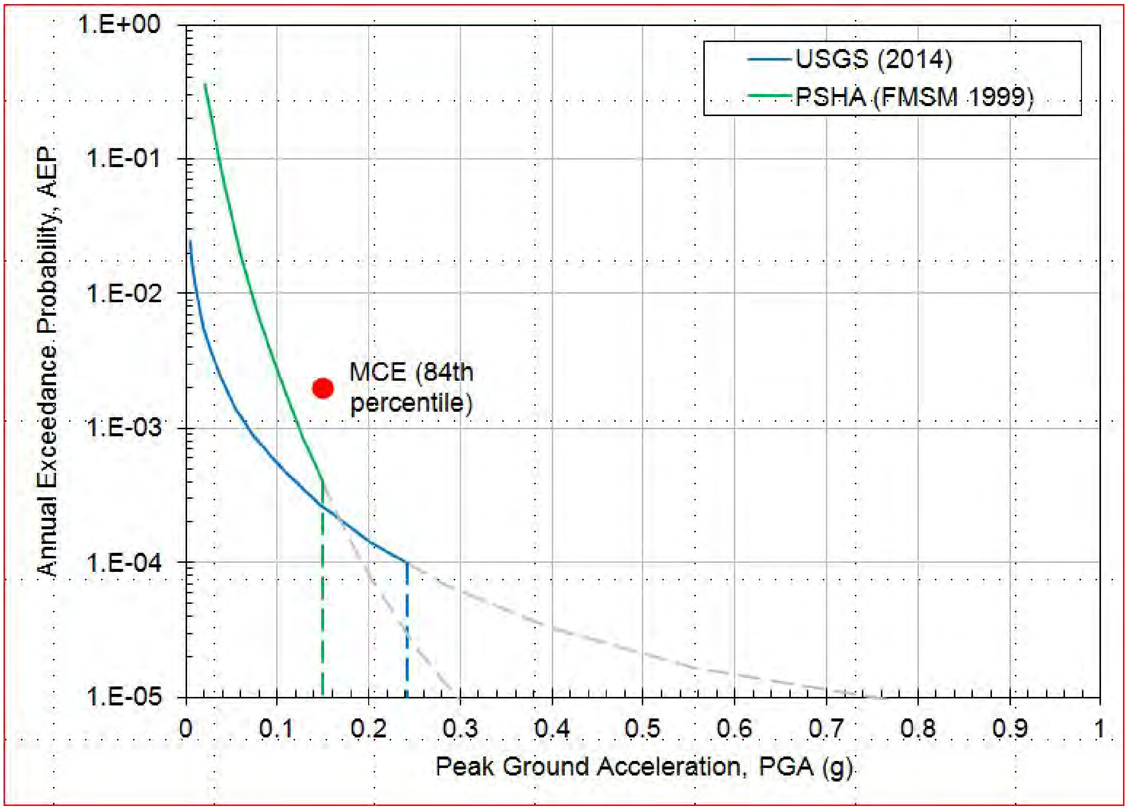


Figure 27 Seismic hazard curve for PGA.

Source: USGS, Earthquake Hazards Program, 2014, http://geohazards.usgs.gov

Based on USGS (2014) data, the PGA for the OBE is 0.016g, and the PGA for an earthquake with an AEP of 1/10,000 is 0.242g. This provides a basis for the general loading level. However, this should not necessarily be considered the maximum loading. The PGA corresponding to selected common values of return periods is shown in Table 13.

For the area in the vicinity of the proposed dam, the estimated seismic hazard is considered low. For perspective, a PGA of about 0.2g is generally required to knock objects off of shelves, and 0.1g is sometimes used as an approximate lower limit for damage to unreinforced masonry such as brick chimneys (FEMA 2000). Such estimates are approximate, and local site conditions will affect any estimated damage distribution.

Table 14 Peak horizontal ground acceleration summary*.

Earthquake	Return Period (years)	PGA (g)
Operating Basis Earthquake (OBE)	144	0.016
Maximum Design Earthquake for non-critical structures	975	0.067
International Boundary Commission Maximum Considered Earthquake	2,475	0.118
Intermediate earthquake	4,975	0.171
Reasonable limit suggested by ICOLD Bulletin 72 (2010)	10,000	0.242

Source: USGS (2008)

4 * Foreseeable Effects of the Alternatives

An environmental analysis was conducted for the alternatives and discussion of impacts is presented below. This chapter describes the potential impacts on the relevant resources describes in Chapter 2 and how future conditions in the study would change based on each alternative, including the recommended plan.

4.1 Climate and Climate Change

Climate change is not anticipated to increase flood risk in the project area. Flood risk results primarily from localized convection and processes at this scale cannot be resolved by the current generation of climate models. Significant disagreement exists across climate models about the future strength (increase or decrease) of the monsoon, El Nino or tropical storms. Small projected increases in monthly flows do not equate to increases in floods equivalent to the project PMF. Consequently, there is no expectation that future flooding would exceed the current PMF as modeled. This finding is in line with eth ECB 2016-25 Appendix D, which acknowledges the inadequacy of the available climate data for modeling. No additional analysis is required at this time.

Impacts from construction alternatives, including the recommended plan, future O&M activities, borrow and disposal area and the use of staging/access areas, to climate and climate change would be less than significant.

4.2 Hydrology, Hydraulics and Sedimentation.

The proposed project (Dam C) would provide long-term benefits to human health and safety through a significant reduction in flood hazard to Hatch. The hydrologic, hydraulic and sedimentation analyses for the selected alternative are discussed in this section.

4.2.1 Post-Project Floodplains

Peak water surface elevations were determined by routing the 50%, 20%, 10%, 4%, 2%, 1%, 0.5%, and 0.2% chance exceedance events through each alternative dam size. No residual flooding from Spring Canyon occurs in Hatch for events up to and including the design frequency of each dam. Life safety risk is reduced in the village of Hatch since the proposed project will prevent floodwaters from Spring Canyon from entering the village up to the design event.

There is, however, flooding from the small portion of the watershed downstream of the dam as well as interior drainage that is not addressed by this project. These sources of flooding may be addressed in the future by the local sponsor (see the post-project inundation maps which show interior drainage flooding in Hatch included in Appendix A - Hydrology & Hydraulics).

The proposed project will capture sediment transported along Spring Canyon Arroyo. Periodic maintenance will be required to remove accumulated sediment from the detention basin. This sediment will be disposed of at approved locations. Sediment management within the detention basin provides a positive economic impact by preventing these sediments from being deposited in downstream irrigation infrastructure or the Village of Hatch.

The existing floodplain from Spring Canyon below the proposed dam is entirely developed. There would not be any significant additional development due to implementation of the recommended plan.

4.3 Site Geology

The project site lies at the boundary between the modern floodplain of the Rio Grande and the dissected highlands of the Rincon Hills to the south. The proposed dam site is downstream from the mouth of Water Canyon, one of many north-flowing arroyos fringing the highlands along the south edge of the Rio Grande floodplain. The proposed dam will capture flow from Spring Canyon, adjacent to Water Canyon on the east, by means of a diversion channel.

Most of the footprint of the proposed dam sits atop fluvial deposits of the modern Rio Grande floodplain consisting of roughly 5 to 10 feet of clay underlain by sand and gravel. Sandy alluvial fan deposits are present at the mouth of Spring Canyon at the east (right) dam abutment, and are expected near the mouth of Water Canyon at the west (left) dam abutment as well.

The Rincon Hills are the source of the flow that will be captured by the proposed dam, but the rocks and older sedimentary formations that comprise the hills do not crop out at the dam site, except at the east and west dam abutments where older arroyo, fan, and terrace deposits of boulder gravel to silt-clay may be encountered, along with possible pedogenic carbonate cement (Seager et al 1995).

The Rodey fault is a steeply northeast-dipping normal fault which crops out about one-half mile southwest of the project site and which is shown by Seager et al (1995) as projecting beneath the east (right) dam abutment and potentially the main embankment as well. The Rodey fault does not offset the older alluvial deposits near the site and is therefore not considered active (Appendix F, Exhibit A, Section 2.1).

The future without project or no action alternative would have no effect on existing conditions at the site. There would be no significant effect to the geology of the area.

4.4 Environmental Resources

4.4.1 *Affected Environment

4.4.1.1 Water Resources

4.4.1.1.1 Surface Water

The proposed project is located on a typically-dry stream channel. Flows along this channel may occur only a few times each year, and these flows are flashy (large peak flows, short flow durations). Instead of temporarily ponding within and damaging the municipal areas of Hatch, water from these flows would be ponded in the retention basin behind the proposed dam immediately upstream of Hatch, and gradually released into the Colorado Drain.

Under all alternatives, the proposed construction of the inlet channel would capture and divert flows from Spring Canyon into the proposed retention basin. The flows would then be released into the Colorado Drain. The Colorado Drain heads east and joins the Rio Grande about 2.5 miles downstream. The proposed project would reduce the peak discharge reaching the Colorado Drain. The recommended plan is designed for construction at an estimated 0.2% chance exceedance event. The earthen dam includes an emergency overflow spillway in the event that flood flows exceed storage capacity. All alternatives, including the recommended plan would capture flows and release them into the Colorado Drain, which eventually reaches the Rio Grande. Therefore, the ultimate destination would be the same. However, with implementation of the alternatives, including the recommended plan, less ponding may occur and more surface water would enter the Colorado Drain.

The proposed project will reduce potential evaporative and infiltration losses. This is accomplished by limiting detention time to 96 hours or less per the New Mexico State Engineer and Interstate Compact requirements. Floodwaters would be exposed to evaporation for two to three times longer in the No Action alternative since floodwaters are ponded within and around the Village of Hatch for days or weeks. Further discussion of pan evaporation rates is presented in Section 2.1 Climate and Climate Change.

The Colorado Drain acts as the main conveyance of storm water from local drainage including small arroyo drainages downstream along the drain. The proposed project functions by capturing flood flows and releasing them slowly into the Colorado Drain. Thereby lengthening the time that the Drains capacity is occupied by water from Spring Canyon. Dam C will include an intake tower and gated outlet that will provide flexibility to operate the facility and would not exacerbate the capacity limitations of Colorado Drain. The flow rate could be reduced to limit the discharges to available downstream capacity of the Colorado Drain until the Sponsor and stakeholders resolve the capacity issues from unregulated arroyos and retention structures downstream. This will have a beneficial impact to the community by providing local entities the ability to regulate floodwaters to reduce or prevent flood damages. This ability is somewhat limited since state law requires the release of flood waters within 96 hours of capture.

Section 404 of the CWA, (33 U.S.C. 1251 *et seq.*) as amended, provides for the protection of waters of the United States through regulation of the discharge of dredged or fill material. The USACE Regulatory Program (33 CFR Parts 320-330) requires that a Section 404 evaluation be conducted for all proposed construction that may affect waters of the United States. The proposed action is authorized under Nationwide Permit No. 43 for Stormwater Management Facilities. Although the proposed inlet channel exceeds the linear foot limit, there would be no loss of waters and this action would have minimal impact. Because the proposed action meets the conditions of this Nationwide Permit, the 404(b)(1) analysis has already been completed and additional 404(b)(1) analysis is not required. All conditions under this permit would be adhered to during construction. Section 401 of the CWA, (CEA; 33 U.S.C. 1251 et seq.) as amended, requires that a Water Quality Certification be obtained for anticipated discharges associated with construction activities or other disturbance within waterways. Section 401 of the CWA does apply to this project, as there would be discharge associated with construction activities or other disturbance within waterways. The State of New Mexico will be notified that the project will follow all conditions of the NWP and the General 401 requirements. All Best Management Practices described throughout the document would be adhered to during project implementation.

Section 402 of the Clean Water Act (CWA; 33 U.S.C. 1251 et seq.) as amended, regulates point-source discharges of pollutants into waters of the United States and specifies that stormwater discharges associated with construction activities shall be conducted under National Pollutant Discharge Elimination System (NPDES) guidance. Construction activities associated with stormwater discharges are often characterized by activities such as clearing, grading, and excavation, subjecting the underlying soils to erosion by stormwater. The NPDES general permit guidance would apply to this project because the total project area is greater than one acre. Therefore, a Stormwater Pollution Prevention Plan (SWPPP) is required and would be prepared by the contractor for this project. Impacts from stormwater are expected to be negligible.

4.4.1.1.2 Groundwater

Groundwater at the proposed dam site is between 5 and 15 feet below ground surface (Appendix F – Geotechnical Engineering). For all alternatives, including the recommended plan, during excavation and construction, groundwater could be adversely impacted by oils, hydraulic fluids, or other industrial chemicals, due to the shallow nature of groundwater. To minimize potential negative impacts to groundwater, the Environment Protection Plan developed for the construction of the dam would address this issue. Additionally, after construction and during operation of the dam, the flood pool may have a short-term impact on groundwater elevation below and adjacent to the dam. Excavation of the impoundment area behind the dam may lead to a higher recharge/infiltration rate due the removal of soil above the water table, thereby increasing the elevation of the water table when there is a pool behind the dam. The magnitude of this impact is dependent on the retention time of the flood pool (48 hours, maximum), and the height of the pool (hydraulic head and time). During floodwater retention, the pool elevation will be higher than the ground elevation adjacent to the dam, which would have a short-term effect on the elevation of groundwater.

Groundwater moves much slower than surface water, and therefore, there would be a lag time from the time the dam fills and empties. In other words, the effects of the rise in groundwater could lag by behind the discharge from the dam. Groundwater would reach equilibrium much slower, and its effects would linger for some time after the pool is released. Preliminary modeling (Appendix F – Geotechnical Engineering) indicates that groundwater would not daylight in areas adjacent to the dam. However, additional subsurface investigation is required to accurately characterize the subsurface soil and groundwater. Therefore, additional drilling would be performed to: 1) further characterize subsurface soil for grain size distribution (soil texture), quantities, and soil hydraulic conductivity; 2) determine whether the leaking water line, that is now fixed, contributed to the unusually high groundwater table for this area; 3) determine whether the groundwater table is naturally shallow and not caused by the water line leakage, and; 4) if the groundwater table is naturally high, evaluate the need for any additional localized groundwater modeling. If the elevation of groundwater decreased as the result of the repair of the water line, there may be no need for any additional modeling.

Given the information provided above, there would be short-term effects to the localized groundwater system, but these effects should not negatively impact the surrounding area as a result of the alternatives, including the recommended plan. There would be no long-term effects as a result of the construction alternatives, including the recommended plan, future O&M activities, borrow and disposal areas, or staging/access roads.

4.4.1.1.3 Floodplains and Wetlands

Floodplains: EO 11988, *Floodplain Management*, provides Federal guidance for activities within the floodplains of inland and coastal waters. USACE implementation guidance is contained in ER 1165-2-26. The EO requires Federal agencies to take action to reduce the risk of flood damages, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by floodplains. The proposed project would reduce flood risk to property, infrastructure and human safety through a reduction in volume and frequency of flooding in Hatch originating in Spring Canyon. Section 3.7 describes the expected monetary benefits to structures and infrastructure from the proposed project. There is a similar reduction in flood risk to human safety from the reduced frequency and volume of flooding in the inhabited portion of the floodplain.

The floodplain within the study area is entirely developed including agriculture, commercial and residential buildings, roads, sidewalks and parking lots. Future development would be expected to include converting agricultural lands to additional commercial and residential development. Future with-project conditions are not expected to be significantly different from future conditions without a project (Fig. 28).

Figure 28. Approximate extent of the 1 ACE floodplain - FEMA flood insurance map.

Many floodplain benefits such as nutrient cycling and habitat creation or enhancement does not occur due to the lack of riparian or wetland habitats in the Spring Canyon floodplain downstream of the proposed dam site and, therefore, the proposed project would not have significant impact on these resources.

Detailed analyses were performed for the final array of alternatives and have demonstrated that structural improvements combined with flood warning and evacuation plans are the only practicable and cost effective alternatives that achieve the objectives of the project. Future conditions with and without project would be similar with respect to future development and floodplain values.

Alternatives considered are detailed in Section 3.6 and include:

- No Action: This alternative would involve no Federal action within the base flood plain as a result of this study. No additional reductions in flood risk to the area would be realized.
- Flood proofing and raising existing structures and infrastructure: This was determined not to be a cost effective alternative.
- Floodplain evacuation: This was determined not to be a cost effective alternative.

- Conveyance channels: Inclusion of conveyance channels may achieve objectives but were determined not cost effective.
- Construction of detention structures above the damage area.

Public scoping and, later, information meetings have been held and public comments were received on the proposed study. All public comments received are in favor of the project. Coordination with interested parties and resource agencies has been on-going through the course of the study.

As a result of the analysis required for compliance with E.O. 11988 and ER 1165-2-26, USACE has made a determination that the proposed dam project will significantly reduce flood risk to property, infrastructure and human safety. The proposed project has little or no adverse effects to natural floodplain functions over the existing or future without project conditions and is therefore compliant with E.O. 11988.

The approximately 1.0 acre of riparian habitat along Rodey Lateral would be unchanged by the proposed project. Therefore, construction alternatives, including the recommended plan, future O&M activities, borrow and disposal areas, or staging/access roads, would have no effect on wetlands.

4.4.1.2 Climate

Although climate models lack the spatial resolution to model the kinds of extreme but localized rain events that cause flooding in the Southwest, including southern New Mexico, there is a general consensus among climate scientists that warmer air can hold more water vapor and, therefore, produce more precipitable water when lifted (Gershunov et al. 2013). Consequently, even in areas where average conditions may become more arid, larger individual precipitation events are anticipated, and anticipated to occur more frequently than historically.

However, there is no consensus on the likely magnitude of these changes. Increases in extreme precipitation events have not been observed to date in the Southwest (Gershunov et al. 2013). Future trends in the North American Monsoon, that period of heightened summer rainfall when extreme precipitation events frequently occur, are also not resolved well in the current generation of models (Gershunov et al. 2013). Consequently, at this time, there is no basis for assuming that future storms would exceed the PMP event, or produce floods greater than the 0.2% chance event.

FRM projects are designed to contain flows of a particular range of events and therefore are not susceptible to changes in frequency of flood events below the design flows. Without a change in the severity of flood events, the dam will continue to perform as designed with lower risks from flooding, as predicted.

There would be no effect on the area’s climatic conditions from construction alternatives, including the recommended plan, future O&M activities, borrow and disposal areas, or staging/access roads.

4.4.1.3 Air, Sound and Visual Quality

Increases in suspended dust particles and construction equipment emissions would be minimal and would not result in permanent or significant long- or short-term detrimental effects on air quality. During construction, noise levels would increase locally; however, the increase would be minor and temporary, ending when construction is complete. Small increases in suspended dust particles would have minor effects on visual quality. Equipment with water sprinklers would be used during construction to minimize dust. Therefore, construction alternatives, including the recommended plan, future O&M activities, borrow and disposal areas, or staging/access roads, would result in temporary but negligible effect on local air, sound, and visual quality.

4.4.1.4 Biological Resources

4.4.1.4.1 Plant and Animal Communities

The foreseeable effects of the construction alternatives, including the recommended plan, future O&M activities, borrow and disposal areas, and use of staging/access roads on the vegetation of the area would be minor. Under all alternatives, dam construction would permanently replace 2.5 ac of land. However, due to years of drought conditions, this area has minimal, low quality vegetation. There is about 1.0 acre of upland riparian habitat within the project area, located along the south bank of the Rodey Lateral. Direct removal of the upland riparian habitat is not expected as a result of the recommended plan. Excavated surfaces behind the dam would be seeded with certified weed-free native vegetation. Therefore, construction alternatives, including the recommended plan, future O&M activities, borrow and disposal areas, and use of staging/access roads, would result in minor and temporary adverse impacts to vegetation.

Wildlife in the area would be briefly disturbed during the construction of the dam, outlet works conduit, and other associated structures included in the recommended plan. Some mobile wildlife would leave the construction area upon initiation of these activities. Wildlife displacement during construction would be minimal. Therefore, due to the overall limited disturbance of the construction alternatives, including the recommended plan, future O&M activities, borrow and disposal areas, and use of staging/access roads, only short-term, minor adverse impact would occur to wildlife.

4.4.1.4.2 Special Status Species

Project construction would have no effect on special status species. No Federal- or State-listed (threatened, endangered, proposed threatened or endangered, or candidates for threatened or endangered status) are known to occur in the vicinity of the proposed project and are unlikely to occur there in the future, with or without the project. Therefore, construction alternatives, including the recommended plan, future O&M activities, borrow and disposal areas, and use of staging/access roads, would have no effect to special status species. No other special status species are known to occur in the vicinity of the proposed project and are unlikely to make significant use of the project area in the future, with or without project.

4.4.1.4.3 Fish and Wildlife Coordination Act Report

The USFWS conducted a FWCA Report and it was received by the USACE on February 8, 2007. The report discusses wildlife and vegetation in the project area (Figure 29), the potential for special status species, as well as project impacts. The USFWS also provided several recommendations and mitigation alternatives. The USFWS, USACE, and the Doña Ana County Flood Commission agreed upon mitigation for the removal of terrestrial habitat at the proposed earthen dam construction site. However, at current conditions, terrestrial habitat has decreased significantly within the footprint of the proposed dam (Figure 30). A site visit was conducted on June 20 and December 4, 2014 to inventory these changes. Vegetation within the proposed project area is very scattered and is limited to honey mesquite, Siberian elm, and salt cedar. Due to the significant decrease in terrestrial habitat at this location, mitigation of 2.5 ac of terrestrial habitat is not warranted. The other recommendation by USFWS was to replace all mature standing riparian trees or shrubs along Rodey Lateral at a 1:1 ratio if disturbed during construction. Although the removal of trees is not anticipated during construction, the majority of the trees that currently exist along Rodey Lateral are Siberian Elm and salt cedar, which are non-native and invasive. No mitigation of trees is anticipated for the proposed project.

Cumulative Effects

NEPA defines cumulative effects as "…the impact on the environment which results from the incremental impact of the action when added to other, past, present, and reasonably foreseeable future actions regardless of what agency (Federal or Non-Federal) or person undertakes such other actions."

The proposed construction footprint lies within a semi-urban area that has some resemblance to what was present prior to semi-urban development. Most environmental impacts that have occurred within the proposed project area have stabilized and have been considered the baseline against which impacts of the proposed project have been compared. The adverse cumulative impacts upon the biological resources of the proposed project would be minor. Conversely, the proposed project would substantively benefit the Village of Hatch by reducing the flood hazard and flood damage potential to existing properties within the floodplains of the proposed project area.

Figure 29 Picture of vegetation in the area of the proposed dam in 2006.

Figure 30 Picture of vegetation in the area of the proposed dam in 2014.

The proposed construction alternatives, including the recommended plan, future O&M activities, borrow and disposal areas, or use of staging/access roads, when combined with the past, present, or future activities in the Village of Hatch would not significantly add to or raise local cumulative environmental impacts to a level of significance.

4.4.1.5 Cultural Resources

USACE sent a final consultation letter to the New Mexico State Historic Preservation Officer on February 5, 2015 regarding the determination of effect for the project. Because sites LA 152981, LA 152982, LA 152983 and LA 152984 were previously determined ineligible, these sites are not considered historic properties and were removed from consideration during project planning. The project, however, does have the potential to affect both the Rodey Lateral and the Colorado Drain. Both of these historic properties are listed in the National Register of Historic Places (NRHP) as contributing elements to the EBID (NR# 97000822). The potential impact would occur at the junction between the two ditches directly downstream of the dam to the north. At present, water from the proposed flood pool drains through a culvert under Rodey Lateral and into the Colorado Drain.

The USACE is proposing to retain the overall structure and function of this flow path, and use culvert point for the outlet structure of the dam. Work in this area would include modifying the existing culvert under the Rodey Lateral into a similar concrete outlet works conduit that would carry water from the flood pool, under the dam and the Rodey Lateral, and release it into the Colorado Drain. Because this work will be completely buried under the Rodey Lateral and the ditch will be returned to its present, earth-lined form; and because the function, alignment and character of the Rodey Lateral will not change as a result of the project, the USACE is of the opinion that the project will result in “no adverse effect” to the Rodey Lateral. Within the Colorado Drain, installation of an approximately 60-foot section of wire-wrapped rip rap will be necessary in order to protect the ditch from erosion at the point at which flows area released through the outlet works into the ditch. Currently this outlet point is unlined and requires extensive maintenance due to erosion during high flows. The existing concrete headwall and apron will also need to be replaced where the pipe daylights into the ditch. Replacement of the concrete headwall and apron will be in kind and will not alter the appearance, function or character of the ditch.

While these modifications do alter a small portion of the Colorado Drain, the impact is negligible as only 60 of the 9,000-foot length of the ditch will be impacted, amounting to less than 1% of the total length. In addition, the construction of the dam will allow flood flows into these historic ditches to be regulated. Currently these flows can back up against the Rodey Lateral and run unchecked into the Colorado Drain causing significant damage and requiring the ditches to be repaired. With the dam in place, flows will be captured and released into the Colorado Drain at levels the ditch can handle without causing damage. For this reason, the USACE determined that the project will have a beneficial effect for both historic ditches and that the project will result in “no adverse effect” to either the Rodey Lateral or the Colorado Drain. The New Mexico State Historic Preservation Officer concurred with this determination of effect on March 9, 2015 (Appendix D; HPD Consultation Nos. 82820, 92445 and 100814). No further cultural resources investigation is recommended at this time.

4.5 Hazardous, Toxic, Radioactive Waste

Future conditions with the project executed in all likelihood will improve conditions at the site. A domestic wastewater leach field system is located beneath the site. If the project is constructed, the owner is obligated to remove the leach field, the source of these chemical compounds, and any contaminated soils that may be present in accordance with federal and state laws and regulations before construction begins.. Although the wastewater leach field is no longer in service and not used for any purpose, the source of these compounds may still be present in the leach field and the surrounding soils. Removing the leach field will remove any remaining source of the chemical compounds, thereby, increasing the quality of groundwater near the leach field. The abandoned septic system, the leach field and the unauthorized dump will be removed or mitigated. The water main that was leaking has been fixed and, with construction of the proposed project, will be relocated outside the footprint of the dam.

There is no evidence in the researched records (Appendix E - Environmental Engineering) that indicate that the construction alternatives, including the recommended plan, future O&M activities, borrow and disposal areas, or use of the staging/access roads would contribute to HTRW impacts, or exasperate any exiting HTRW conditions. However, there would be a slight improvement to the area because the leach field/septic system would be removed before construction occurred. Per USACE regulation, an environmental assessment will be repeated at the site 6 months prior to construction. At that time, all sources of borrow and disposal, staging and access areas will be inspected for indications of possible contamination. Testing of that material will be conducted if warranted.

4.6 Real Estate

The proposed project (for all construction alternatives) would require the sponsor to acquire and/or provide fee interest for the dam site, construction areas and permanent structures (dam, retention basin, inlet and outlet works, the spillway and channels). The sponsor would provide permanent easement interest in flowage and ponding areas of the dam.

There are seven separate private landowners within the project area. These properties were verified with the Doña Ana County Assessor’s Office on August 13th, 2013. The Village of Hatch holds fee title to approximately 7.68 ac, Doña Ana County holds fee title to approximately 13.95 ac; the State of New Mexico holds fee title to approximately 38.83 ac; private ownership is held in fee by one landowner and totals approximately 0.70 ac. The staging area is approximately 3.00 ac within the project boundary footprint, and is owned by the State of New Mexico in fee. The majority of the access road used is owned by Doña Ana County and 0.5 ac near the project footprint is owned in fee by a private landowner. Table 14 shows a breakdown of ownership.

Table 15 Breakdown of Ownership in Project Area

Feature	Ownership	Interest to be acquired/provided	Acres
Dam Structure	Village of Hatch	Fee - Standard Estate #1	4.75
	Dona Ana County	Fee - Standard Estate #1	3.22
	State of New Mexico	Fee - Standard Estate #1	5.69
	Private Land Owners	Fee - Standard Estate #1	0.70
Flood Pool Area	State of New Mexico	Permanent Easements for Flood Control Standard Estate #9	30.90
	Village of Hatch	Permanent Easement for Flood Control Standard Estate #9	2.93
	Dona Ana County	Permanent Easement for Flood Control Standard Estate #9	10.72
Staging Area	State of New Mexico	Temporary Work Area Easement Standard Estate #15	3.00
Access Road	Private Land Owner	Access Road Easement Standard Estate #15	0.5

4.6.1 Facility/Utility Relocations

Under all construction alternatives, including the recommended plan, a waterline would be relocated or removed by the county before the start of construction of the new dam. The abandoned leach field components would be removed by the Sponsor prior to construction. The existing Rodey Lateral embankments (located northeast of the proposed dam) would be removed and replaced as required to install the new dam’s outlet works conduit. Suitable material from the existing spoil berm will be included in borrow for earthen dam construction. The excavation of the pool area would take place regardless of whether we use the material or not. An existing spoil berm would be removed in its entirety as part of the new dam construction contract. No other public facility or service would be impacted from the construction alternatives, including the recommended plan.

4.6.2 Impact on Real Estate Acquisition due to Suspected or Known Contaminants

Based on a Phase I Environmental Site Assessment, there are no known hazardous, toxic or radioactive waste materials are present in the project area. However, a domestic wastewater leach field system is located on the site. State officials indicated that the leach field has overflowed causing mosquito and health problems. Wastewater samples were collected in late August 2004 and were analyzed for VOCs, metals, and inorganic compounds. The analyses detected trace volatile organic compounds including 2-butanone (methyl-ethyl-ketone), toluene, tetra-hydro-furan, ammonia, and organic nitrogen. None of the concentrations of these volatile organic compounds exceeded New Mexico Groundwater Quality Control Commission standards for groundwater.

4.7 Socioeconomics

4.7.1 Land Use and Classification

Land use within the proposed project area would not change due to the recommended plan. There would be no displacement of people or farms. Therefore, construction alternatives, including the recommended plan, future O&M activities, borrow and disposal areas, and use of staging/access roads, would have no effect on land use and classification of the land use.

4.7.2 Demographics

The construction alternatives, including the recommended plan, future O&M activities, borrow and disposal areas, and the use of staging/access roads would have no impact on the long term demographics, community cohesion, community growth or the employment in Hatch and Doña Ana County. Population and employment impacts would be minimal during the next 50 years. During the construction period there would be minor impacts. The study area comprises portions of the urbanized area within the Village of Hatch, New Mexico, consisting of residential, public and commercial structures. Hatch is located in the northwest corner of Doña Ana County, New Mexico, near the Rio Grande River. Hatch is a fairly small population center within the county. The 2000 U.S. Census determined that 1,673 of the county's 174,682 people lived within the village. The 2010 Census identified 1,648 persons within the Village and 209,233 persons within the county. Agriculture comprises the main industry within the study area, while the county has a heavy government presence in the White Sands Test Facility (NASA and DoD) and the White Sands Missile Range (DoD). The demographics of Hatch and Doña Ana County would not change due to the construction alternatives, including the recommended plan, future O&M activities, borrow and disposal areas, and use of staging/access roads.

5 Recommendation

The recommended alternative consists of an earthen embankment with roller compacted concrete spillway and subsurface drainage system for seepage control. The outlet works would drain water from the retention basin into the Colorado Drain. An inlet channel would bring water from the Spring Canyon arroyo into the off-channel retention basin. The proposed project is designed to detain up to the 0.2% chance exceedance event from the Spring Canyon Watershed and slowly release the stored water over approximately 96 hours. An automated stage warning system will be installed to inform the local emergency managers of significant flow into the structure.

The proposed project would result in only minimal adverse impacts to water quality, air quality, noise levels, soils, vegetation, land use, floodplains, wildlife, and waters of the United States during construction. The project would have minimal adverse impacts to floodplains, land use and water quality. There would be long-term benefits to human health and safety from a significant reduction in flood hazards which would outweigh these short-term adverse impacts. There would be no adverse cumulative effects to the environment from the proposed project.

5.1 Views of the Non-Federal Sponsor

The Doña Ana County Flood Commission has affirmed their intent to participate in the project. The results attained in the additional analyses conducted and presented in this Feasibility Report have not changed the sponsor's favorable support of this project. The sponsor has the state-chartered responsibility for providing FRM to the Village of Hatch, and recognize the importance to their constituents of proceeding with this project. The Corps has received statements of financial support from the Doña Ana County Flood Commission which continue to show interest and support for this project.

5.2 Study Schedule

The following table indicates the schedule for the remaining milestones for the study.

Table 16 Schedule of Project Milestones

Milestones	**Date**
Sign FONSI	October 2019
Begin Design and implementation	October 2019
Complete Plans and Specs for first construction contract	November 2020

Physical construction of the project will depend on funding availability and acquisition strategies implemented during the Design and Implementation Phase.

5.3 Cost Sharing Requirements

A revised cost estimate was prepared for the recommended plan in more detail. Table 17 presents Federal and non-Federal cost apportionment for the project. The total project cost in Table 17 below, differs from that presented in table 11 due to further refinement of design, quantities and an update to program year interest rates.

The non-Federal sponsor is responsible for the cost share amount equal to 35% of total project costs including land, easements, rights-of-way, relocations, and disposal areas (LERRD). The non-Federal sponsor is responsible for 100% of OMRR&R. The sponsor must provide a minimum of 5% or $637,000 in cash as part of their cost share.

OMRR&R becomes the sponsor responsibility after construction of the project. Estimated OMRR&R costs are estimated at $22,550 annually (Oct. 19 price level). These estimates will be refined during final design and development of the project.

Federal implementation of the recommended project would be subject to the non-Federal sponsor agreeing to comply with applicable Federal laws and policies. The non-Federal sponsor shall, prior to implementation, agree to perform the required items of cooperation including but not limited to those items listed below:

1. Provide, without cost to the United States, all lands, easements, rights-of-way, and disposal areas, necessary for construction of the project;

2. Provide, without cost to the United States, all necessary relocation and alterations of buildings and utilities, roads, bridges, sewers and related or special features;

3. Hold and save the United States free from damages due to construction and the subsequent maintenance of the project, except for damages which are caused by the fault or negligence of the United States or its contractors, and, if applicable, adjust all claims concerning water rights;

4. Maintain and operate the project works after completion without cost to the United States in accordance with regulations prescribed by the Secretary of the Army; and,

5. Provide a cash contribution of at least 5% of the project cost and additional cash if necessary so that the total non-Federal contribution would not be less than 35% of the total project cost.

Table 17 Costs share apportionment for the estimated project costs.

	Federal	Non-Federal	Total
Project Features**	$10,323		$10,323.00
LERRDs	$50	$643	$693
PED	$1,094		$1,094
Construction Management	$625		$625
Subtotal	$12,092	$643	$12,735
5 percent Cash Contribution	-$637	$637	
Adjustment	-$3,178	$3,177.50	
Total	$8,278	$4,457	$12,735
Percent of Subtotal	65%	35%	100%

Upon completion of the project construction, the Government would turn the project over to the local sponsor who would be responsible for operating, maintaining, repairing, rehabilitating and replacing the project features in perpetuity, in accordance with the project partnership agreement.

Albuquerque District Engineers Recommendation

I recommend that the South Pacific Division Engineer approve the earthen embankment dam and appurtenant structures as described as Dam C in this report be advanced to the Design and implementation phase, as a Federal project, with such modifications that may be advisable in the discretion of the Commander, Albuquerque District, U.S. Army Corps of Engineers. The proposed project will significantly reduce flood risk to the Village of Hatch, New Mexico. This detailed project report and environmental assessment developed under the USACE authority under Section 205 of WRDA 1948 as amended took into consideration significant aspects to include: environmental, social, and economic effects, as well as engineering feasibility.

The estimated project first cost (Oct. 2019 price level) of the Recommended Plan is $12,735,000 with an estimated Federal cost of $8,278,000 and an estimated non-Federal cost of $4,457,000. The estimated annual OMRR&R cost is $22,550.

This recommendation is made with the understanding that Federal implementation of the Recommended Plan would be subject to the non-Federal sponsor complying with applicable Federal laws and policies.

26 SEP 2019
Date

Larry D. Caswell, Jr.
Lieutenant Colonel, U.S. Army
District Engineer

6 *Coordination and USACE Review Process

6.1 Agency Coordination and Collaboration

Scoping letters were mailed on March 13, 2006, to appropriate Federal, Tribal, State, and local government agencies, as well as private individuals and agencies who may have a potential interest in or who have expressed an interest in the proposed project. A public meeting was held in Hatch, New Mexico, on April 19, 2007. The EBID is participating as a cooperating agency.

Agencies and concerned entities consulted formally or informally in preparation of this Environment Assessment include:

- U.S. Fish and Wildlife Service, NM Ecological Services Field Office
- U.S. Environmental Protection Agency, Region 6, Office of Planning and Coordination (6EN-XP)
- U.S. Army Corps of Engineers, Regulatory Branch
- Comanche Nation of Oklahoma
- Fort Sill Apache Tribe
- Mescalero Apache Tribe
- Navajo Nation
- Pueblo of Isleta
- White Mountain Apache Tribe
- Ysleta del Sur Pueblo
- New Mexico Forestry and Resources Conservation Division, Energy, Minerals, and Natural Resources Department
- Federal Emergency Management Agency. Mitigation Division
- Natural Resources Conservation Service
- Bureau of Reclamation
- Middle Rio Grande Conservancy District
- New Mexico Department of Game and Fish, Conservation Services Division
- New Mexico State Engineer
- New Mexico State Historic Preservation Officer
- New Mexico Environmental Department, Water and Waste Management Division
- New Mexico Department of Transportation
- Doña Ana County, District 1 Commissioner
- Doña Ana County Flood Commission
- Elephant Butte Irrigation District (Cooperating Agency)
- Sierra Soil and Water Conservation District
- International Boundary Water Commission
- Village of Hatch, Mayor
- BNSF Railway

Information on the proposed project including project background, purpose and need, project description, proposed alternatives, and project area map were mailed to all entities contacted in the above list. Additionally, a notice of availability for public review of the DPR/EA was published in the Las Cruces Sun News on 5 March 2017. A public meeting was held on 15 March 2017 in Hatch.

6.2 Comments and Responses to Scoping Letter

Comments and concerns received from scoping letter inquiries concerning the proposed construction project and explanation of the resolution include the following:

- The Natural Resources Conservation Service (NRCS) provided comments concerning the releases from the proposed Spring Canyon Dam. They are also concerned that these releases would fill the Colorado Drain to capacity and those downstream releases from the Rodey, Porter Private, and Porter-Weisenhunt dams would then appear to cause flooding by adding floodwater discharges to the drain, which would already be flowing full.
    - The proposed project will include an intake tower and gated outlet which will provide flexibility to operate and maintain the facility, and would not exacerbate the capacity limitations of Colorado Drain. The flow rate could be reduced to limit the discharges to available downstream capacity of the Colorado Drain. The further analysis of coincident flows and operation of the dam outlet will be performed during detailed engineering of the recommended plan. An operations and maintenance manual will include specifics of regulating releases from the dam.
- The NRCS also has an interest in the effect that the proposed project might have on the existing Spring Canyon Dam.
    - The proposed project is downstream of the existing Spring Canyon Dam and would have no effect to the existing structure.
- The New Mexico Department of Game and Fish (NMDGF) provided several comments. First, they believe that the economic analysis should take into account future climate change and consider the likelihood of extreme precipitation events and the probability of flood events in Doña Ana County.
    - Climate change is acknowledged in Section 2*Existing and Expected Future Without-Project Conditions as well as Section 3.8.6
    - Although there is evidence for more heavy precipitation events, there is not a general pattern of significant trends in annual floods throughout the United States that can be accounted for.
- NMDGF suggests that following construction, the excavated surfaces behind the dam be seeded with certified weed-free native vegetation.

  - In accordance with the FWCA report found in Appendix C – Environmental Resources, the excavated surfaces behind the dam will be seeded as suggested.

- NMDGF suggests that the upper end of the inlet channel be constructed using designs and materials that would prevent development of a headcut in Spring Canyon. Also, at the lower end of the inlet channel, the excavation area should be constructed using designs and materials that would prevent development of a headcut within the channel itself.

  - The design of the proposed project includes measures to prevent headcutting (see the Appendix A - Hydrology & Hydraulics, as well as Appendix J - General Engineering).

- NMDGF questioned whether the facility intended to store runoff until it evaporates or if there is provision for regulated releases of collected water.

  - The proposed project is not intended to store any waters of the U.S.

- NMDGF suggested that the long-term operation and maintenance plans for the facility should include how to manage sediment accumulation behind the dam. Project planning should also consider how long-term operation and maintenance of the facility can address adequate drainage capacity in the Colorado Drain.

  - The proposed project will include an intake tower and gated outlet which will provide flexibility to operate and maintain the facility and would not exacerbate the capacity limitations of Colorado Drain. The flow rate could be reduced to limit the discharges to available downstream capacity of the Colorado Drain. For a design life of 50-years, 30 AF of sediment can be expected to be deposited in the retention basin. An additional 30 AF of storage was added to the retention basin volume of the proposed project to account for sediment accumulation over the life of the project.

7 *Preparers and Quality Control

7.1 Preparation

This DPR/EA was prepared by the U.S. Army Corps of Engineers, Albuquerque District. The Product Delivery Team and principal preparers included:

Steve Boberg –Hydraulic Engineer
Jeremy Decker – Archaeologist
Lance Faerber –Structural Engineer
Danielle Galloway – Biologist
Lynette Giesen –Project Manager
Robert Grimes – Economist
David Henry –Geologist
Bruce Jordan – Geotechnical Engineer
Michael Mills – Civil Engineer
Ben Miranda – Real Estate
John Peterson – GIS
Kathy Skalbeck – Planner
Ted Solano – Civil Engineer
Tim Tetrick – Cost Engineer

7.2 Technical Review

7.2.1 District Quality Control

The Albuquerque District's Quality Control Reviewers included:

Stephen Brown – Hydrologic Engineer
Bill Brown – Real Estate
Robert Browning – Economist
William DeRagon – Biologist
Mark Doles – Plan Formulation
Gregory Everhart - Archaeologist
Suzy Hess-Britelle - Geologist
Cecilia Horner - HTRW
Huff Horton – Civil Engineer
Dwayne Lillard – Geotechnical Engineering
Michael Prudhomme – Cost Engineer
Shelley Ramos – Geotechnical Engineering
Julie Alcon – Environmental and Planning

7.2.2 Agency Technical Review

The Agency Technical Reviewers (ATR) included:

Marc Masnor – ATR Team Leader
David Williams – Hydraulic Engineering
Brian Maestri – Economics / Risk and Uncertainty

Joseph Jordan – Environmental Resources / NEPA
Dr. Lewis Hunter – Geotechnical Engineering
Michael Clay – Civil Engineering
Leslie Williams – Real Estate
Phillip Ohnstad – Cost Engineering
James Neubauer – Cost Engineering MCX ATR Coordinator

7.2.3 Independent External Peer Review

The Flood Risk Management Planning Center of Expertise (FRM-PCX) coordinated this Independent External Peer Review. The Panel Members were selected and managed by Logistic Management Institute (LMI).

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