# Española Valley, Rio Grande and Tributaries, New Mexico

DRAFT Final Integrated Feasibility Report and

Environmental Assessment

August 2015

US Army Corps
of Engineers

Albuquerque District
South Pacific Division

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DEPARTMENT OF THE ARMY
ALBUQUERQUE DISTRICT, CORPS OF ENGINEERS
4101 JEFFERSON PLAZA NE
ALBUQUERQUE NM 87109-3435

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# PRELIMINARY DRAFT FINDING OF NO SIGNIFICANT IMPACT (FONSI)

The U.S. Army Corps of Engineers (USACE) proposes to restore 256 acres of the bosque in the floodplain communities of the Pueblos of Ohkay Owingeh and Santa Clara by (1) improving hydrologic function by constructing grade restoration facilities (GRFs), high-flow channels, terrace lowering, willow swales, ponds, and wetlands, and (2) restoring native vegetation and habitat by removing exotic species, and restoring riparian gallery forest (*bosque*). The approximate federal cost of the project is $41,925,000.

The proposed management measures for Ohkay Owingeh Pueblo include: 6 GRFs (1 located along the Rio Chama, 1 located along the Rio Grande upstream of the Rio Grande/Rio Chama confluence, and 4 located below the Rio Grande/Rio Chama confluence), terrace lowering, non-native vegetation removal and high flow channels. The proposed management measures for Santa Clara Pueblo include: vegetation removal, high-flow channels, swales, and bank line lowering. San Ildefonso Pueblo removed ecosystem restoration from their objectives and did not participate in this process with the other sponsors.

USACE working with the Pueblos of Ohkay Owingeh, San Ildefonso, and Santa Clara evaluated structural and non-structural flood damage reduction measures. The measures evaluated included levees, ring levees, floodwalls, floodproofing, emergency action plans, and other non-structural measures. At the conclusion of the planning process there were no FRM alternatives that met both USACE and sponsor goals and objectives. Therefore, no FRM measures were included in the final array of alternatives.

The Recommended Plan alternative and the No Action alternative were evaluated to meet the overall purpose and need of the project, which includes improving habitat quality and increasing the amount of native bosque communities, promoting bosque habitat heterogeneity, implementing measures to reestablish fluvial processes in the bosque, creating new wetland habitat, recreating hydraulic connections between the bosque and river, protecting and enhancing potential habitat for listed species, and creating opportunities for recreational, educational and interpretive features.

Section 404 of the Clean Water Act (CWA) requires analysis under the EPA’s 404 (b) (1) Guidelines if USACE proposes to discharge fill material into water or wetlands of the United States. During proposed construction, USACE would follow Nationwide Permit 33 (Temporary Construction, Access, and Dewatering) because of the potential need to dewater the channel for construction of the grade restoration facilities, and at the bank of the river when constructing the high-flow channels; and Nationwide Permit 27 (Aquatic Habitat Restoration, Establishment, and Enhancement Activities) for the proposed restoration features listed above. All conditions under Nationwide Permits 33 and 27 would be adhered to during construction. A water quality certification permit under Section 401 of the CWA would also be required and would be obtained from the Pueblos.

The Recommended Plan has been designed to avoid adverse effects to historic properties. Cultural resources surveys were conducted in 2015 on Santa Clara Pueblo. Ongoing consultation with both Sponsors, will determine the presence of historic properties within or immediately adjacent to the Recommended Plan's Area of Potential Effect (APE). USACE has determined that the Recommended Plan would have no adverse effect to historic properties; the New Mexico State Historic Preservation Office (SHPO) concurred with this determination on [date] for those portions of the project within Ohkay Owingeh, and the Santa Clara Pueblo Tribal Historic Preservation Office (THPO) concurred with this determination on [date] for those portions of the project within Santa Clara Pueblo. Should previously unknown artifacts or other historic properties be encountered during construction, work would cease in the immediate vicinity of the resource. A determination of significance would be made and further consultation on measures to avoid, minimize, and/or mitigate potential adverse effects would take place with the New Mexico SHPO, the Santa Clara THPO, the Pueblos of Ohkay Owingeh and Santa Clara, and with American Indian Tribes that have cultural concerns in the area.

USACE consulted with the U.S. Fish and Wildlife Service (USFWS) under Section 7 of the Endangered Species Act, and concurrence was requested. USFWS concurred with the Corps' statement that the Recommended Plan "may affect, but is not likely to adversely affect," the Southwestern Willow Flycatcher, "may affect, but not likely to adversely affect," the Yellow-billed Cuckoo, and "may affect, but not likely to adversely affect," the New Mexico Meadow Jumping Mouse. The USFWS also concurs that the Recommended Plan "May affect, but not likely to adversely modify designated or proposed critical habitat" for these three species. The Corps would implement all reasonable and prudent measures (RPMs) stated in the Biological Opinion during construction.

All Best Management Practices described in this document would be adhered to during project implementation including: (1) construction sequencing as described in Section 2; (2) sediment management; (3) equipment inspection; (4) compliance with water quality permits; (5) adherence to schedule and best management practices to avoid impacts to endangered, protected, or avian nesting species; (6) equipment cleaning prior to entering and before leaving project areas to avoid transfer of weed seed; (7) adherence to all recommendations in the Fish and Wildlife Coordination Act Report and Biological Opinion; and (8) oversight by a qualified biologist to monitor adherence to these conditions during construction.

The Recommended Plan would result in only minor, short-term and temporary adverse impacts to soils; water quality; air quality and noise levels; aesthetics; vegetation; floodplains and wetlands; fish and wildlife; endangered species; socioeconomic considerations; and recreational resources during construction. The long-term benefits of the Recommended Plan include a decrease in noxious weeds combined with increases and improvements to soil moisture; water quality; aesthetics; floodplains and wetlands; native vegetation and biodiversity; native habitat for fish and wildlife; potential habitat for endangered species; and recreational resources. The positive cumulative effects would outweigh short-term adverse impacts. The following elements have been analyzed and would not be adversely affected by the Proposed Action: hydrology; hydraulics and geomorphology; cultural resources; Indian Trust Assets; prime and unique farmland; hazardous, toxic and radioactive wastes; and environmental justice.

The Recommended Plan has been coordinated with Federal, State, tribal and local governments with jurisdiction over the ecological, cultural, and hydrologic resources of the project area. Based on these factors and others discussed in the Environmental Assessment, the Recommended Plan would not have a significant effect on the human environment. Therefore, an Environmental

Impact Statement will not be prepared for this project, and the Recommended Plan is recommended for construction.

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|---|---|
| Date | PATRICK J. DAGON<br>LTC, EN<br>Commanding |

# EXECUTIVE SUMMARY

This integrated General Investigation Report (GI) and Environmental Assessment (EA) addresses alternative plans to provide flood risk management (FRM) and ecosystem restoration in the floodplain communities of the Pueblos of Ohkay Owingeh, Santa Clara and San Ildefonso. During the course of this study, after ecosystem restoration management measures had been identified, San Ildefonso Pueblo's Tribal Council determined to remove ecosystem restoration from their part of the study due to economic constraints. USACE and San Ildefonso continued to formulate FRM alternatives.

The Flood Control Act 18 Aug 1941, Section 4, Public Law (PL) 228, 77th Congress, 1st Session, H.R. 4911, Section 4, states in part "The Secretary of War is hereby authorized and directed to cause preliminary examinations and surveys for flood control, to be made under the direction of the Chief of Engineers, in drainage areas of the United States and its territorial possessions, which include the following named localities: Rio Grande and Tributaries".

The study area is located in southern Rio Arriba County and includes a small portion of northern Santa Fe County. Study area boundaries currently extend one mile east and west of the centerline of both the Rio Chama and Rio Grande from the northern border of Ohkay Owingeh Pueblo, through the Santa Clara Pueblo lands and to the southern border of San Ildefonso. The Rio Grande tributaries Santa Cruz River, Arroyo Guachupangue, and the Rio Pojoaque are also included in the study area

Two types of flood events occur in the study area : spring snowmelt runoff from northern New Mexico and southern Colorado, and the runoff from monsoonal storms most often entering the Rio Grande via its tributaries, the Santa Cruz River, the Guachupangue Arroyo (Santa Clara Pueblo), and the Rio Pojoaque (San Ildefonso Pueblo).

According to New Mexican newspapers of the time, the Great Flood of 1874 flooded the entire Española Valley after heavy winter snowpack melted under early spring rains that spanned the entire upper Rio Grande basin. Isolated rain storms from July through September of 1912 caused localized flooding in which the flows at Otowi Bridge, on the southern boundary of San Ildefonso, were estimated to peak at 29,000 cfs. In 1921, spring runoff after a heavy winter snowpack caused flood waters to flow at an estimated 100,000 cfs. The flood of 1924 was estimated to flow at 244,000 cfs at San Ildefonso and the bridge at Española was again washed out. The spring of 1941 brought 29 inches of rain between January and May on top of the winter's snow pack. This flood caused major property damage within the study area.

Another problem is the severe degradation and loss of riparian habitat along the Rio Grande and its tributaries. The Rio Grande and the Rio Chama once flowed with braided channel and supported a mix of riparian and wetland habitats referred to as the "bosque". Bosque is the name for areas of gallery forest found along the flood plains of stream and rivers in the southwestern United States. It derives its name from the Spanish word for woodlands. Substantial stands of cottonwoods, willows, New Mexico olives, and shrubs once occupied the valley bottom within the floodplains. The Rio Grande is highly incised and no longer floods the riparian areas.

Several non-structural and structural alternatives for FRM were examined.

- Emergency Preparedness Plans

- Flood Warning Systems
- Wet Floodproofing
- Dry Floodproofing
- Elevation of Structures
- Acquisition of Existing Structures
- Relocation of Existing Structures
- Floodwalls
- Levees
- Ring Levees

A broad range of measures were considered to develop alternatives for Ecosystem Restoration (ER).

- Boulder Weirs
- Grade Restoration Facilities (GRFs)
- Deformable Riffles
- Rock Sills
- Riprap Grade Control
- Low Head Stone Weirs
- Terrace Lowering
- High-flow Channels
- Willow Swales / Wetlands
- Bank Line Embayments

The final result of economic analyses demonstrates that, other than the levee along Arroyo de Guachupangue (which was eliminated by the local sponsor), no FRM measures for the Española Valley are economically justified.

The array of preliminary alternatives is described in detail in Section 4.0. These alternatives and measures were compared to the forecasted future condition without a project (No-Action Alternative) through a 50-year period of analysis. Of the alternative plans evaluated, the tentatively selected plan meets the project's ecosystem restoration objectives as well as planning criteria for completeness, effectiveness, acceptability, and efficiency. The tentatively selected plan is the National Ecosystem Restoration (NER) plan, which increases the net quantity and / or quality of desired ecosystem resources.

The tentatively selected plan reflects feasibility level planning and design. The major features of the NER plan are the GRFs necessary to create overbanking at more frequent precipitation events. The tentatively selected plan was chosen from the array of alternatives because it met the study objectives in a cost efficient manner. The PDT and Pueblo sponsors selected best buy (BB) 36 as the NER plan.

The results of the study show that the total cost for the project is expected to be $64.7 million. Of that, the management measures for Ohkay Owingeh are expected to cost $35.5 million and the management measures for Santa Clara are expected to cost $29.2 million. Within Ohkay Owingeh Pueblo, the management measures include: 6 GRFs (1 located along the Rio Chama, 1 located along the Rio Grande upstream of the Rio Grande/Rio Chama confluence, and 4 located below the Rio Grande/Rio Chama confluence), terrace lowering, non-native vegetation removal and high flow channels. For Santa Clara Pueblo, management measures include: vegetation removal, high-flow channels, swales, vegetation removal and bank line lowering. BB36 was the first plan that meets the study objectives for the study.

Both Pueblos, Ohkay Owingeh and Santa Clara, have expressed confidence that they will be able to provide their cost share for implementation of the project which is expected to have a seven to ten year construction period.

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# List of Acronyms

| | |
|---|---|
| AAHU | Average annual habitat units |
| ACE | Annual Chance Exceedance |
| AF | Acre-feet |
| AFY | Acre-feet per year |
| APE | Area of potential effect |
| ARMS | Archaeological Records Management System |
| BCR | Benefit-cost ratio |
| BISON-M | Biota Information System of New Mexico |
| BOR | U.S. Bureau of Reclamation |
| CDP | Census data population |
| CE/ICA | Cost estimate/incremental cost analysis |
| CEQ | Council on Environmental Quality |
| CFR | Code of Federal Regulations |
| Cfs | Cubic feet per second |
| CHAP | Combined Habitat Assessment Protocols |
| CWA | Clean Water Act |
| EAD | Equivalent annual damages |
| EPA | U.S. Environmental Protection Agency |
| ESRI | Environmental Systems Research Institute |
| FEMA | Federal Emergency Management Agency |
| FRM | Flood risk management |
| GRF | Grade restoration facility |
| HEAT | Habitat Evaluation Assessment Tool |
| HEC-EFM | Hydrologic Engineering Center-Ecosystem Functions Model (software) |
| HEC-FDA | Hydrologic Engineering Center-Flood Damage Assessment (software) |
| HEC-HMS | Hydrologic Engineering Center –Hydrologic Modeling System (software) |
| HEC-RAS | Hydrologic Engineering Center-River Analysis System (software) |
| HU | Habitat unit |
| IBIS | Interactive Habitat and Biodiversity Information System |
| ITR | Independent technical review |
| IWR | USACE Institute for Water Resources |
| IWR-Plan | IWR planning software |
| KEC | Key environmental correlates |
| KEF | Key ecological functions |
| LERDDS | Lands, easements, rights-of-way, relocation, and disposal areas |
| LiDAR | Light detection and ranging (aerial laser used to develop topography) |
| MRG | Middle Rio Grande |
| MRGCD | Middle Rio Grande Conservancy District |
| NAAQS | National Ambient Air Quality Standards |
| NED | National Economic Development |
| NEPA | National Environmental Policy Act |
| NER | National Ecosystem Restoration |

| | |
|---|---|
| NHPA | National Historic Preservation Act |
| NMCRIS | New Mexico Cultural Resources Information System |
| NMED | New Mexico Environment Department |
| NRHP | National Register of Historic Places |
| OMRR&R | Operation and maintenance, repair, replacement and rehabilitation |
| OSE | Other Social Effects |
| P&G | USACE Planning Guidance Notebook (ER1105-2-100) |
| PCEs | Primary constituent elements |
| PDT | Project development team |
| PED | Pre-engineering and design |
| RED | Regional Economic Development |
| SHPO | State Historic Preservation Office/Officer |
| SJC | San Juan Chama project |
| TCP | Traditional cultural property |
| THPO | Tribal Historic Preservation Office/Officer |
| Tmax | Maximum temperature (generally, highest daytime temperature) |
| Tmin | Minimum temperature (generally, lowest overnight temperature) |
| TSP | Tentatively selected plan |
| USACE | U.S. Army Corps of Engineers |
| USC | U.S. Civil Code |
| USGS | U.S. Geological Survey |

# Regional Terms

Some of the terms used in the southwestern U.S. water resources planning may be unfamiliar to readers outside of the region. Definitions of some of these terms are provided here.

Arroyo – n. a water-carved gully or channel: dry wash, ravine

Bosque – n. woods or forest

Pueblo – n. any of some 25 Native American peoples living in established villages in northern and western New Mexico and northeast Arizona.

pueblo – n. a permanent village or community of any of the Pueblo peoples, typically consisting of multilevel adobe or stone apartment dwellings of terraced design clustered around a central plaza.

rio – n. river

# 1 - Project Information

## 1.1 Project Authorization

This report was prepared as a response to the Flood Control Act of 1941 and by Congressional Resolution, Española, Rio Grande and Tributaries, NM (2009). These authorities are described below.

### 1.1.1 Flood Control Act 18 Aug 1941

The Flood Control Act, 18 Aug 1941, Section 4, Public Law (PL) 228, 77th Congress, 1st Session, H.R. 4911 authorized examinations and surveys for flood control throughout the Rio Grande Basin, including its tributaries. The Act states, in part:

> *Section 4. The Secretary of War is hereby authorized and directed to cause preliminary examinations and surveys for flood control, to be made under the direction of the Chief of Engineers, in drainage areas of the United States and its territorial possessions, which include the following named localities, and the Secretary of Agriculture is authorized and directed to cause preliminary examinations and surveys for runoff and water-flow retardation and soil erosion prevention on such drainage areas; the cost thereof to be paid from appropriations heretofore or hereafter made for such purpose: PROVIDED, That after the regular or formal reports made on any examination, survey, project, or work under way or proposed are submitted to Congress, no supplemental or additional report or estimate shall be made unless authorized by law except that the Secretary of War may cause a review of any examination or survey to be made and a report thereon submitted to the Congress if such review is required by the National defense or by changed physical or economic conditions; AND PROVIDED FURTHER, That the Government shall not be deemed to have entered upon any project for the improvement of any waterway or harbor mentioned in this Act until the project for the proposed work shall have been adopted by law:*
>
> *Rio Grande and Tributaries, New Mexico.*

### 1.1.2 Resolution, Senate Committee on Environment and Public Works

On 10 December 2009, the U.S. Senate Committee on Environment and Public Works of the 111$^{th}$ Congress, 1$^{st}$ Session, directed the Secretary of the Army to review the report of the Chief of Engineers on the Rio Grande and Tributaries transmitted to Congress on 27 June 1949 and related reports to determine whether additional projects were necessary in the Española Valley to meet Federal flood risk management, ecosystem restoration and allied goals (Figure 1).

**111th Congress**
**1st Session**

# United States Senate

## COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS

### COMMITTEE RESOLUTION

### ESPANOLA VALLEY, RIO GRANDE AND TRIBUTARIES, NEW MEXICO

RESOLVED BY THE COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS OF THE UNITED STATES SENATE

That the Secretary of the Army is requested to review the report of the Chief of Engineers on the Rio Grande and Tributaries transmitted to Congress on June 27, 1949, and other pertinent reports, with a view to determining whether any modifications of the recommendations contained therein are advisable in the interest of flood control, ecosystem restoration and other allied purposes on the Rio Grande and its tributaries in New Mexico.

Chairman          Ranking Minority Member

Adopted: Dec. 10, 2009

**Figure 1 Copy of the resolution of the Senate Committee on Environment and Public Works authorizing ecosystem restoration as a part of the original flood risk management study.**

## 1.2 Federal Interest

The purpose of this study is to determine whether or not there is a Federal interest in the implementation of a project along the Rio Grande and its tributaries' floodplains within the study area. This study is to determine whether or not flood risk management (FRM), ecosystem restoration, and recreation alternatives are technically feasible, economically practicable, sound with respect to environmental considerations, and legally acceptable. The three Tribes, as the non-Federal sponsors, support the project purposes to provide FRM, ecosystem restoration, and passive recreation.

## 1.3 Non-Federal Sponsors

The non-Federal sponsors for the Española Valley, Rio Grande and Tributaries, New Mexico study are the three dependent sovereign nations: Ohkay Owingeh Pueblo, Santa Clara Pueblo, and San Ildefonso Pueblo. The 2010 U.S. Census determined that for the Ohkay Owingeh Pueblo, Santa Clara Pueblo and the San Ildefonso Pueblo, the populations living within pueblo boundaries were 1,143, 1,018 and 524 respectively.

## 1.4 *Study Area

The study area is located in southern Rio Arriba County and includes a small portion of northern Santa Fe County. Study area boundaries are the 0.2% annual chance exceedance (ACE) event[1] floodplains for the Rio Grande and Rio Chama from the northern border of Ohkay Owingeh Pueblo, through the Santa Clara Pueblo lands and to the southern border of San Ildefonso. The lowest reaches of three tributaries of the Rio Grande (Santa Cruz River, Arroyo Guachupangue, and the Rio Pojoaque) are also included in the study area (Figure 1).

The City of Española lies within the study area and extends along both the east and west banks of the Rio Grande. Española is approximately 25 miles north-northwest of Santa Fe and 85 miles south of the New Mexico-Colorado border. The 2000 U.S. Census determined that 9,688 of Rio Arriba County's 41,190 people lived within Española.

Ohkay Owingeh Pueblo is the northernmost pueblo in the study area. It is mainly situated north of the Rio Grande/Rio Chama confluence and includes both banks of the upstream (north of the confluence) Rio Grande and Rio Chama. Ohkay Owingeh Pueblo's Rio Grande and Rio Chama corridors are a heavily "checker boarded" area with many private, non-Indian in-holdings close by, including those belonging to the City of Española.

Santa Clara Pueblo is located south of Ohkay Owingeh Pueblo and is separated from Ohkay Owingeh Pueblo by non-Tribal land. Santa Clara Pueblo is situated immediately next to the City of Española along the Rio Grande, south of the Rio Chama confluence (denoted in Appendix B as the "downstream Rio Grande") and includes three tributaries that flow directly into the Rio Grande. They include: the Santa Cruz River, which flows into the Rio Grande from the east;

[1] 500-year event

Arroyo Guachupangue, which flows into the Rio Grande from the west; and Santa Clara Creek, which is south of the Guachupangue and flows into the Rio Grande from the west. Santa Clara Pueblo's Rio Grande corridor is a heavily "checker boarded" area with many private, non-Indian in-holdings close by, including those belonging to the City of Española. The majority of the City of Española is located within the boundaries of Santa Clara Pueblo.

Santa Clara Creek was removed from the study after the Las Conchas fire in the late summer of 2011. Due to the heavy losses of vegetation in the upper watershed, and the resulting changed hydrology, the Pueblo of Santa Clara requested a new flood risk management study be started under Section 205 focused on the Santa Clara Creek watershed.

San Ildefonso Pueblo is the southernmost pueblo within the study area. It lies south of the City of Española and Santa Clara Pueblo along the Rio Grande. San Ildefonso is also situated at the downstream end of the Rio Pojoaque, which flows into the Rio Grande from the east.

This study area falls within New Mexico Congressional District number 3.

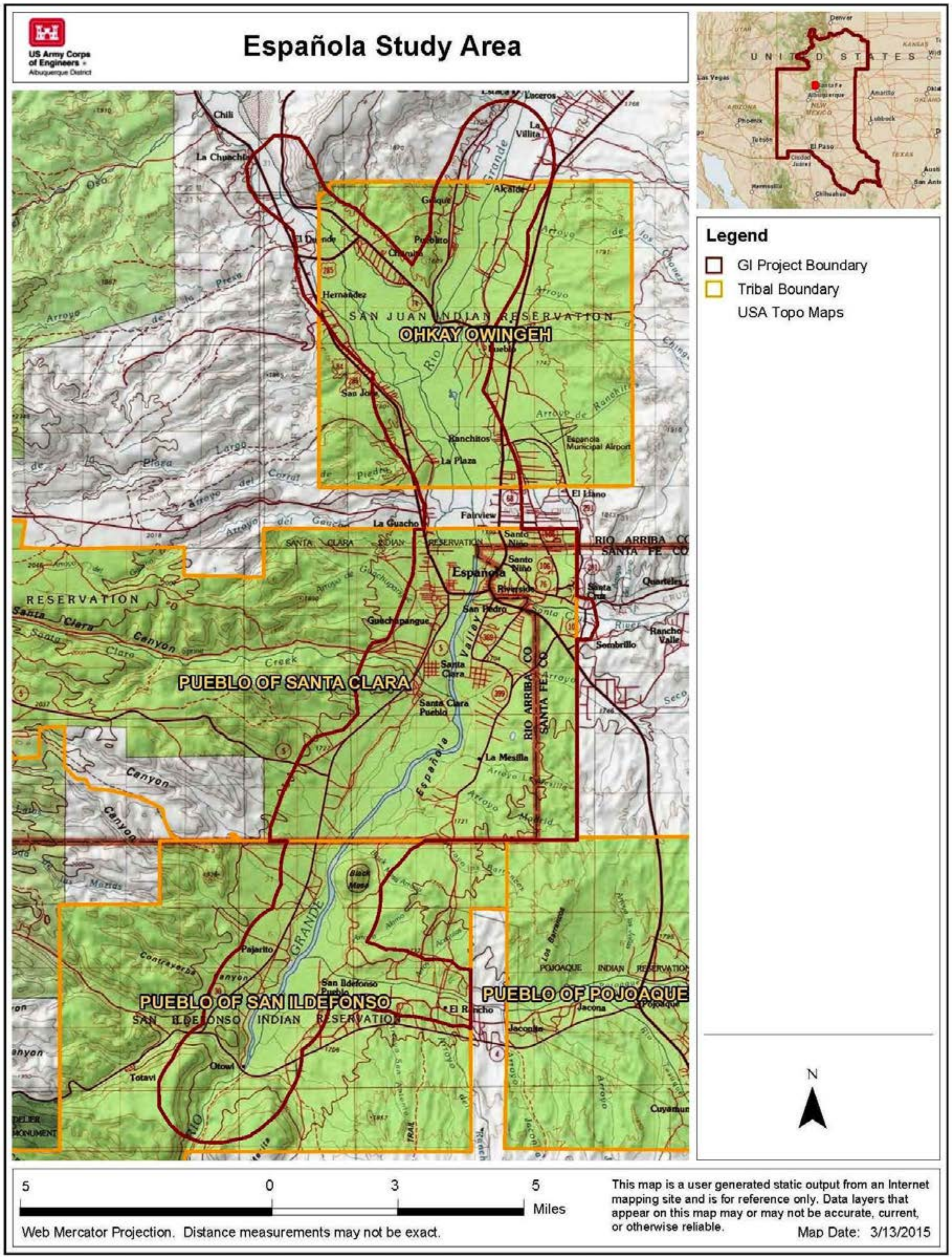



**Figure 2 Vicinity and study area.**

## 1.5 *Purpose and Need for Action

The Pueblos of Ohkay Owingeh, Santa Clara and San Ildefonso, in partnership with USACE, are conducting this feasibility study to identify and define flood risk management, ecological degradation, and incidental passive recreation resource problems and to develop solutions to reduce flood risk to structures, infrastructure, and human safety, to improve riparian habitat and functionality, and to create passive recreation opportunities.

### 1.5.1 Flood risk management

Flood damages caused by high flows in the Rio Grande and its tributaries are a primary issue of local concern. Existing conditions floodplain mapping shows that the areas of highest concern are the confluences of the Rio Grande and its tributaries; the Santa Cruz River and the Guachupangue Arroyo (Santa Clara Pueblo); and the Rio Pojoaque (San Ildefonso Pueblo).

Flooding has been a major issue in the Española Valley throughout the historic period. Several large flood events occurred in the late 1800s and early 1900s with the largest resulting from heavy winter snowpack melting under early spring rains.

Many significant floods have occurred in the last century; however, most were smaller than the 5 % annual chance event (ACE) event[2] (river flows of 10,000 cubic feet / second (cfs)). Scurlock (1998) documented 12 damaging floods of greater than 5% ACE within the Española Valley, including the Pueblos of Ohkay Owingeh, Santa Clara and San Ildefonso, between the years 1835 and 1951. SPA has documentation for the floods of 1969 and 1977.

According to New Mexican newspapers of the time, the Great Flood of 1874 flooded the entire Española Valley after heavy winter snowpack melted under early spring rains that spanned the entire upper Rio Grande basin. The flooding lasted from late April through the month of June as the flood waters from the Rio Grande continued to rise and fall depending upon the temperatures in the upper Rio Grande basin and the cycle of spring rains upon the snowpack. In 1880, an intense summer rain storm almost washed out the local church at Ohkay Owingeh and caused extensive damage to the back portion. In 1884, the bridge crossing the Rio Grande at Española was washed out. It’s been estimated that this flood peaked at more than 100,000 cfs and caused damages from the northern end of the Española valley south to El Paso, Texas.

[2] 20-year event

**Figure 3 Española Valley flood of 1941.**

Isolated rain storms from July through September of 1912 caused localized flooding in which the flows at Otowi Bridge were estimated to peak at 29,000 cfs. In 1921, spring runoff after a heavy winter snowpack caused flood waters to flow at an estimated 100,000 cfs. Flooding lasted from mid-April through June. Extended regional summer rains on already saturated ground caused summer flooding to extend into August. The flood of 1924 was estimated to flow at 244,000 cfs at San Ildefonso and the bridge at Española was again washed out. The spring of 1941 brought 29 inches of rain between January and May on top of the winter's snow pack. This flood caused major property damage within the study area. Additional flood information, as well as photos, from the 1941, 1942 and 1951 floods, are found in Appendix I - Plan Formulation Section 2.3.1. The floods of 1969 and 1977 damaged roads, utilities and structures within the valley.

Flooding continues to be a problem in the study area. In addition to flooding due to ponding and flash floods along smaller arroyos and drainages, flooding due to overbanking flows has occurred along the major tributaries of the Rio Grande, including the Rio Chama, Rio Pojoaque and Santa Cruz Rivers.

On 18 April 2010, rain and snowmelt runoff caused flood flows along the Chamita River, resulting in minor damage to fields and barns on the west side of Chamita (Albuquerque Journal, 2010). High precipitation statewide over the period 13-18 September 2013 produced areas of high precipitation in the study area, resulting in saturated soil, water ponding and overbank flooding. Damages reported at San Ildefonso were $55,000 and at least one vehicle was trapped in the floodwaters (NOAA 2015b). It is unclear how much of these damages were due to overbanking floods, and how much to other causes. On 18 September 2013, large, slow moving thunderstorms in the Rio Chama basin upstream of Ohkay Owingeh caused heavy rainfall on soils already saturated by a week of rain. This resulted in flows at the USGS gage Rio Chama at Chamita to rise to 9.14 ft, the 6th highest on record (NOAA 2015a). Flows overtopped the river's banks in Chamita, flooding several homes and businesses near the junction of U.S. 84 and 285 (Peterson and Uyttebrouck, 2013). Approximately $100,000 in property damages were reported (NOAA 2015a).

On 15 August 2010, precipitation east of Española resulted in flood flows along the Santa Cruz river resulting in flash flooding the vicinity of La Puebla, immediately east of the study area (NOAA 2015b). On 15 July 2014, strong thunderstorms occurred over high terrain east of San Ildefonso as part of a larger band of precipitation extending from Abiquiu to areas southeast of San Ildefonso. Flooding was reported along the Santa Cruz river at La Puebla and elsewhere (NOAA 2015b).

On 15 July 2014, strong thunderstorms occurred over high terrain east of San Ildefonso resulting in flood flows along the Rio Pojoaque. A water rescue occurred in El Rancho in the eastern portion of San Ildefonso within the study area (NOAA 2015b).

### 1.5.2 Ecosystem restoration

The Rio Grande and its tributaries have suffered severe channel degradation and loss of riparian habitat. Historically, the Rio Grande and the Rio Chama supported substantial growths of cottonwoods, willows, New Mexico olives, shrubs, and wetlands (locally, these riparian communities are termed *bosque*). The Rio Grande is highly incised and no longer regularly inundates the riparian areas (Appendices C and I), as a result of which these communities are not regenerating. With local sponsorship, the Corps can participate through its congressional authorities to restore function and increase high value habitat through the Española Valley study area. The goal of this collaborative effort is to formulate and evaluate a suite of alternatives in order to identify a cost effective plan, the recommended plan, which meets the objectives of the study and can be implemented to improve the bosque ecosystem structure and function.

As a result of incision and other changes, stands of healthy native riparian habitat, including wetlands, are rare and scattered in the study area. Loss of riparian habitat is an important conservation issue in the arid Southwest. Riparian habitat comprised approximately 720,000 acres in the 1780s of what would later become the State of New Mexico (only 0.9 percent of New Mexico). As of 1998, approximately 33 percent of the riparian habitat had already been lost in New Mexico (USEPA and NMED 1998). This combination of riparian, wetland, and fringe habitat is extremely valuable due to its rarity. The Nature Conservancy lists desert riparian woodland as a very rare although significantly important cover type and describes restoration of wetland and riparian systems as critical (Marshall et al 2000).

The bosque of the Española Valley study area is an ideal location for restoration because of its unique quality and critical value as wildlife habitat and its importance on a local, regional, national, and international scale. Resource values within the Española reach of the Rio Grande are significant because the bosque:

- Remains an important corridor for terrestrial and avian species.
- Functions as a critical link in a corridor connecting two designated Wild and Scenic River areas, eight national wildlife refuges, and several state parks and wildlife management areas.
- Embodies the largest remaining continuous cottonwood forest found in North America. Over half of the 277 land birds found in the MRG are residents, and 54 bird species breed within this habitat (Yong and Finch 2002).
- Constitutes a critical travel corridor connecting Central and South America to North America along the Rio Grande Flyway.

It has been estimated that up to 70 percent of bird species in the arid Southwest are riparian-dependent during some part of their life cycles (Krueper 1993). As a direct consequence of the loss and degradation of riparian habitat, the area has experienced a major reduction in bird species diversity and in the populations of remaining species. In addition, destruction of native riparian habitat facilitates an increase in invasive plant species that are more tolerant of disturbed conditions. Such plants consume more water than do native vegetation because of their ability to occupy a greater areal extent on the landscape, placing additional strains on limited water supply.

The Pueblo of Ohkay Owingeh completed approximately 930 acres of habitat restoration between 2004 and 2008 using funds from the Middle Rio Grande Endangered Species Collaborative Program, USFWS, and the Bureau of Indian Affairs. These projects focused on treating invasive salt cedar and Russian olive, combined with construction of small high-flow channels.

Tribal sponsors have identified lands available for future projects. There are opportunities to accomplish significant restoration within the study area. Restoration options have the potential to increase wetland and riparian habitat acreage and quality, thereby expanding wildlife diversity and quantity, controlling invasive plant species, reducing the risk of wildfires and providing an ecological resource that is historically and culturally significant and valuable to the tribes and the region.

In addition to carrying out the authorities granted to the Corps for ecosystem restoration and specific legislation provided for initiation and support of this study, the project complies with the letter or intent of several Federal laws, executive orders, and treaties, with which the Corps must comply, concerning restoration and conservation efforts, which include:

- North American Waterfowl Management Plan. The project will increase the amount and quality of resting, breeding, and foraging habitat for waterfowl.
- Executive Order No. 11990 (Protection of Wetlands) and North American Wetlands Conservation Act of 1989. The restoration project will conserve, create, or improve a significant portion of the study area, which is largely considered wetland habitat under the Executive Order and Act. Permanent and seasonal wetlands will be created and temporary inundation of the floodplain will be restored to over 400 acres of the study area.
- Executive Order No. 11988 (Floodplain Management). Through restoration efforts, the project will improve, and in most cases restore, critical functions that provide for the health of the floodplain.
- Endangered Species Act of 1973, as amended. The project will provide important habitat for the endangered Southwestern Willow Flycatcher, Yellow-Billed Cuckoo, and New Mexico Meadow Jumping Mouse.
- Bald Eagle Protection Act of 1940. The project would ensure existing and future roost sites for migratory eagles. The restoration would indirectly benefit the eagle from water quality and higher fish availability.
- Migratory Bird Treaty Act of 1918, Migratory Bird Conservation Act of 1929, and associated treaties. Habitat improvements and diversification will benefit 140 resident and migratory birds using the MRG as a travel corridor and breeding site. Habitat improvements will benefit neotropical migrants by providing essential feeding and resting habitats along the Rio Grande flyway.

Many aspects of the bosque are associated “with cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community" (Parker and King 1990:1). Restoring the bosque, therefore, also provides cultural and religious benefits for the Tribal sponsors (see Section 2.4.1.2 Traditional Cultural Properties).

Additional flooding and ecosystem photos may be found in Appendix I – Plan Formulation. Additional information regarding Purpose and Need for ecosystem restoration may be found in Appendix C – Environmental Resources, or for recreation may be found in Appendix B – Economics.

### 1.5.3 Recreation

In addition to restoration efforts, opportunities exist to improve passive recreation opportunities associated with the restored floodplain. Historically, the bosque has been used by recreationists for fishing, hunting, hiking, horseback riding, bird watching, and picnicking. Ecological degradation of the bosque within the study area has caused the numbers of people who use the bosque for passive recreation to decline. In addition, the bosque is culturally important to the members of the Tribal sponsors.

### 1.6 Regulatory Compliance

This Environmental Assessment (EA) was prepared by USACE, Albuquerque District, in compliance with all applicable Federal Statutes, Regulations, and Executive Orders, 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 (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*.)
- Executive Order 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*.)
- Executive Order 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*.)
- Executive Order 11593, Protection and Enhancement of the Cultural Environment
- Executive Order 11990, Protection of Wetlands
- U.S. Army Corps of Engineers' Procedures for Implementing NEPA (33 CFR Part 230; ER 200-2-2)
- Farmland Protection Policy Act (7 U.S.C. 4201 *et seq.*)
- Executive Order 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)

- Executive Order 13524, Federal Leadership in Environmental, Energy, and Economic Performance
- EO 13653, Preparing the United States for the Impacts of Climate Change

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

## 1.7 Planning Process

The USACE plan formulation process, as specified in ER 1105-2-100 (Planning Guidance Notebook) was used to develop measures and elements used in solving identified problems and ultimately to develop an array of comprehensive alternatives from which a plan is recommended for implementation.

This section presents the rationale for the development of a tentatively selected plan. It describes the USACE iterative six-step planning process 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. **Identifying Problems and Opportunities:** The specific problems and opportunities to be addressed in the study are identified, and the causes of the problems are discussed and documented. Planning goals are set, objectives are established, and constraints are identified. This has been accomplished for the current study stage.
2. **Inventorying and Forecasting Resources:** 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. **Formulating Alternative Plans:** 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. **Evaluating Alternative Plans:** 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 (National Economic Development [NED], Environmental Quality [EQ], Regional Economic Development [RED], and Other Social Effects [OSE]) specified in

USACE' *Principles and Guidelines* and ER 1105-2-100. This has taken place for the final array of alternatives and tentatively selected plan during this phase of study.

5. **Comparing Alternative Plans:** 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 and ecosystem restoration 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 tentatively selected plan.

6. **Selecting the Recommended Plan:** A plan is selected for recommendation, and related responsibilities and cost allocations are identified for project approval and implementation.

### 1.7.1 Public Concerns

The non-Federal sponsors and the public have expressed interest in addressing flooding risk management issues from the Rio Grande, the Arroyo Guachupangue, the Santa Cruz River, and the Rio Pojoaque. These watercourses have caused damages in the past from small, frequent events, and there is concern that larger, less frequent events, will result in significant damages.

Ohkay Owingeh Pueblo has also expressed an interest in addressing FRM resulting from flows in the Rio Grande and its tributaries. These problems are affecting critical infrastructure within the floodplains, in particular the San Juan Elementary School. They have also expressed an interest in bosque habitat restoration, including the removal of non-native species and the planting of native species. Some of the bosque area is used in traditional / cultural practices.

Santa Clara Pueblo has expressed an interest in addressing FRM problems throughout the Pueblo. The central Pueblo area frequently suffers from flood problems. Also, the existing spoil banks along the Santa Cruz River are inadequate, with frequent flood damages resulting from their poor condition. For many areas in the bosque, there is a need for a hazardous fuels reduction treatment plan that can be accomplished through ecosystem restoration measures. The Pueblo expressed an interest in restoring the bosque areas and potentially including recreational facilities, such as picnic areas, river walks, and biological exhibit areas. Some of the bosque area is used in traditional / cultural practices.

San Ildefonso Pueblo has expressed an interest in addressing FRM problems along the main stem of the Rio Grande and the Rio Pojoaque. They have also expressed an interest in restoring the Rio Grande's floodplains and its bosque, including the removal of non-native species and replanting with traditional native species. Some of the bosque area is used in traditional / cultural practices.

#### *1.7.1.1 Non-Federal sponsor's planning considerations*

Each of the three Tribal sponsors, the Pueblos of Ohkay Owingeh, Santa Clara and San Ildefonso, expressed their desire at various times during the study that they wanted to limit the locations of FRM and ecosystem restoration measures to their Tribal lands. In addition:

- Ohkay Owingeh preferred that formulated FRM alternatives be limited to the area in the vicinity of the San Juan Elementary School instead of all Tribal lands located within the floodplain.
- Santa Clara preferred that formulated non-structural FRM alternatives be limited to critical infrastructure within the floodplain.

During the course of this study, after ecosystem restoration management measures had been identified, San Ildefonso Pueblo's Tribal Council determined to remove ecosystem restoration from their part of the study due to economic constraints. USACE and San Ildefonso continued to formulate FRM alternatives.

### 1.7.2 Problems and Opportunities

Water resources projects are planned and implemented to solve problems, meet challenges and seize opportunities. In the planning setting, a problem can be thought of as an undesirable condition such as those expressed by the public above. An opportunity offers a chance for progress or improvement of the situation. The identification of problems and opportunities gives focus to the planning effort and aids in the development of planning objectives. Problems and opportunities can also be viewed as local and regional resource conditions that could be modified in response to expressed public concerns. This section identifies the problems and opportunities in the study area based on the assessment of existing and expected future without-project conditions.

#### *1.7.2.1 Flood risk management*

USACE reduces the risk to human safety and property damage in the event of floods through the Flood Risk Management business line. With the exception of reservoirs, upon completion, most infrastructure built under the auspices of FRM is transferred to the non-Federal sponsor, who then owns and operatives the project.

Over the years, USACE's mission of addressing the causes and impacts of flooding has evolved from flood control and prevention to more comprehensive FRM. These changes reflect a greater appreciation for the complexity and dynamics of flood problems – the interaction of natural forces and human development – as well as for the Federal, State, local, and individual partnerships needed to manage the risks caused by heavy rains.

Risk management is the process of identifying, evaluating, selecting, implementing, and monitoring actions to mitigate levels of risk. Its goal is to ensure scientifically sound, cost-effective, integrated actions that reduce risks while taking into account social, cultural, environmental, ethical, political, and legal considerations. USACE's approach to FRM relies on productive collaborations with partners and stakeholders, including the Federal Emergency Management Agency (FEMA), the Department of Housing and Urban Development, the National Oceanic and Atmospheric Administration (NOAA), affected State agencies, sponsors, and citizens. Effectively and efficiently, these collaborations heighten the nation's awareness of flood risks and consequences.

Floodplain mapping demonstrates the potential of flood risks to private property, public infrastructure, and to human health and safety:

- *Opportunities exist to reduce flood risk to private property and public infrastructure within the study area.*
- *Opportunities exist to prevent flood risks to human health and safety within the study area.*
- *Opportunities exist to increase awareness of flood potential within the study area.*
- *Opportunities exist to provide a basis for future local planning regarding development on the floodplain within the study area.*

*1.7.2.2 Ecosystem restoration*

Ecosystem restoration is one of the primary missions of the USACE Civil Works program. The purpose of Civil Works ecosystem restoration activities is to restore significant ecosystem function, structure, and dynamic processes that have been degraded. Ecosystem restoration efforts involve a comprehensive examination of the problems contributing to the system degradation, and the development of alternative means for their solution. The intent of restoration is to partially or fully reestablish the attributes of a naturalistic, functioning, and self-regulating system:

- Channelization activities, unlawful gravel mining and non-engineered spoil banks have modified the hydrology in the study area, thereby changing the composition of native bosque plant species and associated wildlife habitats.
- Surface/groundwater interactions and sedimentation dynamics that are important for sustaining and regenerating bosque vegetation have been negatively affected by changes in river hydrology.
- Tribal and cultural resources have become limited due to changes in habitat.
    - *Opportunities exist to reconnect the Rio Grande and tributaries to their floodplains within the study area.*
    - *Opportunities exist to restore sustainable ecosystem structure and function to valuable bosque habitat within the study area.*
    - *Opportunities exist to improve water quality in the Rio Grande and its tributaries by addressing turbidity, sediment deposition, and aggradation through ecosystem restoration measures within the study area.*
    - *Opportunities exist to expand Tribal use of the river and bosque within the study area.*

An interagency habitat team was convened with members from the Pueblos of Ohkay Owingeh, San Ildefonso, and Santa Clara, and representatives from the U.S. Fish and Wildlife Service

(USFWS), U.S. Bureau of Reclamation (BOR), New Mexico Department of Game and Fish (Game and Fish), the U.S. Forest Service (USFS), and the U.S. Bureau of Indian Affairs (BIA), La Calandria Consultants, and the Audubon Society. The habitat team participated in reviewing two potential models for estimating habitat values (Appendix C). The team provided input to sponsors and the USACE on possible habitat restoration measures for the project, assisted with screening measures, and reviewed documents.

### 1.7.3 Planning Objectives and Constraints

Planning objectives are specified in an iterative process. It begins with broad and general objectives and proceeds through a refining process to study specific objectives. Early in the study, they are vague but reasonable statements of what we want our recommended plan to produce. As the study progresses and our understanding of the problems increases, the objectives become more specific. Unless otherwise specified, it should be assumed that the period of analysis is the appropriate time frame for meeting the objectives. Constraints may evolve in a similar fashion.

#### *1.7.3.1 *Federal planning objectives*

Alternative plans are evaluated with respect to the four accounts discussed in Section 1.6:

- Contribute to the NED consistent with protecting the Nation's environment, pursuant to National environmental statutes and applicable Executive Orders, and following other Federal planning requirements.
- Contribute to NER through increasing the net quality and/or quantity of desired ecosystem resources.
- Determine whether ecosystem restoration plus FRM in this reach of the Rio Grande are consistent with the Federal objectives stated above.

#### *1.7.3.2 *Specific planning objectives*

- Reduce flood risk to private property and public infrastructure within the study area for the life of the project.
- Reduce flood risks to human health and safety within the study area for the life of the project.
- Reconnect the Rio Grande and its tributaries to their floodplains within the study area for the life of the project.
- Increase the amount and quality of valuable bosque habitat in the study area for the life of the project.
- Increase the diversity of riparian habitat types in the study area for the life of the project.

- Provide recreational opportunities to the public in the study area for the life of the project.

*1.7.3.3 Specific planning constraints*

Water delivery policies and regulations will affect water availability for ecosystem restoration measures. Water oriented legislation and policies include, but are not limited to the following:

- Rio Grande Water Compact.
- New Mexico State Engineer's Regulations.

### 1.7.4 Key uncertainties

Each of the three non-Federal sponsors is an individual, dependent sovereign nation with its own government and Tribal legislation. Per Tribal policy, each of management measures needed to go before each Tribal council for review and resolution prior to alternative formulation. This was accomplished. The process will have to be repeated prior to implementation in order to become a part of their Tribal code.

## 1.8 Existing and Ongoing Water Projects

### 1.8.1 San Juan Chama Project

Bureau of Reclamation's (BOR) San Juan Chama (SJC) Project consists of a trans-basin diversion that takes water from the Navajo, Little Navajo, and Blanco Rivers, upper tributaries of the San Juan River (of the Colorado River Basin), for use in the Rio Grande Basin in New Mexico (Reclamation 2013). The firm yield of the SJC Project is 96,200 acre feet per year, which provides Supplemental Water supplies for various communities and irrigation districts.

The water from the San Juan Chama Project is included in modeling supporting the hydrology, hydraulics and ecosystem restoration aspects of this study.

*1.8.1.1 Heron Dam and Reservoir*

Heron Dam and Reservoir (Heron) on Willow Creek (a tributary to the Rio Chama) in northern New Mexico was built in the late 1960s and is the principal storage reservoir for SJC Project water from the San Juan River system of the upper Colorado River Basin (Reclamation 2013). Only imported SJC Project water may be stored in Heron Reservoir requiring all native flows to be bypassed; therefore, Rio Grande Compact requirements do not apply.

*1.8.1.2 Nambe Falls Dam*

The Pojoaque Tributary Unit, a component of the SJC Project, stores water at the Nambe Falls Dam and Reservoir (Reclamation 2013). The dam is located on the Rio Nambe, which is a tributary to the Rio Grande, and provides approximately 1,030 AF of Supplemental Water for about 2,768 acres of irrigated lands. About 34% of the irrigated lands are Indian lands located on the Nambe, Pojoaque, and San Ildefonso Pueblos.

Construction of Nambe Falls Dam began in June 1974 and was completed in June 1976. Cyclical operations of Nambe Falls consist of non-irrigation season operations and irrigation season operations and cause depletions to native Rio Grande water.

To offset these depletions and to keep the river whole, Reclamation releases SJC Project water from Heron Reservoir, as is described in the 1972 Contract (#14-06-500-1986) between Reclamation and the Pojoaque Valley Irrigation District. An annual depletion amount is calculated for Nambe Falls operations for the entire year, and the offsetting SJC Project water is released from water allocated for this purpose at Heron Reservoir. The actual annual SJC Project water allocation used to offset the effects of Nambe Falls Reservoir storage has varied.

### 1.8.2 Abiquiu Dam and Reservoir

#### *1.8.2.1 Flood regulation*

The Abiquiu Dam and Reservoir project is situated on the Rio Chama about 32 river miles upstream from its confluence with the Rio Grande. The project was authorized for construction by the Flood Control Act of 1948, (Public Law [P.L.] 80-858) and the Flood Control Act of 1950 (P.L. 81-516). Construction of Abiquiu Dam was initiated by USACE in 1956 and the project was completed and placed into operation in 1963. The dam is a rolled earth fill structure with a crest length of 1,800 feet, and the maximum height above the stream bed is approximately 341 feet. The drainage area contributing flow to Abiquiu Reservoir comprises 2,146 square miles. Inflow to Abiquiu Reservoir is, in part, regulated by Heron and El Vado dams, which are operated by the BOR.

Abiquiu Dam was initially authorized to be operated solely for flood and sediment control. Subsequent legislation added authority for water supply storage (specifically, San Juan-Chama Project water storage). The reservoir's storage allocations include 502,000 ac-ft for flood control and 77,039 ac-ft for sediment retention. At the end of 2009, an estimated 40,616 ac-ft of the initial 77,039 ac-ft sediment reserve space remained unfilled. Storage of San Juan-Chama water occurs within the flood-control space and unused portion of the sediment reserve space.

Under current operating procedures, Rio Grande basin flow and releases from El Vado Reservoir upstream are passed through Abiquiu Reservoir without regulation. The only situation in which USACE would take any action would be to maintain the safe channel capacity downstream. Due to reach-specific safe channel capacity constraints, releases from Abiquiu Reservoir are restricted to 1,800 cfs directly below the dam; 3,000 cfs at the Chamita gage for the Rio Chama downstream from the dam; and 10,000 cfs at the Otowi gage (southern boundary of San Ildefonso) for the Rio Grande main stem. At the Chamita and Otowi locations, the Rio Chama and Rio Grande channels carry flow from sources other than Abiquiu Dam. USACE limits releases from Abiquiu Dam such that those releases, in combination with current in stream flows, do not exceed any of the three safe channel capacity limits.

Operation of Abiquiu Dam for flood control is coordinated with Cochiti, Galisteo, and Jemez Canyon dams, which are jointly operated for a maximum safe channel capacity of 7,000 cfs at the Albuquerque gage (Central Avenue Bridge). Flood regulation is initiated at Abiquiu Dam when flows into the reservoir exceed the capacity of the Rio Chama downstream from the dam or when flows on the Rio Grande equal or exceed its channel capacity. Flood regulation at Abiquiu Reservoir can be expected from April through June. The maximum water storage to date has been 402,258 ac-ft (elevation 6,261.1 feet), which occurred in June 1987.

#### *1.8.2.2 Hydropower*

Abiquiu Dam was modified in 1991 to include a hydroelectric power facility. The County of Los Alamos constructed and maintains the power plant. Effectively, all dam releases are currently diverted through the power plant for generation of electricity. However, a written agreement between the County and USACE prior to constructing the plant stipulates that no releases will be made specifically for the benefit of the power plant (USACE 1995). The plant is a run-of-the-river facility and has no impact on reservoir storage or releases.

### 1.8.3 The Bureau of Reclamation's Middle Rio Grande Project

The Middle Rio Grande Project was authorized by the Congress to improve and stabilize the economy of the Middle Rio Grande Valley by rehabilitation of the Middle Rio Grande Conservancy District facilities and by controlling sedimentation and flooding in the Rio Grande. The Bureau of Reclamation (Reclamation) and USACE jointly planned the comprehensive development of the project.

Reclamation undertook the rehabilitation of El Vado Dam, rehabilitation of project irrigation and drainage works, and channel maintenance. USACE was assigned the construction of flood control reservoirs and levees for flood protection from Espanola to Albuquerque, NM.

The Reclamation project extends along the Middle Rio Grande Valley from Cochiti Dam south to the backwaters of Elephant Butte Reservoir. It includes maintenance of the Rio Grande in the vicinity of Truth or Consequences, New Mexico.

Built originally by the Middle Rio Grande Conservancy District, the irrigation features of the project divert water from the river to irrigate up to 89,652 acres of irrigable land between Cochiti and Elephant Butte dams. There are 30,000 acres of Indian water right lands within the project. Construction features rehabilitated by Reclamation in addition to El Vado Dam are Angostura, Isleta, and San Acacia Diversion Dams (Reclamation, 2009). Only El Vado Dam is relevant to this study as it is the only feature which lies upstream of the study area.

#### *1.8.3.1 El Vado Dam and Reservoir*

MRGCD initiated construction of El Vado Dam in 1929 and completed it in 1935 (Reclamation 2013). Reclamation operates El Vado Dam and Reservoir pursuant to the 1951 contract with the MRGCD. The total maximum storage of El Vado Reservoir is about 196,000 AF, though sediment and operational restrictions have reduced its effective capacity to about 180,000 AF. El Vado is used to store native Rio Grande and SJC Project water for MRGCD and to store native flows to ensure there is sufficient supplies for the prior and paramount lands of the Six MRG Pueblos pursuant to the "Agreement: Procedures for the Storage and Release of Indian Water Entitlement of the Six Middle Rio Grande Pueblos," approved by the Secretary of the Interior, December 28, 1981, (1981 Agreement) (discussed below). MRGCD is not a party to the 1981 Agreement. When space is available, Reclamation and MRGCD may store SJC Project water in El Vado Reservoir for other users and other purposes. Storage of large volumes of SJC Project water may take place for extended periods of time.

Consistent with Article XVI9 of the Compact, water is held in El Vado each year regardless of Article VII restrictions, to ensure that water can be provided to meet the demand for the Six MRG Pueblos, which is tracked separately with a daily accounting model and released to specifically meet the demand for the Pueblos. Pursuant to the 1928 Act, the Pueblos have the prior and paramount right to divert Rio Grande natural flow; but due to diversions by others, sufficient natural flow may not always be available to the Pueblos when needed. Consequently, the Secretary of the Interior designates space in El Vado Reservoir to ensure that water is available for prior and paramount lands of the Six MRG Pueblos should the natural flow prove insufficient. This water can be released to meet irrigation demand for prior and paramount lands, as discussed below.

Within El Vado Dam sits a Federal Energy Regulatory Commission-regulated hydroelectric plant that is owned and operated by Los Alamos County. The plant operates as a "run of the river" facility; therefore, releases are not made for the sole purpose of generating power, but power is a byproduct of releases made for MRG Project purposes.

# 2 - Existing and Expected Future Without-Project Conditions

Existing conditions are defined as those conditions that exist within the study area at the time of the study. The expected future without-project condition, which is the same as the “No Action” alternative, is a projection of how these conditions are expected to change over time if no USACE plan is implemented and forms the basis against which alternative plans are developed, evaluated, and compared. The term baseline is also used to refer to the existing conditions at the time of a measurement, observation, or calculation and may be used occasionally throughout this report.

The expected future without-project condition is the most likely condition expected to exist in the future in the absence of a proposed water resources project. Proper definition and forecast of the expected future without-project condition are critical to the success of the planning process. The expected future without-project condition constitutes the benchmark against which alternatives are evaluated. Forecasts of the expected future without-project conditions shall consider all other actions, plans and programs that would be implemented in the future to address the problems and opportunities in the study area in the absence of a USACE project. Forecasts should extend from the base year (the year when the proposed project is expected to be operational) to the end of the life of the project.

## 2.1 Hydrology, Hydraulics and Sediment Transport

### 2.1.1 Hydrology

Hydrology investigates the relationship between rainfall, runoff, and stream flows within watersheds. The hydrologic analyses for this project included a standard flood risk analysis and an environmental features analysis. The flood risk analysis was performed with statistical methods using U.S. Geological Survey (USGS) river gage data and watershed modeling using HEC-HMS. The flood flows for eight risk levels were determined. The hydrology for the ecosystem restoration measures for two tributaries and the Rio Grande was solely based on USGS gage data. This hydrologic analysis was completed with HEC-EFM for two target species: willows and cottonwoods (Appendix A).

The annual chance exceedance (ACE) (0.2%, 0.5% 1%, 2%, 5%, 10%, 20%, and 50%) refer to the probability of a particular flow event being exceeded in any one year. Therefore, the previous nomenclature of the “100-year flood” is more properly defined as the flood having a 1% chance of being exceeded in any one year. Similarly, the 5% ACE flood was previously called the “20-year” flood, the 2% ACE flood was previously called the “50-year” flood, and the 0.2% ACE flood was called the “500-year” flood (Appendix A, Attachments 1 and 3).

#### *2.1.1.1 Historic Conditions*

The Rio Grande and Rio Chama are regulated systems whose flows are strongly impacted by irrigation withdrawals, water storage reservoirs, and downstream water deliveries. Flow reductions of 40-70% on the Rio Grande due to upstream irrigation withdrawals (National Resource Commission, 1938) have resulted in reduced meander wavelength, increased channel sinuosity, reduction in multiple-channel reaches and increased channel stability in the Upper Rio Grande Basin. Upper basin water resource development projects probably had little impact on the annual sediment loads of the Rio Grande, since historically, the sediment delivery to the Española Valley reach from the Upper Basin was low.

Flow changes on the Rio Chama have been more profound. Closure of Abiquiu Dam in 1963 resulted in the capture and storage of winter runoff, resulting in significant reductions in peak spring runoff flows in the lower Chama. These changes have also reduced spring runoff flows on the Rio Grande below the confluence, since historically a large fraction of these flows originated on the Rio Chama. In addition, during major precipitation events, reservoir releases from Abiquiu Dam are scheduled to not coincide with peak flows on the Rio Grande, significantly reducing peak flows downstream of the confluence. Finally, Abiquiu Dam captures sediment from the Rio Chama that historically would have been the major source of sediment transported by the rivers through the Española Valley. Additionally, Heron Lake, a smaller storage reservoir upstream of Abiquiu, also retains spring runoff. Both Abiquiu and Heron release stored water for irrigation during the summer months, augmenting base flow. Much of this water transits the study area on its way to users downstream.

The Colorado River compact has led to increased summer flows along the Rio Chama and Rio Grande. Since completion of the San Juan-Chama project in 1971, approximately 110,000 ac-ft of water is diverted annually from the Colorado Basin, stored in reservoirs along the Rio Chama upstream of the study area, and released to irrigators downstream of the study area during the summer and early fall.

Thus water storage on the Rio Chama has had the effect of both reducing spring runoff flows and increasing summer base flows throughout the study area. In addition, sediment is trapped behind storage dams, resulting in downstream flows that are sediment-starved compared to historic flows, with significant impacts to channel form and function.

#### *2.1.1.2 Existing Conditions*

The Rio Grande originates in the San Juan Mountains of southern Colorado at an elevation above 14,000 ft, and flows through the San Luis Valley before turning south to enter the Rio Grande Gorge near the Colorado-New Mexico state line. The Rio Grande emerges from the canyon near the town of Embudo at the northern end of the Española Valley. Through the Española Valley, about 30 miles in length, the Rio Grande receives runoff from high mountains and foothills (Sangre de Cristo Mountains) to the east and lower mountains and plateaus (Jemez Caldera) to the west (Figure 4). The Rio Grande exits the Española Valley through White Rock canyon, at the head of which is Otowi Gage at an elevation of approximately 5,488 ft.

The Rio Chama originates along the south side of the San Juan Mountains at an elevation above 12,000 ft and flows generally southeast towards its confluence with the Rio Grande at an elevation of 5,615 ft 15 miles downstream of Embudo. Dams along the Rio Chama have significantly affected stream flow (see Historic Condition section above, and Appendix A).

Four additional tributaries are included in this assessment (Figure 4). The Rio Pojoaque and the Arroyo Guachupangue, the largest and smallest of these four tributaries respectively, are arroyos with ephemeral flows. The remaining tributaries, Santa Clara Creek and the Santa Cruz River have flows year round. While locally important water sources, these tributaries' flows are small compared to those the Rio Grande and Rio Chama.

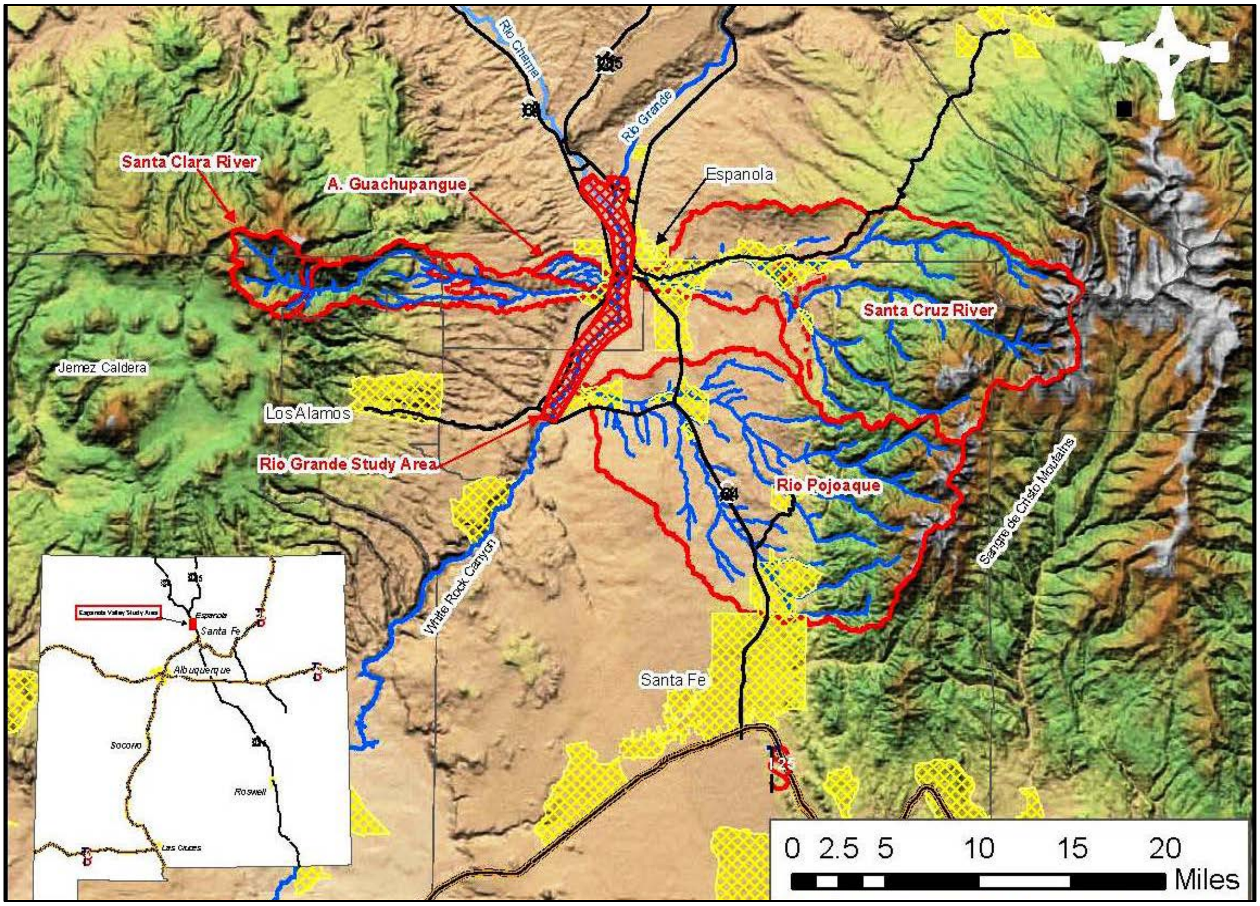



**Figure 4 Map showing locations of Rio Grande and its tributaries in relationship to the study area.**

Peak discharges are developed so that the risk of flooding can be estimated in the floodplains. The peak discharge is the flood flow that produces the highest flood stage and maximum extend of flood inundation.

Two watersheds were modeled using HEC-HMS v.3.1.0 and Environmental Systems Research Institute (ESRI) ArcMap 9.1 with the HEC-GeoHMS add-ons. Then USGS gage data was used for the other four waterways (Table 1) (Figure 5).

**Table 1 Summary of peak discharges for the Rio Grande and its tributaries.**

| | | Estimated Peak Discharge per ACE (cfs) at confluence | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Drainage Area (sq. mi.)** | **50%** | **20%** | **10%** | **4%** | **2%** | **1%** | **0.5%** | **0.2%** |
| Rio Grande* | 11,360 | 6,525 | 10,450 | 13,100 | 15,700 | 19,050 | 21,600 | 24,200 | 27,650 |
| Rio Chama | 3,159 | 2,550 | 3,225 | 3,700 | 4,375 | 5,250 | 6,000 | 6,975 | 8400 |
| Arroyo Guachupangue | 4.9 | 2,50 | 820 | 1,240 | 1,830 | 2,300 | 2,800 | 3,300 | 3900 |
| Santa Clara Creek | 50 | 200 | 840 | 1,580 | 2,700 | 3,600 | 5,200 | 9,300 | 15900 |
| Santa Cruz River | 183 | 550 | 1,920 | 3,200 | 4,800 | 6,100 | 8,000 | 10,500 | 16000 |
| Rio Pojoaque | 195 | 250 | 4,300 | 8,070 | 12,500 | 16,900 | 22,200 | 28,200 | 37800 |

**At Otowi Bridge.*

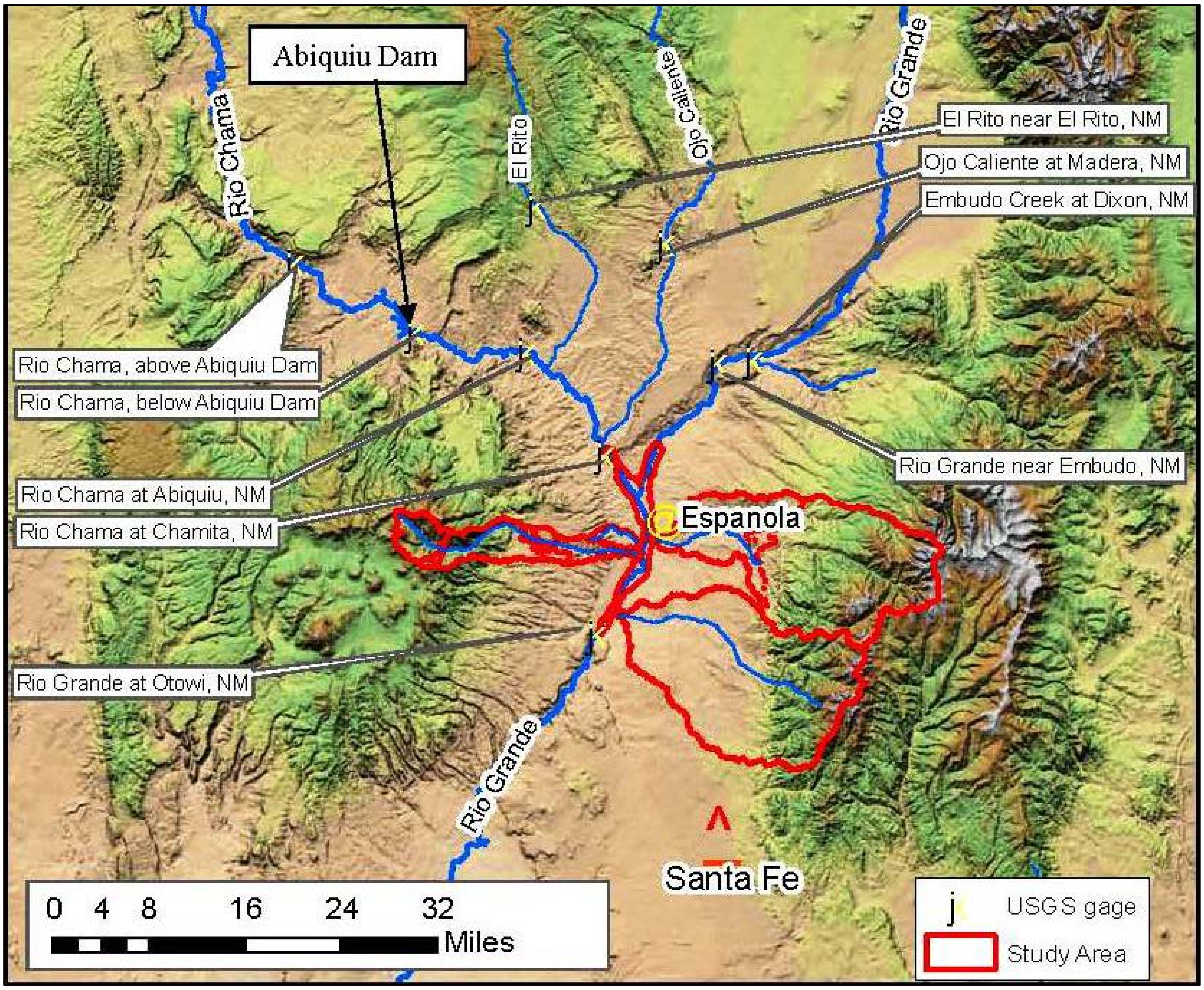



**Figure 5 Map of USGS gage locations in relationship to the study area and Abiquiu Dam.**

### *2.1.1.3 Expected Future Without-Project Condition*

Although the stream gage record is considered extensive on this section of the Rio Grande, 120 years is not enough time to accurately estimate the full suite of potential peak flows for the expected future without-out project condition. The average and variability of flows at gages in the study area mask large changes in actual flow over the gaging period of record, including a wet period without historic precedent and two droughts.

The expected future without-project hydrology is anticipated to remain largely unchanged as there are no plans for additional flood risk management or water conservation storage structures on either the Rio Grande or the Rio Chama. There are currently no plans to alter how these structures are operated and no plans to change the schedule for downstream water delivery. Land use and land cover are also not anticipated to change significantly from their current condition.

Climate models project long term warming throughout the Upper Rio Grande basin (Melillo et al 2014), including in the winter at higher elevations across the southwest , including the Sangre de Cristo and Jemez Mountains (Gutzler 2006). This is likely to reduce the amount of precipitation falling as snow and therefore reduce spring runoff volumes and summer base flows on the Rio Grande and its tributaries (Reclamation 2013), including those in the study area. For more information on climate change impacts to the study area, see Appendix G.

### 2.1.2 Fluvial Geomorphology

An understanding of river and stream channel responses to human-caused and natural occurrences is necessary to formulate appropriate measures to address FRM and ecosystem restoration issues of management, conservation and restoration. The study of past effects is necessary to intuit future changes.

The geomorphic investigation primarily focused on the Rio Grande from the upstream (northern) boundary of the Ohkay Owingeh Pueblo downstream into the White Rock Canyon, which is located on the San Ildefonso Pueblo just downstream of Otowi Bridge (about 20 miles) and the Rio Chama from about one mile upstream of the Ohkay Owingeh Pueblo boundary to its confluence with the Rio Grande (Appendix A, Attachment 2).

#### *2.1.2.1 Historic Conditions*

Expansion of irrigated agriculture in the post-Spanish period probably resulted in a significant reduction in the native bosque vegetation, but it is unlikely that there were significant impacts to the river channels. Overgrazing of the watersheds by sheep and cattle led to a significant increase in watershed sediment yield and subsequent aggradation of the Rio Grande streambed and the floodplain.

Large flood flows in 1941 and 1942, and the aggraded nature of the Rio Grande in the Española Valley, led the New Mexico State Engineer to construct non-engineered spoil banks in 1949. The May-June flood in 1952 caused significant damage to these spoil banks, and as a result, the BOR straightened and channelized the river, rebuilt the spoil banks using dredged material between 1955 and 1957. Excess spoil from dredging was used to fill in old Rio Grande meanders. Channel maintenance and bank stabilization activities by the BOR were conducted as necessary to maintain the channel capacity into the 1980s.

Extensive sand-and-gravel mining occurred in the Rio Grande and on the floodplain/terrace in the lower reaches of the Ohkay Owingeh Pueblo in the 1980s. Approximately 10 feet of material was removed from the bed of the river and this has lead to both vertical instability and increased rates of lateral erosion of the over-heightened banks. The combined effects of the channelization and the sand-and-gravel mining caused the upstream migration of channel bed head-cuts that caused incision that varies from over 10 feet at the downstream end of the reach to about 2 to 3 feet at the upstream end of the Ohkay Owingeh Pueblo reach.

There are few data available to characterize the historical channel conditions in the Rio Chama or the major tributaries within the project reach.

### *2.1.2.2 Existing Conditions*

The combined effects of reduced peak flows, channelization and spoil piles, channel incision and the extensive presence of bank-reinforcing non-native vegetation (primarily Russian olive and tamarisk) have resulted in a 68-84% reduction in channel width and a reduction in active floodplain width for both the Rio Grande and Rio Chama. In conjunction with channel incision and a 50% decrease in sedimentation due to upstream dam construction, the reduced peak flows have effectively disconnected the rivers from their floodplains. The bed is currently stable (neither aggrading nor degrading). From a geomorphic perspective, the historical floodplains located along the Rio Chama and Rio Grande within the project boundaries under existing conditions should probably be classified as "terraces." A much wider and more densely vegetated bosque has developed compared to the bosque shown in 1935 aerial photographs as a result of colonization of inactive portions of the floodplain that were active in 1935. On both rivers, flows in excess of the 20% ACE peak flow are now required for floodplain inundation.

#### 2.1.2.2.1 Rio Grande

Channel sinuosity (the ratio of the channel length to the straight line valley length) for the individual sub-reaches of the Rio Grande and Rio Chama was determined from the 2007 aerial photography of the project reach. Under existing conditions, the Rio Grande, regardless of reach, is a very low sinuosity river. In 1935, the Rio Grande also had very low sinuosity and the channel, in certain reaches, was braided or wandering. In the Santa Clara and San Ildefonso Pueblo reaches, there is evidence of lateral migration, and if this is allowed to continue, there will be an increase in channel sinuosity over time. Comparison of the active channel and floodplain widths on the 1935 and 2007 aerial photographs indicates that the active channel width on the Rio Grande has been reduced by about 80 percent.

#### 2.1.2.2.2 Rio Chama

The combined effects of the reduced peak flows and reduced sediment supply, since the construction of Abiquiu Dam, should result in a channel with increased sinuosity. Although the sinuosity of the Rio Chama is slightly higher than that of the Rio Grande, it is still a low sinuosity river. However, in the lower reaches approaching it’s confluence with the Rio Grande, there is an indication that the sinuosity is increasing.

On the lower Rio Chama, there is some lateral migration of the river, and the sinuosity of the river has increased over time.

### *2.1.2.3 Expected Future Without-Project Conditions*

The mobile boundary sediment-transport models were executed over a 26-year simulation period to estimate the amount of aggradation or degradation and associated changes in channel geometry. The simulation period was based from WY1980 to WY2005 rainfall data from the City of Espanola. This rainfall was modeled in HEC-HMS for the two tributary watersheds to obtain flow hydrographs.

Results from the 26-year simulations are generally consistent with the results from the simulations for the eight individual flood hydrographs (Appendix A, Attachment 4, Sections 3.2 in both reports) and show little change from the existing conditions geomorphology.

### 2.1.3 Hydraulics

Water in a wetland, lake or a river is called surface water, and is lost by evaporation, infiltration, transpiration, and discharge to the oceans. The total quantity of water available in any system is dependent upon the storage capacity of any reservoirs, the permeability of the soil, the overflow characteristics of the watershed, precipitation, and the rate of evaporation and transpiration. The quantity of water consumed fluctuates over a time to which appropriate measures are sometimes necessary to manage natural resources.

The Rio Grande and its tributaries were hydraulically modeled using HEC-RAS v. 3.1.3. The model geometry was based on a variety of data including information from a 2007 survey of the main channel, previous cross-section surveys, and LiDAR-based mapping of the study reach. HEC-GeoRAS v. 4.1 and ArcGIS 9.2 were used to delineate the inundated area for each of the modeled flows (Appendix A, Attachments 3 and 5).

#### *2.1.3.1 Existing Conditions*

##### 2.1.3.1.1 Rio Grande

For hydraulic modeling purposes, the river was divided into 2 reaches with reach 1 beginning upriver of the northern border of Ohkay Owingeh and going downstream to the confluence with the Rio Chama. Reach 2 starts at the confluence with the Rio Chama and goes downriver 4,030 feet beyond Otowi Bridge towards the southern boundary of San Ildefonso. The hydraulic depth varies significantly in the Rio Grande (3.7 feet to 13.7 feet); with relatively shallow depths upstream of its confluence with the Rio Chama and large depths in the Española reach. Floodplain mapping indicates that the widest flooding occurs in the reach of the Rio Grande between Santa Clara Creek and the Santa Clara / San Ildefonso boundary because of the many floodplain constrictions (bridges). Significant wide flooding at the higher peak flows also occurs upstream from the NM Highway 74 Bridge (Ohkay Owingeh) through the City of Española, and downstream from the Rio Pojoaque (San Ildefonso) (Table 2).

In both the Rio Grande and Rio Chama, very little overbank flooding is indicated at the 50% ACE event, and relatively minor flooding occurs at the 20% ACE. The spoil piles in the vicinity of the City of Española generally contain flows up to the 10% ACE, with localized flow breakouts that cause relatively minor flooding at lower flood levels. Moderate flooding occurs at the 4% ACE due to overtopping of the spoil banks at numerous locations. The spoil banks do not contain flows that equal or exceed the 2% ACE resulting in significant flooding at larger flood flows (Appendix A, Attachment 5).

**Table 2 Acres inundated within each sub-reach of the Rio Chama and Rio Grande for each of the following ACE.**

| Acres inundated by ACE | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sub-Reach | 50% | 20% | 10% | 4% | 2% | 1% | 0.50% | 0.20% |
| Rio Chama | | | | | | | | |
| Ohkay Owingeh | 109.2 | 161.1 | 216.6 | 279.2 | 400.7 | 472.1 | 523.3 | 504.6 |
| Rio Grande | | | | | | | | |
| Ohkay Owingeh | 109.2 | 161.1 | 216.6 | 279.2 | 400.7 | 472.1 | 523.3 | 504.6 |
| Santa Clara | 218.4 | 322.2 | 433.2 | 558.4 | 801.4 | 944.2 | 1046.6 | 1009.2 |
| San Ildefonso | 327.6 | 483.3 | 649.8 | 837.6 | 1202.1 | 1416.3 | 1569.9 | 1513.8 |
| **Total** | **764.4** | **1127.7** | **1516.2** | **1954.4** | **2804.9** | **3304.7** | **3663.1** | **3532.2** |

#### 2.1.3.1.2 Rio Chama

For modeling purposes, the Rio Chama was divided into a single sub-reach. The hydraulic depth in this reach varies in the Rio Chama from 3.6 feet to 8.6 feet (Table 2). As expected, the largest flow depths in the Rio Chama are indicated in sub-reach 1 due to the backwater effects of the Chamita/Hernandez Irrigation Diversion (Appendix A, Attachment 5).

#### 2.1.3.1.3 Other Tributaries

Existing conditions for Santa Clara Creek, the Santa Cruz River, Rio Pojoaque, and the Arroyo Guachupangue are described in Appendix A.

### *2.1.3.2 Expected Future Without-Project Conditions*

A USACE contractor performed hydraulic, geomorphic, and sediment-transport analyses of the study reaches of the Arroyo Guachupangue and the Rio Pojoaque. The specific purposes of the analysis were to assess potential flooding conditions in the study area under existing and future without-project conditions, evaluate the stability of the channels and provide estimates of the sediment supply to the Rio Grande.

The study reaches of the two tributaries are as follows:

- Arroyo Guachupangue: Approximately 1,000 feet upstream from the residential neighborhood at the western limit of the City of Española, NM to the confluence with the Rio Grande (about 1.2 miles).
- Rio Pojoaque: Eastern boundary of the San Ildefonso Pueblo to the confluence with the Rio Grande (about 3.6 miles).

The future without-project analysis was performed by developing floodplain delineation mapping of the 50%, 20%, 10%, 4%, 2%, 1%, 0.5%, and the 0.2% ACE for steady-state peak flows. The channel geometry at the end of the 52-year simulation was imported into of the hydraulic models that were initially used to delineate the existing conditions. Results from the above model runs were used to delineate the flood boundaries for each of the modeled ACE (see Appendix A for results).

### 2.1.4 Sediment transport

Precipitation events and snow melt provide water to arroyos, streams and rivers as overland flow. This overland flow may pick up and move soils, rocks and debris to down slope waterways. The soils, rocks and debris are called sediment and their movement is called sediment transport. Analysis of sediment transport is necessary to properly formulate appropriate FRM and ecosystem restoration measures (Appendix A, Attachment 4).

The analyses were performed using a sediment-routing model that was developed using the mobile bed sediment-transport feature HEC-RAS v. 4.0. The model geometry and basic structure were taken from the hydraulic model that was developed for the floodplain delineation mapping of the arroyo. In-channel bed-material information was developed from bed-material samples collected during the October 2007 field surveys.

#### *2.1.4.1 Existing Conditions*

##### 2.1.4.1.1 Arroyo Guachupangue

Modeling results indicate that very little aggradation or degradation occurs under average annual conditions and during the 50% ACE. At the larger flood events, the majority of the reach is slightly degradational, with less than 1 foot of degradation at flows less than the 1% ACE (Figure 6).

At the downstream limit of the model, slight degradation occurs at flows up to the 10% ACE event, but moderate aggradation is indicated for the less frequent floods. The average annual total bed material volume delivered to the Rio Grande is about 1,740 tons, and ranges from about 620 tons during the 50% ACE event to about 12,830 tons during the 0.2% ACE event. The average annual unit bed material volume delivered to the Rio Grande is about 0.7 tons/acre, and ranges from about 0.2 tons/acre at the 50% ACE to about 4.1 tons/acre at the 0.2% ACE event (Appendix A, Attachment 4).

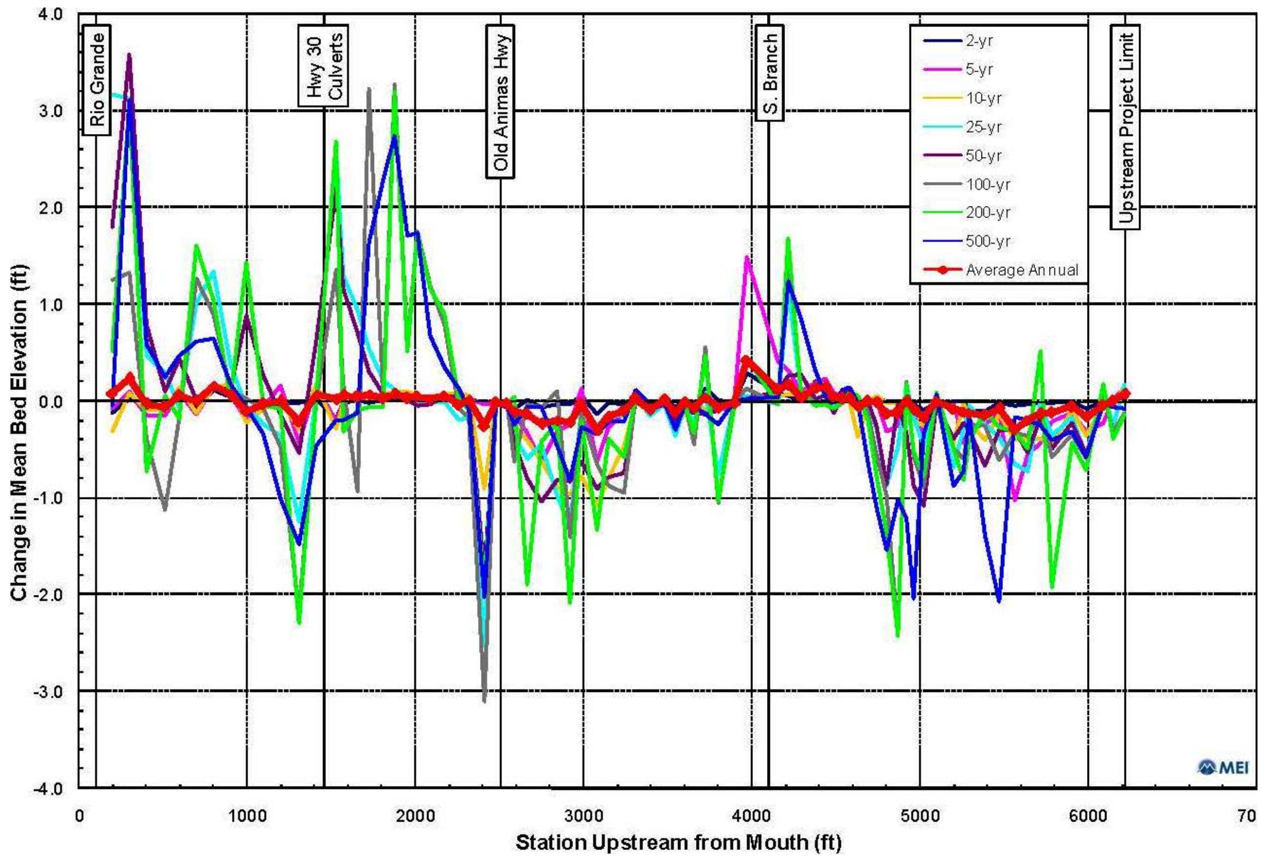



**Figure 6 Modeled change in bed elevation in Arroyo Guachupangue.**

### 2.1.4.1.2 Rio Pojoaque

Modeling results indicate that the overall project reach is roughly in equilibrium with the upstream and tributary sediment supplies, with generally small changes in elevation (less than 2 feet of aggradation or degradation at most cross sections for events up to the 1% ACE event), and average annual changes elevation at individual cross sections of less than 0.4 feet (Figure 7). Relatively little aggradation or degradation occurs under average annual conditions or during each of the flood hydrographs (Appendix A, Attachment 4).

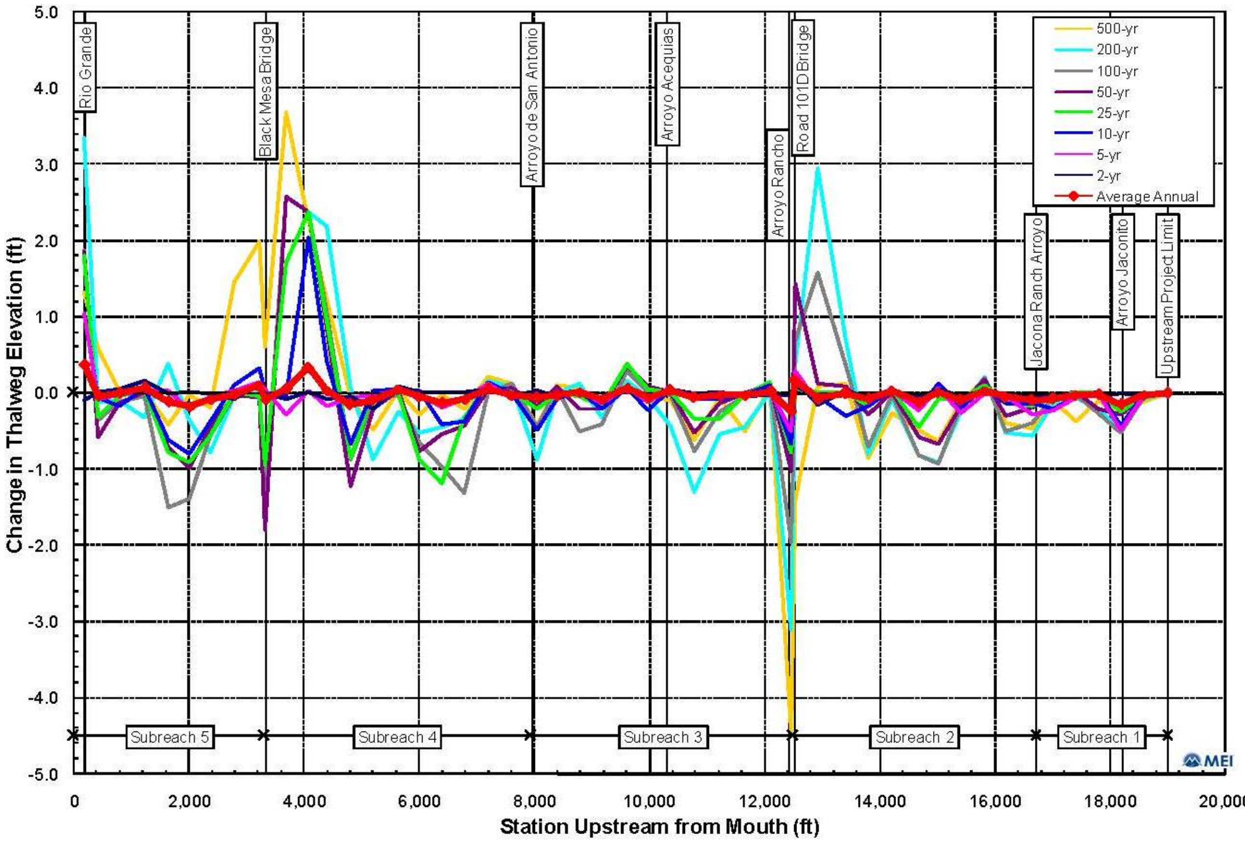



**Figure 7 Modeled change in bed elevation in the Rio Pojoaque.**

### *2.1.4.2 Expected Future Without-Project Conditions*

The mobile boundary sediment-transport models were executed over a 26-year simulation period to estimate the amount of aggradation or degradation and associated changes in channel geometry. The simulation period was based from WY1980 to WY2005 rainfall data from the City of Espanola. This rainfall was modeled in HEC-HMS for the two tributary watersheds to obtain flow hydrographs.

Results from the 26-year simulations are generally consistent with the results from the simulations for the eight individual flood hydrographs (Appendix A: Attachment 4: Sections 3.2 in both reports) and show little change from the existing conditions geomorphology.

Results from the above model runs were used to delineate the flood boundaries for each of the eight modeled floods, and the delineations compared to the existing conditions flood boundaries to determine the potential effects of aggradation and degradation on the extent of flooding.

#### 2.1.4.2.1 Arroyo Guachupangue

For the Arroyo Guachupangue, the predicted change in mean bed elevation is generally less than 1 foot (Figure 6). Local conditions result in about 3 feet of aggradation upstream from the South Branch confluence, under a foot of aggradation throughout the South Branch of Arroyo

Guachupangue reach, and up to 1.4 feet at a construction. The remainder of the Arroyo Guachupangue reach is moderately degradational, except for localized incision downstream from the culverts (Appendix A, Attachment 4).

#### 2.1.4.2.2 Rio Pojoaque

Except for 3.2 feet of aggradation for about 1,000 feet upstream of the Road 101D bridge, some degradation immediately downstream of this bridge, and approximately 0.8 ft of degradation just upstream of the confluence with Jacona Ranch Arroyo, very little change is indicated on the Rio Pojoaque within the study reach (Appendix A, Attachment 4).

## 2.2 Economics

### 2.2.1 Use of HEC-FDA 1.2.5 and special considerations for the study area

Consistent with the requirements set forth in EC 1105-2-412, "Assuring Quality of Planning Models" HEC-FDA version 1.2.5 was used to compute average annual and equivalent annual damages (EAD). Corps guidance stipulates that the plan which reasonably maximizes net national economic development benefits, consistent with the Federal objective, be identified. Project benefits for flood risk management measures are identified through successive iterations of existing and future without-project scenarios, changing key hydrologic and/or hydraulic variables as the measures warrant. FDA is the only model certified for formulation and evaluation of flood risk management plans using risk analysis methods, and was used in this study. Damages are computed in January, 2014 price levels using the fiscal year 2014 Federal discount rate of 3.5%. The period of analysis is 50 years. All tables as it relates to FRM are in January 2014 price levels

The study area included three Native American Reservations including non-tribal land. Furthermore, each tribe contained not only the main stem Rio Grande, but also contained a number of tributaries. Largely due to the hydrology/hydraulic changes in these rivers and tributaries, reaches were needed to differentiate the benefits associated with the four different entities and for each streams within those entities. Figure 4 in Appendix B displays the reaches used in this study.

### 2.2.2 Potential flood damages

It is estimated that the mean 1-percent chance exceedance flood would cause damages of about $4,440,000 in the study area. Tables B-6 and B-7 in Appendix B present the single occurrence damages associated with the 10%, 2%, 1%, and 0.2% chance flows in the assorted floodplains. It was assumed that flood events of a magnitude greater than the 20% chance event damage structures, contents, and vehicles in the flooding areas analyzed. 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 development or growth in the floodplain have not been included, but are not expected to be significant for several reasons. 1) Tribal property, which consists of the majority of the study area, is not expected to develop. 2) Local contacts have noted that most development in the study area may occur outside the floodplain.

#### 2.2.3 Average annual damages

Risk and uncertainty analysis was used to derive average annual damages. Hydrologic and hydraulic uncertainty was combined through Monte Carlo simulations within FDA. When flooding from all sources is considered, the study area faces the risk of approximately $533,190 in structures and contents. Tables B-12 and B-13 in Appendix B presents the average (Equivalent) annual damages that could occur from flooding in the study area without any flood protection. In addition, a sensitivity analysis was conducted to illustrate that when FDA was computed "without risk" the EAD damages only from FDA (structures and contents) decreased from $533,190 to $336,300

### 2.3 Environmental Resources

The Rio Grande is the 5th longest river in North America, and one of the top ten endangered rivers in the world (Wong et al. 2007). The Rio Grande in New Mexico comprises 484 miles (26% of total length). Riparian corridors comprise less than one percent of New Mexico's landscape (USEPA and NMED 1998), yet they are the most important ecosystems in the state (Roelle and Hagenbuck 1995).The Rio Grande flooplain contains patches of undeveloped bosque consisting of cottonwood and willow riparian habitat. Historically, flooding and scour were the basic processes that created and maintained a patchwork of variable age class forest stands in the bosque (Crawford et al. 1993; Scurlock 1998). Water resources development, by limiting flood magnitudes and mitigating stream scour, have contributed significantly to bosque loss through the region and in the project area. The surface area of wet meadows, marshes, and ponds has decreased by 73% along 250 miles of the Rio Grande floodplain in New Mexico.

The Española Valley study area extends nearly 20 miles (4% of the Rio Grande in New Mexico) in a separate sub-basin from the rest of the river valley. Its separation from other sub-basins by upstream and downstream canyons increases the value of the riparian ecosystem.

Forty percent of the Rio Grande floodway in New Mexico is managed by the U.S. Bureau of Reclamation in cooperation with the Middle Rio Grande Conservancy District (MRGCD). The majority of the riparian forest (bosque) managed by these two agencies is downstream of Isleta Pueblo which includes aggrading and incised sub-reaches of the river. Ecosystem restoration in this area must be balanced with irrigation demand and flood damage reduction.

Approximately 10% of the Rio Grande in New Mexico is managed by other federal and state agencies other than USBR and MRGCD. The 150 miles (~31%) of the Rio Grande floodway downstream of Elephant Butte Reservoir is constrained by agriculture. Other pueblos manage about ~60 miles (12%) of the Rio Grande in New Mexico.

The importance of the Rio Grande as a wildlife habitat and cultural resource in the region and nation, as well as the impact on the bosque of earlier interventions by Federal agencies, indicates there is a Federal interest in restoration. Channelization activities, unlawful gravel mining and non-engineered spoil banks have modified the channel geomorphology, thereby changing floodplain connectivity and shifting plant composition from the native bosque plant species to increasing invasive plant species. These changes in vegetation are anticipated to decrease wildlife habitat values. Surface/groundwater interactions and sedimentation dynamics that are important for sustaining and regenerating bosque vegetation have been negatively affected by changes in river morphology and hydrology.

### 2.3.1 Floodplains and wetlands

Executive Order 11988 (Floodplain Management) provides Federal guidance for activities within the floodplains of inland and coastal waters. Federal agencies are required to "ensure that its planning programs and budget requests reflect consideration of flood hazards and floodplain management." Removal of the non-native vegetation may allow the active floodplain to expand. Preservation of the natural values of floodplains is of critical importance to the nation and the State of New Mexico. These natural values include preservation of wetlands.

Wetlands consist of marshes, wet meadows, and seasonal ponds that typically support hydrophytic plants such as cattails, sedges and rushes. Wetlands are a critical component of bosque diversity. Wet meadows were the most extensive wetland habitat type in the Rio Grande valley prior to irrigation. The construction of the MRGCD drains and ditches led to substantial decreases in wetland habitat: from 1918 to present, wetland-associated habitats have undergone a 93% reduction (Hink and Ohmart, 1984; Scurlock, 1998). Wetlands are an integral component of the bosque ecosystem, not only increasing its diversity but also enhancing the value of surrounding plant communities for wildlife. Wetlands have experienced the greatest historical decline of any floodplain plant community. Among the greatest needs of the riparian ecosystem is the preservation of existing wetlands and expansion or creation of additional wetlands (Crawford et al., 1993).

Wetlands are lands transitional between terrestrial and aquatic ecosystems where the water table is at or near the surface or the land is covered by shallow water (Cowardin et al. 1979). Saturation with water determines the nature of soil development and, in turn, the types of plant and animals inhabiting these areas. Wetlands occurring within the riparian zone may be dominated by the same plant species common in the bosque; however, wetlands exhibit wetter soils and support many additional plant and animal species.

Historically, the Rio Grande channel wandered widely throughout its floodplain and abandoned channels often contained sufficient ground water discharge to support marshes (*cienegas*), sloughs (*esteros*), and oxbow lakes (*charcos*; Scurlock 1998, Ackerly 1999). Currently, the extent of wetland plant communities within the Middle Rio Grande reach has been significantly reduced. The ground water elevation throughout the valley was significantly lowered by the construction of the MRGCD drains in the 1930s. Wetland areas throughout the floodplain have been directly displaced by agricultural and urban development. Irrigation and flood control operations have reduced the magnitude of discharges within the floodway -- especially during the spring runoff period -- and limit the extent of overbank flooding.

Jurisdictional wetlands (relative to Section 404 of the Clean water Act) do occur in the Recommended Plan Area. Most wetlands within the floodway have developed in areas with a high groundwater table. Those in shallow basins or relatively far from the river are likely seasonally or temporarily flooded; that is, inundated during the majority, or just a portion, of the growing season, respectively. Within the Rio Grande floodway, most islands, point bars and side channels are periodically inundated by river flows and support marsh, meadow or shrub wetland communities.

Scurlock (1998) has summarized trends for historic Rio Grande riparian communities over the last 150 years (Appendix C). The riparian ecosystem has changed with the decline of cottonwood gallery forest, encroachment of upland junipers, and invasion of salt cedar (*Tamarix ramosissima*), Russian olive (*Elaeagnus angustifolia*), and Siberian Elm (*Ulmus pumila*).

The existing ecosystem condition is the result of the severe channel degradation and reduced floodplain connectivity along the Rio Grande and its tributaries (Appendix C). Gravel extraction (1980s) downstream of Ohkay Owingeh has created a headcut that has exacerbated channel incision, reducing water availability for riparian vegetation (Sparks and Spink 1998; Appendix I). The future without project condition has the headcut extending further upstream on the Rio Chama and Rio Grande, further reducing floodplain connectivity in the project area.

In the future, continued isolation of riparian vegetation in the study area from fluvial geomorphic processes will eventually result in complete dominance of the plant communities by non-native plant species including salt cedar, Russian olive, Siberian elm, and tree of heaven. Current vegetation management techniques such as understory clearing and planting of native species may temporarily reset patches of bosque to more natural structural states, but gradual replacement by non-native species could continue to occur unless the function of the bosque ecosystem and structure of the dynamic mosaic is restored. Eventual conversion of the bosque to a non-native-plant-dominated ecosystem uninfluenced by hydrologic processes, with fire as the new main disturbance mechanism, would diminish habitat suitability and quality for many native animal species. As stated above, some maintenance activities would likely continue by Pueblo staff. Some areas have been planted with native shrubs and trees through other projects. This native vegetation will continue to grow and provide some additional habitat for wildlife.

### 2.3.2 Vegetation communities

The naturally functioning bosque ecosystem was structured largely by fluvial geomorphic processes (cf. Déscamps et al., 1988). Loss of conditions necessary for regeneration of native riparian plants and increasing abundance of nonnative species were identified in river systems throughout the western U.S. beginning in the mid-1970s, with main-stem impoundments typically identified as the primary factor driving alteration of ecosystem structure and function (Fenner et al., 1985; Howe and Knopf, 1991). Impoundments alter the hydrograph, reduce sediment supply in downstream reaches, and cause channel incision and narrowing of the floodplain (Williams and Wolman, 1984).

A major change in vegetation dynamics in the bosque ecosystem has been loss of meander cut-off, meander migration, and flood scour processes, which were a driving force in the dynamics of the naturally functioning system. These processes removed existing vegetation and created new sites for founding of plant communities. Meander cut-off and lateral meander migration no longer occur. Bare soil sites are now created primarily through mechanical disturbance; typically in areas no longer subject to periodic inundation and with relatively dry soil moisture regimes. The existing bosque is becoming senescent due to the lack of flooding events for creating new stands of cottonwood gallery forest.

The frequency and duration of inundation, in addition to moisture requirements for establishment and persistence, also influences the structure of riparian vegetation (Wheeler and Kapp, 1978; Kozlowski, 1984). Riparian plant species vary in their tolerance to inundation and resulting anoxic conditions (Amlin and Rood, 2001). Growth and regeneration of many riparian tree species declines with increasing hydroperiod, and permanent inundation results in eventual loss of tree cover in most riparian ecosystems (Hughes, 1990). Seedlings are particularly sensitive to inundation and tolerance of plants generally increases with age (Jones et al., 1994).

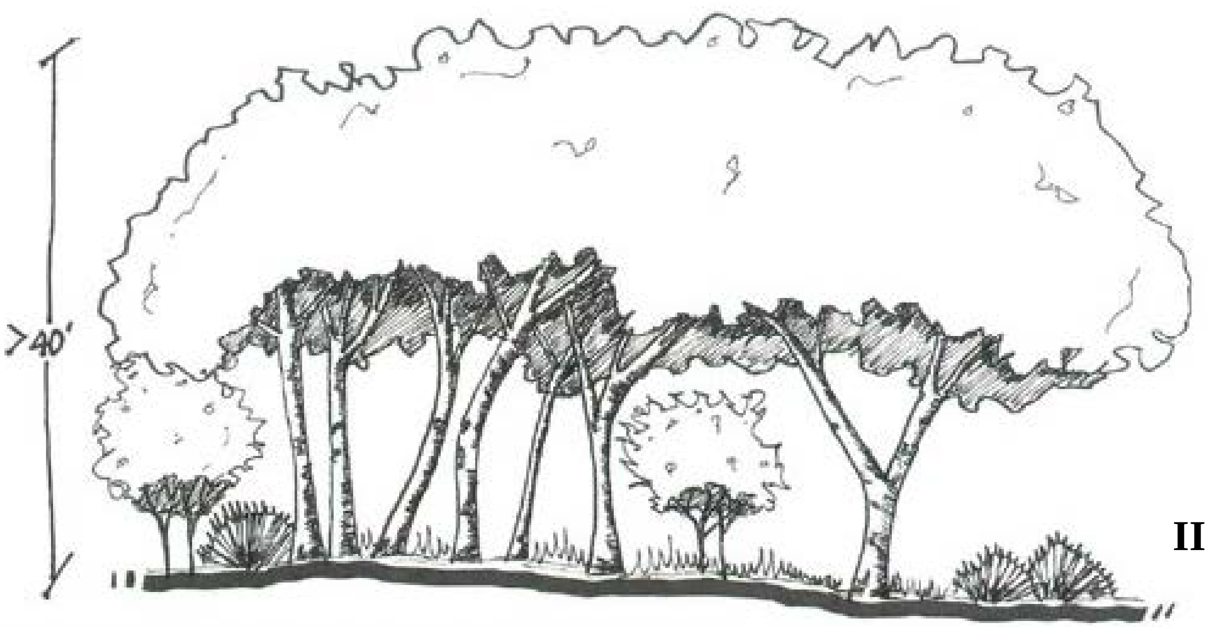
Moisture gradients are a major determinant of the distribution of riparian plant species (Weaver, 1960; Bush and Van Auken, 1984; Tanner, 1986). Soil texture affects moisture regime. Sands drain quickly and, thus, anoxic conditions occur only with high water tables or extended inundation. Fine-particle soils, which are deposited in areas of low current velocity, have high water holding capacity and slow drainage. Fine-grained soils may accumulate at arroyo mouths on the floodplain, behind natural levees, and in oxbows (Hughes, 1990).

Soil moisture levels and depth to ground water on floodplain sites are influenced primarily by surface topography, the variation of which is created through fluvial-geomorphic processes (Malanson, 1993). The limits of riparian vegetation are controlled by depth to the water table (Hughes, 1990). Moisture in upper soil layers is a primary influence on establishment of tree species while ground water levels are important for their persistence (Dawson and Ehleringer, 1991). Soil moisture has a major influence on seed germination and seedling survival of cottonwood (Moss, 1938; Bradley and Smith, 1986; Mahoney and Rood, 1993) and willow (Taylor et al., 1999; Dixon, 2003).

Classification of Rio Grande riparian vegetation relies on plant community designations (Figures 8-10) developed by Hink and Ohmart (1984) and mapping by Sivinski and others (1990). Hink and Ohmart (1984: 37-39) defined six structure types based on vertical foliage density. Structure Type I consists of tall trees – at least 50 ft (15.2 m) with a relatively dense understory of saplings and shrubs (I). Type II structure is also composed of tall trees but with little or no sapling and shrub understory (II). Type III structure consists of mid-size trees (less than 30 ft [9.1 m]) and dense understory vegetation (III). Type IV structure is characterized by open stands of mid-sized trees with widely scattered shrubs and sparse herbaceous growth (IV). Type V structure is dense, short-stature trees and saplings, to about 15 ft (4.6 m) height, often with dense herbaceous growth (V). Type VI structure is scattered plant growth with foliage not exceeding about 5 ft (1.5 m) in height above the ground (VI).

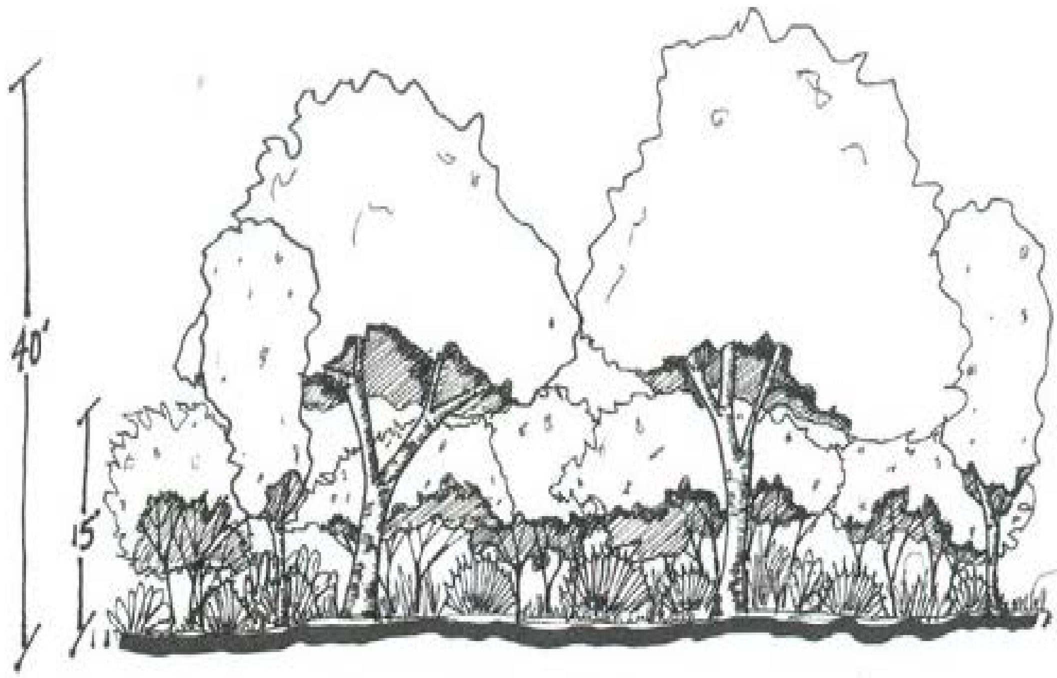
The Combined Habitat Assessment Protocols (CHAP, Appendix C) were used to estimate habitat value for the bosque on Ohkay Ohwingeh (Figure 11) and Santa Clara Pueblos (Figure 12). The future without project condition assumes no additional habitat management by the sponsors. These figures show the relative CHAP value per acre for habitat patches values across the landscape in relation to hydrology, topography, land management and other factors.


**Hink and Ohmart Type I Vegetation - – Mature Riparian Forest with trees 50-60 ft; closed canopy, established understory**



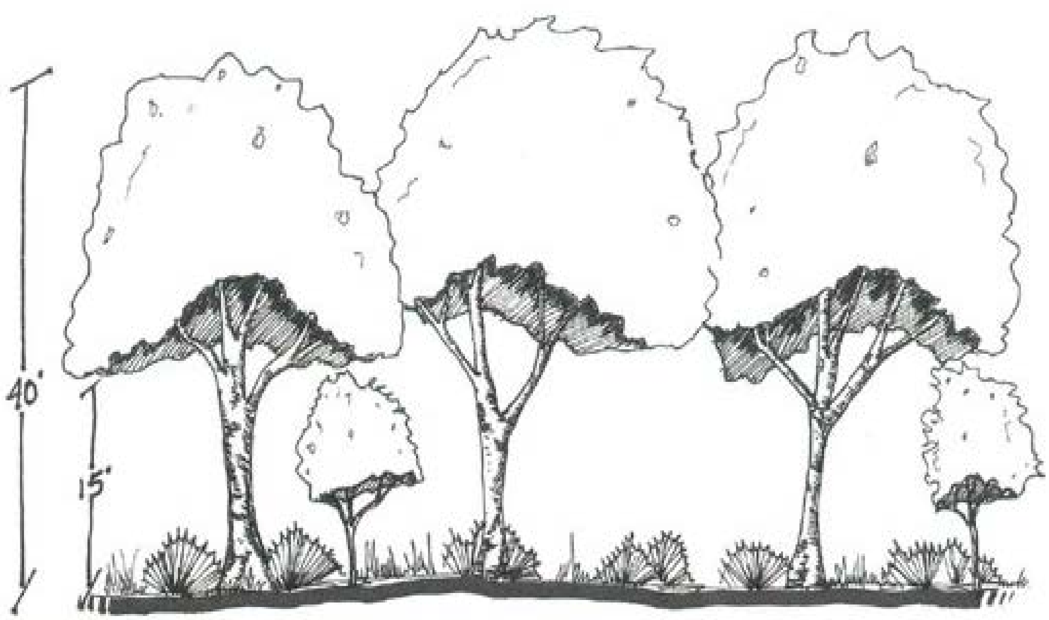

**Hink and Ohmart Type II Vegetation – Mature Riparian Forest with trees over 40 ft; nearly closed canopy, limited understory**

**Figure 8 Hink and Ohmart vegetation classes I and II.**




**III**

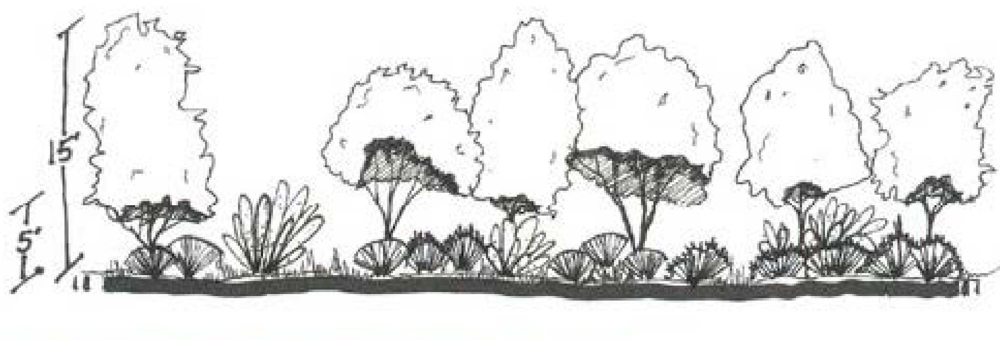
**Hink and Ohmart Type III Vegetation - Intermediate aged riparian woodland; closed canopy; dense understory**




**IV**

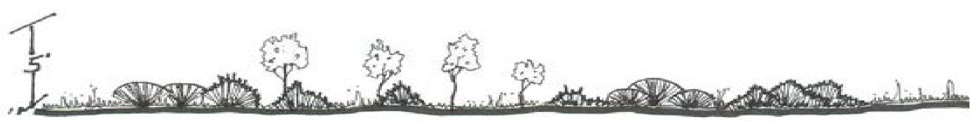
**Hink and Ohmart Type IV Vegetation - Intermediate aged riparian woodland/savannah; broken canopy; mostly grass understory**

**Figure 9 Hink and Ohmart vegetation classes III and IV.**




**V**

**Hink and Ohmart Type V Vegetation – Riparian Shrub up to 15 ft; dense vegetation but no tall trees**




**VI**

**Hink and Ohmart Type VI Vegetation - Sparse vegetation with short shrubs, seedlings and grasses; open areas**

**Figure 10 Hink and Ohmart vegetation classes V and VI.**

The existing vegetation conditions indicate a decline in riparian vegetation due to decreasing floodplain connectivity. The lack of scouring and flood events for generating new stands of riparian cottonwoods and willows are expected to continue into the future. The future without project is anticipated to continue the decline of riparian vegetation along the Rio Grande and Rio Chama, with decreasing habitat value.

**Table 3 Summary of baseline habitat and affected vegetation in the proposed project.**

| Native vegetation | Existing acres | |
|---|---|---|
| C/CW1 (Cottonwood/Coyote willow) | 71.0 | |
| C/CW2 | 70.5 | |
| C/CW3 | 196.8 | |
| C/CW4 | 92.2 | |
| C/CW5 (shrub) | 250.9 | |
| C/NMO5 (shrub with New Mexico olive) | 527.9 | |
| C/CW6 (meadow with Tree willow) | 231.0 | |
| Marsh (6) | 369.7 | |
| Native vegetation subtotal | 1810.1 | 49.7% |
| **Mixed gallery forest / shrubs (1-5)** | **Existing acres** | |
| C/CW with Russian Olive | 234.5 | |
| C/CW with Salt Cedar | 131.8 | |
| Mixed invasive forest | 938.9 | |
| Russian Olive dominated forest | 131.9 | |
| Salt Cedar dominated forest | 31.5 | |
| Mixed gallery forest subtotal | 1468.5 | 40.3% |
| **Other land classifications** | **Existing acres** | |
| Unclassified open area | 365.1 | 10.0% |
| Total Area | 3643.0 | |

### 2.3.3 Noxious weeds and invasive species

The majority of non-native species within the project area are plants. Though some non-native fish and other wildlife may exist, they are not of major concern. The invasive tree species of concern include salt cedar, Russian olive, and Siberian Elm. These species outcompete the native species and can eliminate the native riparian bosque resulting in a drier, more upland habitat.

Executive Order 13112 directs Federal agencies to prevent the introduction of invasive (exotic) species and provides for their control to minimize the economic, ecological, and human health impacts that invasive species cause.

In addition, the State of New Mexico, under administration of the United States Department of Agriculture, designates and lists certain weed species as being noxious (Nellessen 2000). "Noxious" in this context means plants not native to New Mexico that may have a negative impact on the economy or environment, and are targeted for management or control. Class C listed weeds are common, widespread species that are fairly well established within the state. Management and suppression of Class C weeds is at the discretion of the lead agency. Class B weeds are considered common within certain regions of the state but are not widespread. Control objectives for Class B weeds are to prevent new infestations, and in areas where they are already abundant, to contain the infestation and prevent their further spread. Class A weeds have limited distributions within the state. Preventing new infestations and eliminating existing infestations is the priority for Class A weeds. In order to prevent this, all equipment would be cleaned with a high-pressure water jet before leaving an area and entering a new area.

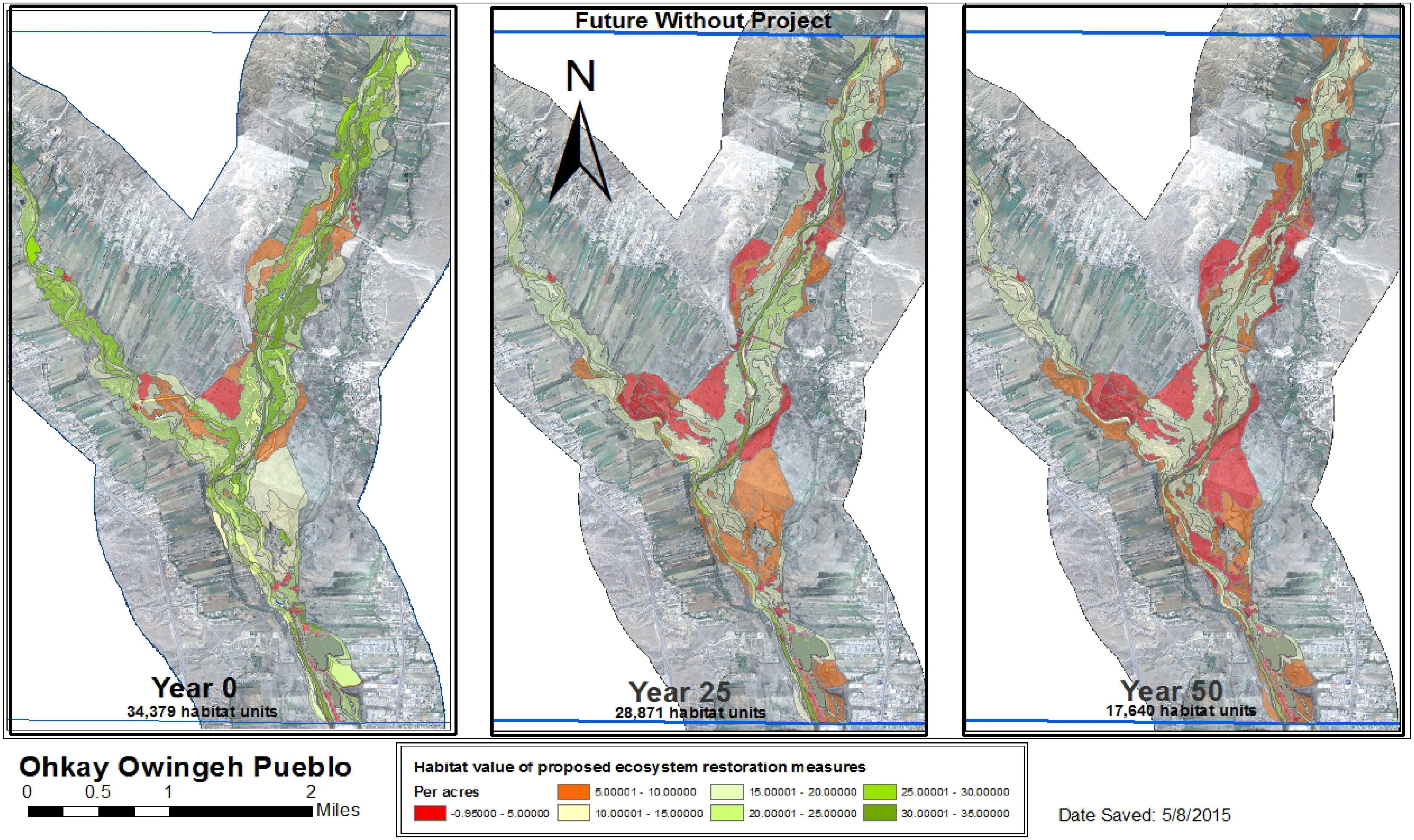



**Figure 11 Change in habitat unit values per acre on Ohkay Owingeh Pueblo calculated using CHAP.**

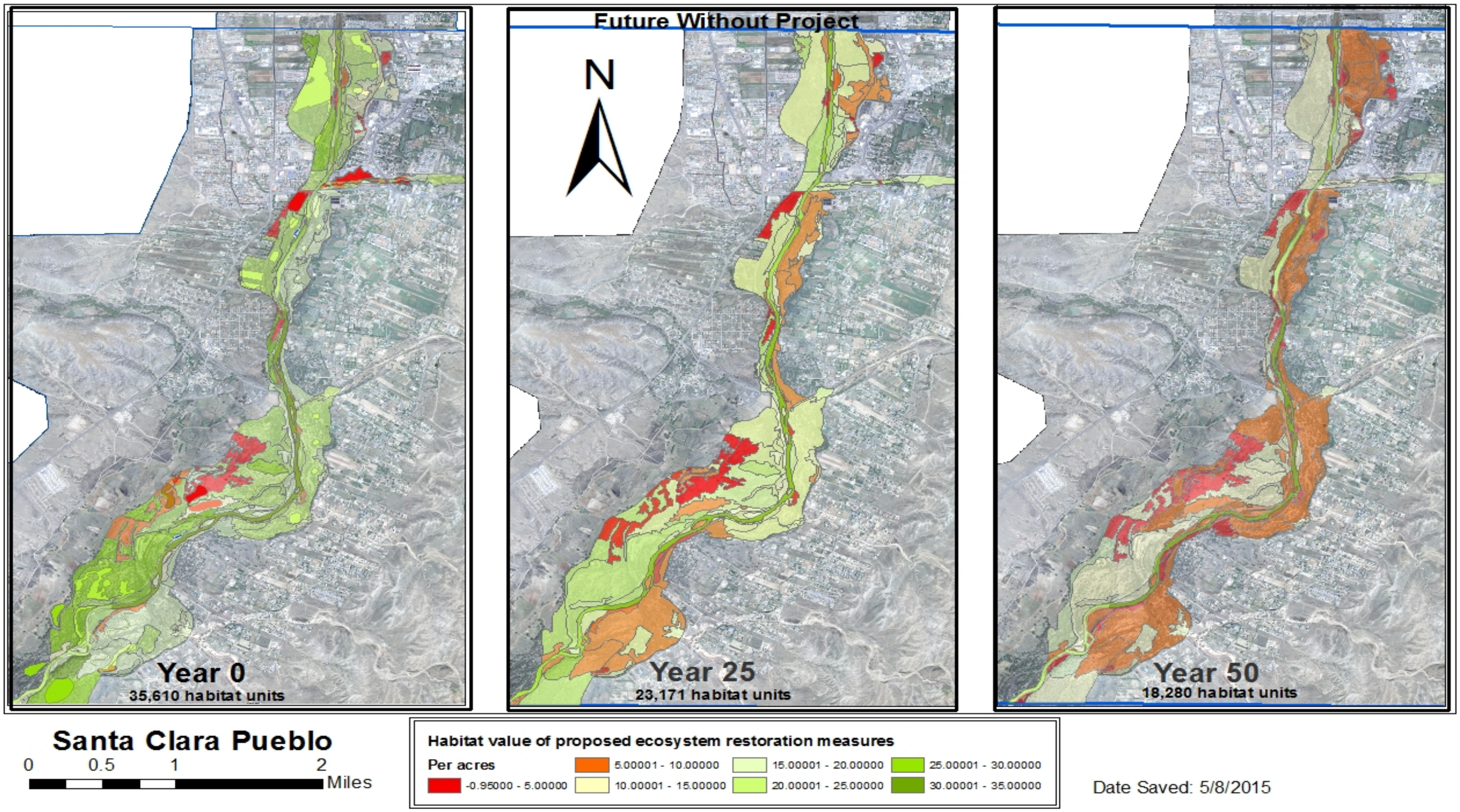



**Figure 12 Change in habitat unit values per acre on Santa Clara Pueblo calculated using CHAP.**

Salt cedar is now a prominent colonizer of exposed, bare soil sites in the bosque (Smith et al., 2002). While individual cottonwood seedlings have a greater competitive effect relative to salt cedar seedlings under ideal soil moisture conditions (Sher et al., 2000), the competitive effect is lost under conditions of water stress (Segelquist et al., 1993) or elevated salinity (Busch and Smith, 1995). Salt cedar produces seed for several months beginning in late spring (Ware and Penfound, 1949; Horton et al., 1960) and therefore colonizes bare, moist-soil sites throughout the summer. Cottonwood, on the other hand, produces seed only for a short time in the spring and seed remains viable for only about a month and a half under ideal conditions (Horton et al., 1960). The flowering and fruiting phenology of salt cedar allows seedlings to establish on and dominate open sites wetted by runoff, rainfall, or river flows during the summer, precluding the possibility for cottonwood establishment on potentially suitable sites the following spring.

Russian olive is established by seed in the understory of mature cottonwood stands and also colonizes openings along the river, often forming dense stands (Hink and Ohmart, 1984; Sivinski et al., 1990). Russian olive is also shade tolerant and can survive in areas where cottonwood canopy exists. Seeds germinate in moist to dry sites and the plant sprouts readily from the root crown after damage to or removal of above-ground portions of the plant (Sivinski et al., 1990). Russian olive was present in the understory in 1981 (Hink and Ohmart, 1984) and continues to increase in the bosque (Sivinski et al., 1990).

Salt cedar and Russian olive are established throughout the project area. The decreasing floodplain connectivity supports expansion of these invasive trees as the riparian vegetation declines. The future without project is based on the expanding presence of salt cedar and Russian olive.

### 2.3.4 Fish and wildlife

The loss of riparian habitat is an important conservation issues in the arid southwest due to its rarity. The bosque ecosystem supports 276 vertebrate species, including birds (167), mammals (54), fish (31), amphibians (8 species), reptiles (14 species) (BISON-M, accessed August 2009; Appendix C).

Herptile abundance and diversity was found to be greatest in habitats that lacked dense canopy cover and that were characterized by sandy soils and sparse ground cover (Hink and Ohmart 1984). Many of the species found in the bosque were representative of drier upland habitats. Hink and Ohmart (1984) did describe a distinct assemblage of species associated with denser vegetation cover in mesic or hydric habitats. Common species included tiger salamander (*Ambystoma tigrinum*), western chorus frog (*Pseudocris triseriata*), bullfrog (*Rana catesbeiana*), northern leopard frog (*Rana pipiens*), many-lined skink (*Eumeces multivirgatus epipleurotus*), black-necked garter snake (*Thamnophis cyrtopsis*), and western painted turtle (*Chrysemys picta bellii*).

The study area provides habitat for about 50 species of mammal at the transition from mountains, canyons, and river floodplain. The endangered New Mexico Meadow Jumping Mouse is dependent on rare wetland habitat historically found in the study area. Maintaining habitat corridors support used by large herbivores and a suite of predators is important for connecting populations. Small mammals were found to be more abundant in moister, densely vegetated habitats and those with dense coyote willow than at drier sites (Hink and Ohmart 1984). Dominant species differed between various habitat types however, so that a variety of habitats increases the diversity of small mammals in the study area.

More than 160 bird species, which are federally protected under the Migratory Bird Treaty Act, are found locally in the Española Valley study area. Since 2001, 152 bird species have been observed at the Los Luceros Important Bird Area (IBA, Audubon Society) upstream of Ohkay Owingeh on the Rio Grande. Habitat managed by the two pueblos exceeds the area and diversity of the 130 acre Los Luceros IBA. Restoration of large patches of riparian habitat could support special status species (section 2.3.5), along with a variety of wading birds, ducks, and songbirds.

Hink and Ohmart (1984) recorded 277 species of birds in the bosque ecosystem. Highest bird densities and species diversity were found in edge habitat vegetation with a cottonwood overstory and an understory of Russian olive (Hink and Ohmart 1984). Studies done by Finch and Hawksworth (2006) indicate that bird densities of the mid-story nest guild show declining trends following treatment and removal of invasive plant species. Removal of some invasive plant species reduces the availability of nesting and foraging substrates for bird species that use the mid-story layer of habitat. Emergent marsh and other wetland habitats also had relatively high bird density and species richness. Thirty of the 46 species of breeding birds found in the bosque used cottonwood forest habitat. No bird species showed a strong preference for Russian olive stands (Hink and Ohmart 1984). However, when Russian olive was present as a component of the understory in cottonwood stands, it appeared to influence the quality of those stands for birds. Therefore the higher bird densities appear to relate to the structure of the habitat rather than species of plant making up that component.

The Rio Grande is a major migratory flyway for avian species (Yong and Finch, 2002). The peak nesting season for birds is April 15 through August 15. The Migratory Bird Treaty Act (MBTA) (16 U.S.C. 703, et seq.) is the primary legislation in the United States established to conserve migratory birds (USFWS, 2004). The list of the species protected by the MBTA appears in title 50, section 10.13, of the Code of Federal Regulations (50 CFR 10.13). The MBTA prohibits taking, killing, or possessing of migratory birds unless permitted by regulations promulgated by the Secretary of the Interior. The U. S. Fish and Wildlife Service (USFWS) and the Department of Justice are the Federal agencies responsible for administering and enforcing the statute.

The Memorandum of Agreement (MOA) between the Federal Aviation Administration, the U.S. Air Force, the U.S. Army, the U.S. Environmental Protection Agency, the USFWS, and the U.S. Department of Agriculture to Address Aircraft-Wildlife Strikes was signed by the Department of the Army in 2002. The agreement was signed in reference to Advisory Circular (AC) 150/5200-33 (1997). Criteria were developed for siting wildlife attractants for a distance of 5,000 feet for airports serving piston-powered aircraft and 10,000 feet for airports serving turbine-powered aircraft. The project area is approximately 6,800 feet from the Ohkay Owingeh airport east of the project boundaries.

The existing conditions have a trend towards dominance of invasive plant species at the expense of overall diversity in the bosque (Appendix C). Those wildlife species preferring the dense, low and mid-story habitat structure would benefit while those preferring open mature cottonwood stands with open mid and understory would become less common. The lack of connectivity between the river and floodplain favors upland wildlife species that are fairly common in the region while the less common floodplain species would remain scarce.

The future without project would be a less heterogeneous habitat favoring only a portion of the existing animal species. If native bosque vegetation patches became smaller and distances between patches increase, then some wildlife species may be lost to the area altogether (Appendix C). Likewise migratory species relying on varying age stands of cottonwood bosque, wetlands, or open meadow would be forced to travel farther possible bypassing the bosque around Española to find suitable habitat.

### 2.3.5 Special status species

Three agencies have a primary responsibility for the conservation of animal and plant species in New Mexico: the U.S. Fish and Wildlife Service (Service), under the authority of the Endangered Species Act of 1973 (as amended); the New Mexico Department of Game and Fish, under the authority of the Wildlife Conservation Act of 1974; and the New Mexico Energy, Mineral and Natural Resources Department, under authority of the New Mexico Endangered Plant Species Act and Rule No. NMFRCD 91-1. Each agency maintains a list of animal and / or plant species that have been classified or are candidates for classification as endangered or threatened based on present status and potential threat to future survival and recruitment (Appendix C).

There are three Federally listed species identified by the U.S. Fish and Wildlife Service (Consultation code 02ENNM00-2014-SLI-0436, 12 Jan 2015) that either occur in the action area and/or have proposed critical habitat in the action area. The species are the Southwestern Willow flycatcher (*Empidonax traillii extimus*) (flycatcher), the Western Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*) (cuckoo), and the New Mexico meadow jumping mouse (*Zapus hudsonius luteus*) (mouse). The other species of interest identified by the U.S. Fish and Wildlife Service (Consultation code 02ENNM00-2014-SLI-0436, 12 Jan 2015) do not meet the criteria for further analysis because there is no critical habitat in the action area, the lack of suitable habitat for the species or primary constituent elements (PCEs), or the species is unlikely to occur in the action area.

#### *2.3.5.1 Southwestern Willow Flycatcher*

Within the action area, critical habitat for the Southwestern Willow Flycatcher (*Empidonax traillii extimus;* flycatcher) has been designated outside pueblo lands in the vicinity of Ohkay Owingeh and Santa Clara Pueblos.

#### *2.3.5.2 Yellow-Billed Cuckoo*

The Western Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*; cuckoo) was listed as a threatened species on October 3, 2014 (USFWS 2014c). Critical habitat for the cuckoo has been proposed along the Upper and Middle Rio Grande Units (New Mexico) on lands owned by Ohkay Owingeh, San Ildefonso and Santa Clara Pueblos (USFWS 2014c). These units are occupied by cuckoos, and provide a corridor for cuckoos moving north.

#### *2.3.5.3 New Mexico Meadow Jumping Mouse*

The New Mexico Meadow Jumping Mouse (*Zapus hudsonius luteus*; mouse) was listed as endangered on the June 10, 2014 (USFWS 2014). Proposed critical habitat for the mouse includes two marshes on Ohkay Owingeh Pueblo (USFWS 2013), but this habitat is believed to be unoccupied. Edge habitat along wetland measures may create suitable habitat for the mouse.

### 2.3.6 Water quality

The Pueblos of Ohkay and Santa Clara have developed their own water quality standards that meet Section 303(d) of the Federal Clean Water Act, and said standards have been accepted by the U.S. Environmental Protection Agency, Region 6. However, the U.S. Environmental Protection Agency has declared the Rio Chama within the boundaries of Ohkay Owingeh as currently impaired for turbidity and fecal coliform (Charles Lujan, pers. comm.).

According to the New Mexico Surface Water Quality Bureau 2008-2010 Clean Water Act Integrated §303(d)/ §305(b) List of Assessed Surface Waters, the Rio Chama from Abiquiu Dam to the Ohkay Owingeh boundary is classified as fully supporting all designated and existing uses. The reach of the Rio Grande between Embudo Creek and the Santa Clara boundary is not supporting of marginal coldwater aquatic life and warm water aquatic life. Probable causes of impairment are polychlorinated biphenyls (PCBs) in fish tissue, turbidity, and unsatisfactory benthic-macroinvertebrate bioassessments. Probable sources of impairment are: atmospheric deposition of toxics; contaminated sediments; highway/road/bridge runoff (non-construction related); inappropriate waste disposal; irrigated crop production; loss of riparian habitat; natural sources; rangeland grazing; and unknown sources.

The segment of the Rio Grande from the San Ildefonso Pueblo boundary to Cochiti Reservoir is classified as not supporting warm water or marginal coldwater aquatic life. The chemical PCB in fish tissue for this reach is the basis for impairment, and probable sources are atmospheric deposition of toxics, contaminated sediments, inappropriate waste disposal, natural sources, and/or unknown sources.

Under the No Action alternative, there would be no potential improvement to water quality through the creation of wetlands. The potential wetland, pond and willow swale habitats would also assist with water quality that may have increased issues due to an increase in human population. Native plants could assist in removing nutrients having a negative effect on water quality due to an increase in non-point source pollution as well.

### 2.3.7 Air quality

The action area is primarily located in Rio Arriba County, New Mexico. The area is an attainment area for all criteria air pollutants. Non-criteria pollutants, such as those from LANL and tailpipe emissions from ever increasing traffic on/through San Ildefonso Pueblo, will continue to be air quality issues. Adjacent to San Ildefonso Pueblo, Bandelier National Monument is a Class I Federal air quality area. Future actions within the study area must account for and avoid potential degradation of the air quality at Bandelier.

There are no documented air quality non-attainment issues in Rio Arriba County, New Mexico (Appendix I). The Santa Fe County Air Quality Control Region is an attainment area for all criteria air pollutants identified in the National Ambient Air Quality Standards (NAAQS). Bandelier National Monument (southwest of the study area) is a Class I Federal air quality area. Future actions within the project study area must account for and avoid potential degradation of the air quality at Bandelier. The future air quality without project is expected to remain unchanged.

### 2.3.8 Noise

The Pueblos generally are quiet, rural settings, with only limited background noise from major highways, aircraft flyovers, sirens, or other urban noise (Appendix I). Santa Clara Pueblo may receive a somewhat higher level of urban background noise due to its proximity to the City of Española. Background noise levels are not expected to change under the without project conditions (Appendix I).

### 2.3.9 Aesthetics

The National Environmental Policy Act (NEPA) and Council on Environmental Quality (CEQ) regulations identify aesthetics on one of the elements that must be considered in determining the effects of a project. Aesthetics include the presence and appearance of landforms, water surfaces, vegetation and human created features relative to the surroundings and settings of the area. These features are primary characteristics of an area or project that determine visual character and the manner in which people view the setting. Aesthetics analysis considers the existing and future appearance, or perception of views, of the project site and areas surround the site, as well as viewer sensitivity.

The aesthetics of the bosque areas along the Rio Grande are internally defined by the three pueblos with a landscape perspective. The pueblos consider the aesthetics to be medium to high in areas where the bosque is functioning as a healthy ecosystem (Appendix I). They consider mature stands of cottonwoods with native understory vegetation as the target condition. Currently, the pueblos have characterized the aesthetics of the bosque and other riparian areas as ranging from poor to high. In areas where fires have occurred and burn restoration has not been implemented, the aesthetics would be considered poor as the bare, burned ground and vegetation dominates the view. Similarly, areas where concentrations of litter have accrued or illegal dumping has occurred, the aesthetics of such sites would be considered poor. In areas where non-native vegetation has been thinned and replanted with native vegetation, the pueblos characterize the aesthetics as medium to high. The goal of returning the river and bosque to pre-flood control conditions was a common theme.

The existing condition for the aesthetics of the bosque and other riparian areas ranges from poor to high. The future without-project conditions are expected to remain unchanged.

### 2.3.10 Land Use and Classification

The Pueblos have seen the effects of increasing intensity of land use along the Rio Grande and Rio Chama (Appendix I). Land use within the pueblos includes hunting, fishing, trapping, gathering, traditional ceremonies, grazing, timber harvest, and agriculture. Aerial photography can delineate several types of land use based on vegetation type. Table 4 summarizes the area of land used for agriculture, range (grazing), and commercial development (urban) by pueblo.

**Table 4 Intensively managed lands outside the riparian study area (upland vegetation), in acres.**

| | **1935** | **1989** | **2002*** |
|---|---|---|---|
| Agricultural | 2399.2 | 1861.6 | 1861.6 |
| Range | 1165.7 | 2039.1 | 2039.1 |
| Urban | 191.4 | 777.1 | 777.1 |
| **Overall** | **3756.3** | **4677.7** | **4677.7** |

*These lands were outside the boundaries of the General Investigations Study and the vegetation mapping during the 2002 URGWOP's study.*

Much of the bosque has been converted to farmlands with a large portion in fee title ownership (Appendix I). Farmland on Santa Clara Pueblo has decreased about 33% from 1935, while on San Ildefonso Pueblo farmland has been converted into rangeland. Livestock grazing is an economically important activity for Tribal members that pueblos are working to balance with ecosystem goals. Grazing has doubled on two of the three pueblos since 1935, but remained nearly steady on Santa Clara Pueblo. Most of the bosque on Ohkay Owingeh is closed to grazing (Appendix I). Santa Clara Pueblo allows grazing in many areas of the Rio Grande bosque riparian corridor within the project study area (Appendix I). San Ildefonso Pueblo excludes grazing from the bosque and within 200 feet of the Rio Grande to prevent injury to riparian habitat.

Many native bosque plants are used intensively by pueblo members for food, fuel, fiber, pigment, medicine, and ceremonial uses (Appendix I). Shrubs like willow or Apache plume are pruned and harvested for baskets and other uses. Yerba manza (*Anemopsis californica*) and other plants were valued and propagated. Ancestral Pueblo agriculture cultivated food plants (corn, beans, and squash) in small plots along with propagating and harvesting native plants in the bosque. Restoration and production of cattails, willows and other forest products for cultural uses is a priority (Appendix I).

Timber is a limited resource the Pueblos manage for the benefit of their Tribal members. Gooding's willow is used for bows while cottonwood trees have been heavily utilized for ceremonial drum construction and carvings (Ohkay Owingeh 2008). Coniferous trees are generally preferred for firewood, though cottonwood and willow may also be used for fuel, (Appendix I). No cutting of native trees is allowed in Ohkay Owingeh riparian areas, while non-native trees can be harvested as part of bosque restoration efforts (Ohkay Owingeh 2008; Santa Clara 2000). Ohkay Owingeh has implemented fuel and non-native vegetation reduction on about nine hundred acres as partial restoration on the Rio Grande and Rio Chama floodplains community (Appendix I).

There are substantial educational opportunities in the bosque that involve Tribal members (Appendix I). Successful educational programs include the Youth Conservation Corps, Ohkay Owingeh Boys and Girls Club summer programs, and the Bosque Ecosystem Monitoring Program (BEMP) (Appendix I). Currently, Tribal members conduct vegetation monitoring, vegetation management, and bird monitoring programs. Nature trails and bosque educational activities would enhance Tribal connections to the bosque.

The future without project land use is expected to change as riparian vegetation declines. Cultural use of native plants would likely to decrease as a function of availability. More upland vegetation would increase pressure to open the bosque for grazing.

#### *2.3.10.1 Recreation*

Recreation within the bosque has generally focused on hunting, fishing, and trapping as culturally important activities for many Pueblo members. Improving fish and wildlife habitat through ecosystem management is a priority for Ohkay Owingeh and Santa Clara members (Appendix I).

## 2.4 Cultural Resources

The bosque is more than simply a location; it is a place of deep cultural importance to the people of Ohkay Owingeh, Santa Clara, and San Ildefonso. Along with the Rio Grande and its tributaries, the bosque is an integral part of the cultural landscape and its health and the health of the rivers are fundamentally intertwined with significant cultural practices. For most tribes, the landscape is an essential part of constructing social identity and the transmission and survival of historical and cultural knowledge and practice. People define themselves in relation to the landscape, and the landscape is an interface where the past gives meaning and context to the present. Loss of the bosque is more than simply the loss of plants and animals; it presents a real threat to customs, beliefs, and practices essential to the cultural identity and continuity of the people of Santa Clara, Ohkay Owingeh, and San Ildefonso. As such, the bosque itself is a vital cultural resource, and the protection of that cultural resource is one of the foundations of this restoration effort.

Section 106 of the National Historic Preservation Act [54 U.S.C. § 300101 et seq.] (NHPA) and its 36 CFR Part 800 implementing regulations require Federal agencies to take into account the effects of their undertakings (e.g., projects or permits) on historic properties. Historic properties are legally considered to be those properties (cultural resources) eligible for listing on the National Register of Historic Places (NRHP). To be eligible for listing, a property must have "the quality of significance in American history, architecture, archeology, engineering, and culture" that can be "present in districts, sites, buildings, structures, and objects" must "possess integrity of location, design, setting, materials, workmanship, feeling, and association" *and* must meet at least one of a set of four criteria relating to association with historical events, historically significant people, distinctive characteristics of a period or style, and/or are likely to yield information important to prehistory or history. There are many examples of historic properties, including archaeological sites, historic buildings, traditional cultural properties (TCPs), and historic districts.

In 2009, USACE began a broad-scale analysis of available information on cultural resources in the study area, which encompassed three pueblos and 35,000 acres; this analysis is presented in detail in Appendix D and Appendix I. No new fieldwork was conducted for this earlier analysis, which relied on existing site information from the New Mexico Cultural Resources Information

System (NMCRIS), a comprehensive database maintained by the New Mexico State Historic Preservation Division's Archaeological Records Management Section (ARMS).

### 2.4.1 Existing conditions analysis

This section reviews the results of data investigations using the NMCRIS database to identify known cultural resources within the original study area. In addition, information about TCPs is discussed along with expectations of future cultural resources surveys. National and State listed properties are identified.

#### *2.4.1.1 Summary of NMCRIS database analysis*

At the time of analysis in 2009, there had been a total of 176 cultural resources surveys documented in the study area, covering approximately 3,200 acres of land, or 9.06 percent of the original study area. As a result of these surveys, a total of 103 archaeological sites were recorded. Note that although 190 total sites have been recorded, only 103 were recorded as part of a formal survey; the remaining sites are not associated with a formal survey. This information is summarized in Table 5 and an overall summary of temporal trends in occupation of the study area is shown in Figure 13.

**Table 5 Summary of previous cultural resources surveys in the study area.**

| Area | Total Acres | Acres Surveyed | Sites Recorded on Survey | Site Centers in Survey Area | Sites/100 Acres | Total Recorded Sites | Percent Surveyed | Extrapolated Total Sites in Entire Study Area |
|---|---|---|---|---|---|---|---|---|
| Ohkay Owingeh | 7,973 | 554 | 16 | 8 | 1.44 | 25 | 6.9 | 115 |
| Santa Clara | 15,573 | 1,735 | 47 | 36 | 2.07 | 88 | 11.1 | 323 |
| San Ildefonso | 7,848 | 572 | 25 | 19 | 3.32 | 57 | 7.3 | 261 |
| Non-Tribal | 3,913 | 339 | 15 | 10 | 2.95 | 20 | 8.7 | 115 |
| Total | 35,307 | 3,200 | 103 | 73 | 2.28* | 190 | 9.1* | 814 |

**These totals are calculated for the entire study area, and are not sums of the rows above them.*

There is no documented Paleo-Indian presence in the study area (Figure 13), and only meager definitive evidence of Archaic-period occupations (three out of 221 components). However, there are a substantial number of components containing chipped-stone artifacts that have not been assigned to a time period, and it is likely many of these artifacts date to the Archaic period. The trend demonstrates a substantial increase in archaeological components beginning approximately 1,500 years ago, which is consistent with overall trends for the Rio Grande Valley as described in the culture history in Appendix D. Cultural use of the Española Valley begins to increase during approximately the AD 600s, or the beginning of the Developmental period. The rate of increase accelerates during the AD 1100s, right at the end of the Developmental and the beginning of the Coalition periods. This is consistent with trends throughout the northern Rio Grande, as populations from the north and west (including the Chaco Canyon and Mesa Verde areas) likely migrated to the Rio Grande during this period. Overall cultural use of the area peaks slightly at the end of the Developmental period, dips slightly, and then peaks again at the end of the Classic period.

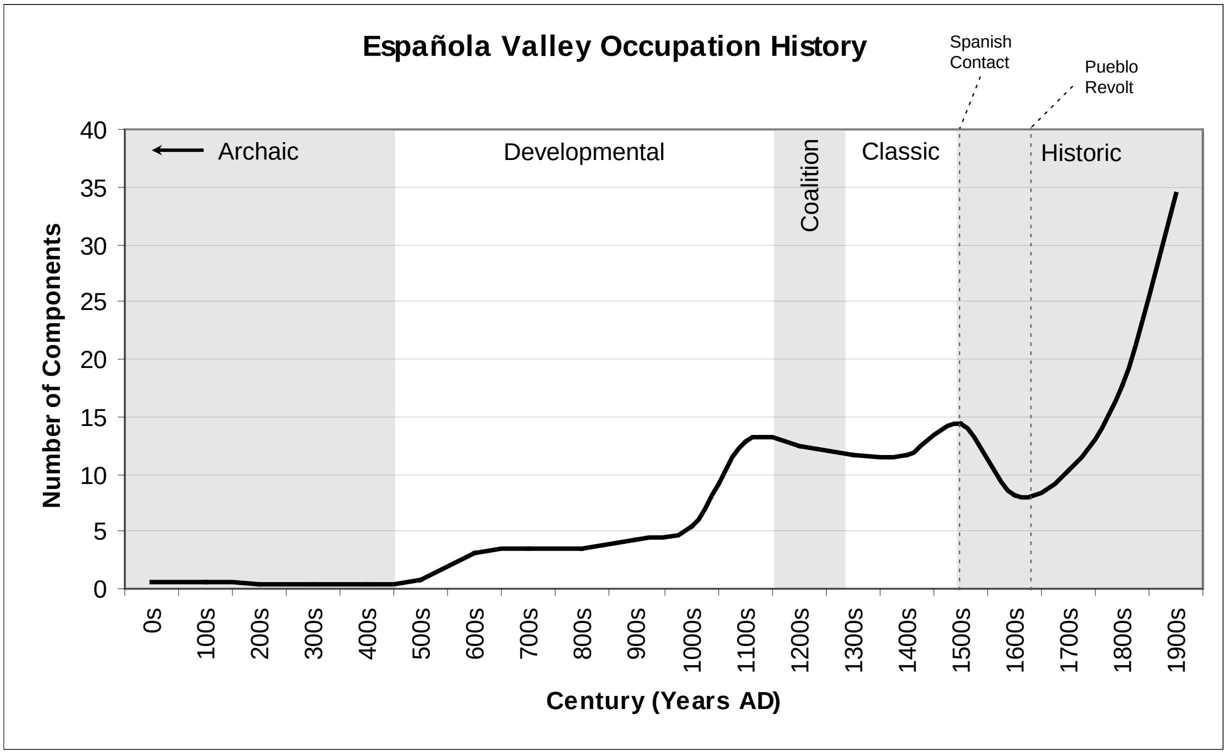



**Figure 13 Occupational history of the Española Valley study area, expressed as the number of identified archaeological components over the last 2,000 years, based on available ARMS records.**

There is a dramatic shift with Spanish contact, however. Between initial Spanish contact in 1540 and the Pueblo Revolts of 1680 and 1696, the number of cultural manifestations in the study area dropped by approximately 50 percent. The number of documented components then increases steadily again beginning in the 1700s and continuing to the present.

The analysis (Appendix D) suggests an overall growth in cultural use of the Española Valley through time, accompanied by increases in the relative proportions of sites on the floodplain, and an increase in the number of large sites. Cultural use of the Española Valley increases again after the Revolt period, with new sites smaller and less concentrated on the floodplain than during previous.

### *2.4.1.2 Traditional cultural properties*

Traditional Cultural Properties (TCPs) are recognized and protected by the National Historic Preservation Act, and are defined and described in National Register Bulletin 38 (Parker and King 1990). A TCP is defined as a property "that is eligible for inclusion in the National Register because of its association with cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community" (Parker and King 1990:1). TCPs are often hard to recognize; they can even be a natural feature or a landscape. Indeed, the Rio Grande bosque throughout the proposed project area is an area of deep and ongoing cultural importance and meaning, and has the characteristics of a TCP. The health of the bosque ecosystem is deeply intertwined with past, present, and ongoing cultural practice, and the goals of this project – developed with ongoing involvement of and consultation with the Tribal sponsors – would provide positive benefits in supporting the future survival of those practices. In addition, Black Mesa, located on the northeast portion of San Ildefonso Pueblo and near the southern end of the proposed project area, was a stronghold of Tribal resistance to Spanish rule during the Pueblo Revolts of 1680 and 1696. Due to Black Mesa's importance in the Pueblo Revolt and its continued cultural importance in the lives of Tribal members, Black Mesa can be considered a Traditional Cultural Property, and it is also listed on the State Register for its association with important events in history (the Pueblo Revolt).

Tribes are the best source of knowledge on TCPs. However, the often deep religious and cultural significance of these properties require great care against widespread sharing of specific information about them . By working closely with Tribal partners, this project has been designed to provide positive benefit to the culturally vital bosque, while minimizing or avoiding negative impacts to TCPs and protecting the confidentiality of traditional knowledge.

#### *2.4.1.3 Cultural Resources Inventory and Consultation*

With the selection of a preferred plan, and for the purposes of Section 106, an Area of Potential Effect (APE) must be designated. According to 36 CFR 800.16, the area of potential effects (APE) for an undertaking is defined as “the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist.” For this project, the APE is defined as those areas containing the footprints of any proposed construction features, as well as those areas within which any ground-disturbing activity (including but not limited to vehicle movement, earth moving, excavation, clearing, grubbing, materials laydown and storage, staging, additional inundation, etc.) might occur.

The currently-defined APE for the this project is shown in Figure 14. The features proposed for Santa Clara include high-flow channels, vegetation management, terrace lowering, and the creation of swales; as such, the defined APE for these measures are drawn widely in order to provide adequate buffers for potential movement of personnel and equipment. At Ohkay Owingeh, the proposed features are generally more closely confined to the channel, and include (in addition to vegetation management and terrace lowering) channel stabilization and grade reduction features. For these proposed features, the currently understood APE includes both the footprints of the eventual features and areas of potential ground disturbance, as well as adjacent areas that might experience modification due to the need to reroute water flow during construction.

Access routes for equipment and staging areas have not yet been selected. When these are chosen, locations and routes will be taken into account to avoid any cultural resources known to be in the vicinity, and the Corps will complete full Section 106 consultation on those routes and locations before any construction begins.

Characteristics of the expected APE are as follows:

- For Section 106 purposes, the expected APE for the proposed project, as currently understood, totals approximately 1,419 acres (925 acres within Santa Clara Pueblo, and 494 acres within Ohkay Owingeh).
- The entirety of the expected APE for this project falls within what would be categorized as “floodplain” or “lowland” areas in the above analysis

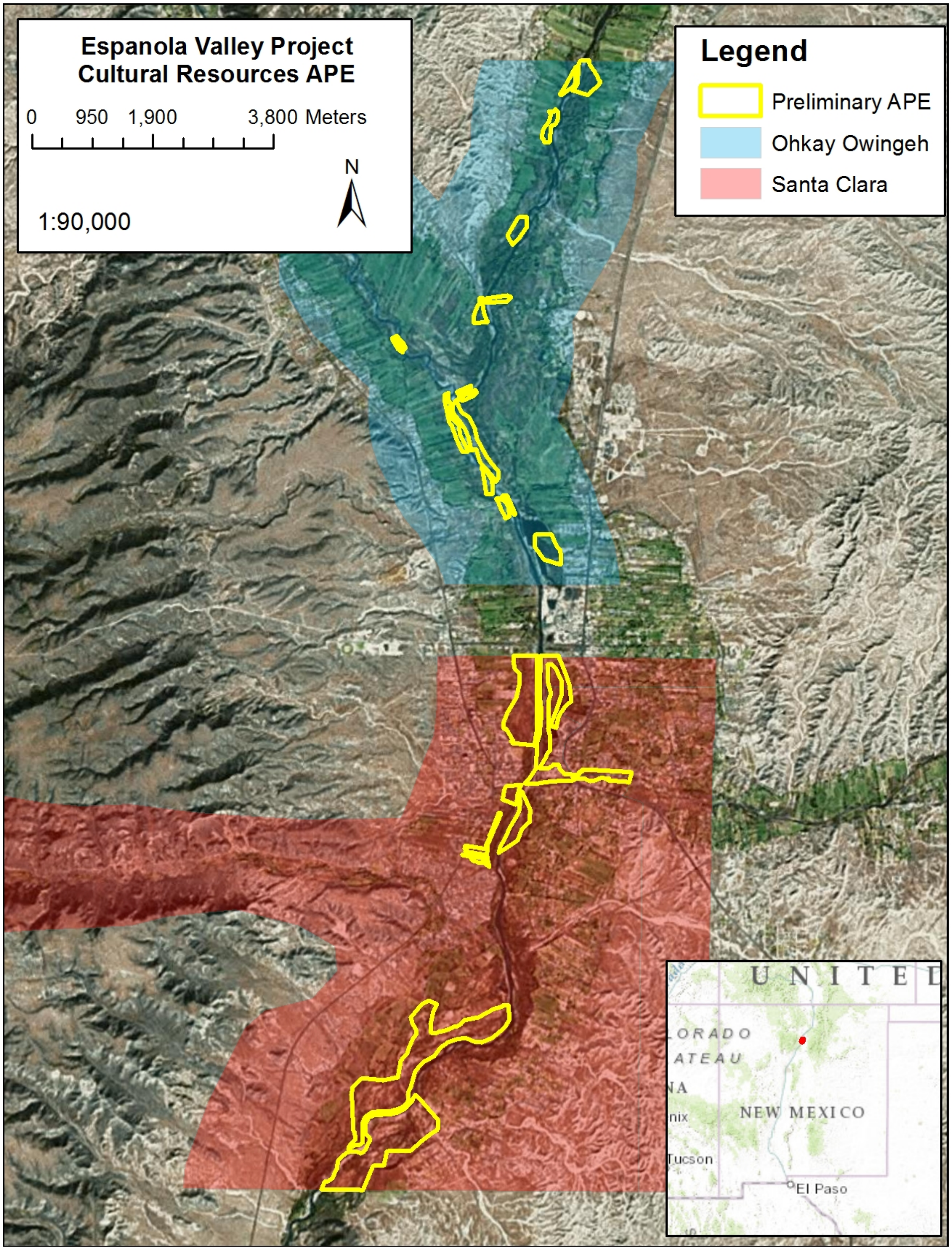



**Figure 14 Preliminary Area of Potential Effect for cultural resources for proposed project.**

#### *2.4.1.4 State and National Register listed properties*

There are seven properties currently formally listed on the State and/or National Register of Historic Places within or in close proximity to the expected APE for the proposed project. State and National Register properties are protected resources, and any work proposed near them needs to consider its impact to the property. Two of these are the pueblos of the two Tribal sponsors. Most of these properties are unlikely to be affected by the kinds of projects that could be anticipated by this study. The Register-listed Black Mesa (located within San Ildefonso boundaries) is in close proximity to the southern portion of the expected APE, is listed here and must be considered for potential effects. Black Mesa is discussed in Appendix D.

**Table 6 State and National Registered properties in the study area.**

| Name | State Register Date | National Register Date |
|---|---|---|
| San Gabriel de Yungue-Ouinge | 12/20/1968 | 10/15/1966 |
| Santa Clara Pueblo | 12/30/1971 | 11/5/1974 |
| San Juan Pueblo (Ohkay Owingeh) | 7/28/1972 | 7/30/1974 |
| La Iglesia y la Plaza de Santa Cruz de la Canada | 2/9/1973 | 8/17/1973 |
| Black Mesa | 9/27/1974 | N/A |
| Bond House | 6/20/1978 | 3/6/1980 |
| Chimayo Trading Post | 4/3/1992 | 5/1/1999 |

### 2.4.2 Identification and Consideration of Historic Properties

The information presented above provides a solid background for future identification of historic properties pursuant to Section 106 of the NHPA. Future steps are as follows.

Identification of historic properties, as described in 36 CFR 800.4, is underway at Santa Clara primarily through archaeological surveys of the project APE, which are ongoing as of August 2015. Preliminary results suggest a smaller number of archaeological sites than originally expected within the Santa Clara APE, and all of relatively recent age. At Ohkay Owingeh, consultation between the Corps, the Pueblo of Ohkay Owingeh, and the New Mexico SHPO is ongoing, with the goal of identifying an appropriate method and approach for avoiding effects to historic properties while maintaining the confidentiality of cultural information within the Pueblo.

After historic properties have been identified (either through traditional archaeological survey, or through alternative methods developed in consultation with the Pueblos and SHPO), the next step in the Section 106 process (36 CFR 800.5) is to determine whether the project will have an effect on any historic property. The project can either have: 1) no historic properties affected, if there are either no NRHP-eligible properties in the APE or impacts to the historic properties that are in the APE will be avoided; 2) no adverse effect to historic properties, if there will be effects to historic properties, but those effects will not be adverse (significantly change the quality of those aspects of the property that make it eligible to the NRHP); or 3) an adverse effect to historic properties. USACE will make formal determinations of effect, and will consult on those determinations with the SHPO (for work outside of Santa Clara Pueblo) and the Santa Clara THPO (for work within Santa Clara Pueblo). In addition, scoping letters will be sent to Tribes and others to determine public, Tribal, and agency interest in the project. Project planning will be closely coordinated with the Tribal sponsors to ensure that any potential impacts to any Traditional Cultural Properties are fully taken into account.

In the first two cases (no historic property affected or no adverse effect to historic property), Section 106 is completed with the agency's determination and SHPO and/or THPO concurrence. If, however, a project will have an adverse effect to a NRHP-eligible historic property, additional consultation is required to determine what actions will be taken to resolve the adverse effects. Typically, resolution of adverse effects could include reporting on results of archaeological excavation, archival documentation, ethnographic interviews, and/or other mitigation measure(s) such as public outreach, but in the present case, development of alternative mitigation options that do not involve unnecessary dissemination of cultural information outside of the Pueblos would be a priority. Any resolution of adverse effect would have to be agreed on by the Tribal sponsors, the Corps and the SHPO before implementation. Consulting parties in the Section 106 process work to codify the mitigation measures in a memorandum of agreement (MOA). Preparing an MOA can be a lengthy process, and for planning purposes, expect any project that will have an adverse effect on a NRHP-eligible property to take a minimum of six additional months of consultation, and more depending on the level of public, Tribal, and agency involvement and the nature of the adverse effect.

### 2.4.3 Expected future without project conditions

Without the proposed project, any historic properties within the proposed project's APE would be expected to remain in approximately their current condition. With available information, there is no indication that any historic properties are currently imperiled or undergoing active change at the present time. Further conclusions can only be drawn after completion of archaeological survey within the proposed project's APE, currently targeted for spring 2015. More broadly, however, the cultural benefits related to cultural practices and the bosque's health would not be realized in the event that the project does not go forward.

## 2.5 Hazardous, Toxic, and Radioactive Waste (HTRW)

This section documents the existing conditions observed during the 2009 preliminary assessment. It also describes the future without-project scenario and its impact to HTRW. USACE anticipates minimal impact of the project on HTRW.

This study has recently reached the stage where specific study areas have been selected for intensive investigation. Existing, future with- and future without-project conditions, of that smaller subset of the initial study area, will be examined in significant detail. A new Phase I Environmental Site Assessment (ESA) will be contracted to determine the likelihood of the existence of Hazardous, Toxic & Radioactive Waste (HTRW) concerns; specifically, ASTM 2247-02, Phase I ESA Assessment for Forestland or Rural Property.

If there are any HTRW issues identified USACE will inform the project manager, project delivery team, and local sponsor(s). USACE will follow USACE Engineering Regulation, HTRW Guidance for Civil Works Projects (ER 1165-2-132).

#### 2.5.1 Water quality

Water quality in the study area would continue to be affected by input from storm water sewer outfalls including solid waste, fecal coliform, nutrients, and organic compounds. Other aspects and characteristics of water quality would remain unchanged from the existing condition without implementation of the proposed project.

Section 404 of the Clean Water Act provides for the protection of waters of the United States" from impacts associated with irresponsible or unregulated discharges of dredged or fill material in aquatic habitats, including wetlands as defined under Section 404(b)(1). In New Mexico, permitting for placement of fill in such areas is the responsibility of the U.S. Army Corps of Engineers, Albuquerque District.

### 2.6 Geology and Soils

#### 2.6.1 Regional geology

The study area lies within the Española Basin, a sediment filled asymmetric west-tilted half-graben that formed as part of the Rio Grande Rift. The Rio Grande Rift created a series of north-south trending faults that resulted in uplifted mountains, widespread volcanism and large sediment filled basins. The Española Basin is bounded by the Sangre de Cristo Mountains to the east, the Jemez Volcanic Field to the west, the San Luis Valley and Chama Basins to the north and the Albuquerque Basin to the south-southwest (Appendix F – Geotechnical Engineering).

#### 2.6.2 Subsurface

Subsurface information specific to proposed construction sites is currently not available. Depth to bedrock is unknown but not expected to be within the proposed limits of foundations. A subsurface investigation was not conducted. As the project alternatives are developed in greater detail, a subsurface investigation will be planned to investigate the subsurface conditions at those specific locations. Subsurface information from the proposed Los Vigiles Grade Reduction Facility (GRF), Española, New Mexico; is provided in Appendix F. This information was obtained in the general vicinity of this project and in 2007.

#### 2.6.3 Future Without Project Geology and Soils

No changes are anticipated in site geology and soils over the life of the project.

### 2.7 Climate

This section provides information on the existing climate in the study area, and on projected changes in future climate conditions. A detailed discussion of regional climate and climate change, along with an assessment of climate impacts to regional hydrology, riparian and aquatic ecosystems, and project features can be found in Appendix G.

#### *2.7.1.1 Existing Climate*

The climate of the Española Valley ranges from semi-arid (approximately 10" of precipitation/year) along the Rio Grande to alpine (approximately 40" of precipitation/year) at the highest elevations of the surrounding mountain peaks. Mountain areas retain snow during the winter months, and melting of the snowpack in spring contributes significantly to spring runoff flows on the Rio Grande and Rio Chama.

A NOAA National Weather Service Cooperative Observer (COOP) station with a relatively complete record is located at Alcalde (Station 290245), along the Rio Grande northeast of Ohkay Owingeh Pueblo. The period of record for this station is 1953 through October 2012. The climate at Alcalde is arid continental with large daily and seasonal temperature differences (see Appendix G). Summers tend to be hot and dry; winters tend towards cool and humid. Peak precipitation occurs during the late summer/early fall (July, August, September) during the peak of the North American Monsoon (monsoon), with a secondary peak in winter. Spring and fall tends towards warm and dry.

The monthly period of record temperature summary at Alcalde (Appendix G) shows that monthly average daytime maximum temperatures (Tmax) are above freezing in all months. Winter Tmax averages 47.7°F, with few winter days with Tmax <=32°F. Monthly overnight minimum temperatures (Tmin) average 17.1°F in winter , but can reach as low as -34°F. In summer, Tmax averages 87.4°F. July is the hottest month, with an average of 16 days with temperatures above 90°F and occasional days where temperatures peak as high as 102°F. Monthly overnight low temperatures (Tmin) average 69.9°F in summer.

At Alcalde, precipitation averages 10.01” per year (Appendix G). In most months, precipitation is 0.75” or less, but is higher during the monsoon season: July receives an average of 1.37”, August 1.89”, September 1.26”, and October 1.04”. Precipitation may fall as snow from October through April, with average monthly snowfall peaking in December at 2.8”.

Floods occur from April through October and are usually the result of rain alone, rain-augmenting snowmelt runoff, or in some rare cases, extremely high snowmelt runoff events. Local rain events caused by convective storms create flash floods on the tributaries, which accumulate in the Rio Grande’s channel. Many of the flood-producing storms on the main stem Rio Grande occur during the transitional periods between spring and summer and between summer and fall. During these periods the strong intrusion of cool northern air interacts with the moist tropical air to produce the widespread storms over the watershed.

Topography significantly influences local climate in winter and summer. In winter, the dominant pattern is for storms to move into the region from the west or northwest; much of the precipitation falls over the western and central portions of the Jemez Mountains, and the amount declines rapidly moving east of the Sierra de los Valles and down slope to the Rio Grande. During the monsoon season, thunderstorm development is encouraged by daytime surface heating over the Pajarito Plateau and Sierra de los Valles. Daytime surface heating causes air to rise, initiating convection that can pull in air from lower areas to the southeast (Bowen 1996). This convection leads to the formation of thunderstorms over the plateau. Westerly winds in the upper atmosphere can push these storms east towards the Rio Grande as well as advect precipitation into the area. The Sangre de Cristo mountains prevent moisture from the Plains from entering the region. The region effectively lies in the rainshadow of the Sangres with respect to moisture transported northwestward from the Gulf of Mexico.

Wind direction is generally from the southeast in summer and from the west in winter, but varies greatly because of local topography and mountain and valley breezes. Los Alamos National Laboratory researchers have deduced a diurnal pattern of wind movement from observations in the various Pajarito Plateau Canyon systems. During the day, the winds tend to blow up-canyon from the east; at night, the winds tend to blow down-canyon from the west. Shear winds have also been noted across the canyons (Pueblo De San Ildefonso 2005).

In recent decades, temperature increases have been observed regionally (Appendix G). Annual temperatures in New Mexico warmed at an average rate of 0.219°F (0.10°C) per decade from 1912 to 2011 but at the faster rate of 0.678°F) (0.34°C) per decade since 1970 (Tebaldi et al. 2012). The same pattern of faster recent warming was also observed in annual average daytime maximum high temperature (Tmax) and annual average nighttime minimum temperature (Tmin). Higher rates of warming have been observed in high elevation areas, particularly in winter. There has been no detectable trend in precipitation.

In the vicinity of the study area, statistically-significant increases in temperature have been observed over the period 1971-2012, particularly in the months of January and March, and in the summer months from May through September. Daytime high temperatures (Tmax) have risen at about 1°F/decade from May through November in the Middle Rio Grande, and at approximately half that rate along the Rio Chama and Jemez River. Rates of warming have been slower in the Jemez Mountain stations. Only in March is there a significant, region-wide warming trend of approximately 1°F/decade.

Nighttime low temperatures (Tmin) have also risen significantly in many months, particularly in the period April through September when a warming trend of approximately 0.5°F/decade was observed. Increases in Tmin were particularly evident in the Jemez Mountains, with significant rates of increase in excess of >0.59°F/decade in all months except February and December. As a result of this warming, there has been a trend towards increasing numbers of late spring days with night time temperatures warmer than 32°F.

Historic precipitation trends in the study area show little in the way of statistically significant trends.

### 2.7.2 Future Without-Project Climate Conditions

As detailed in Appendix G, climate models project warming over the 21st Century of 5-7°F by 2100 as compared to late 20th average temperatures. Modeling using recent RCP scenarios suggests warming may reach as much as 8.5 to 10°F by 2100 under plausible high emissions (large radiative forcing) scenarios, which is slightly higher than earlier estimates. Even with no net changes in precipitation, such warming will exert strong effects on regional hydrology by reducing the regional snowpack, decreasing spring runoff volumes and increasing evaporation rates.

## 2.8 Socioeconomics

The majority of the study area and affected populations is in Rio Arriba County, New Mexico. The population of Rio Arriba County has decreased slightly from 41,190 in 2000 (U.S. Census Bureau 2014). The majority of the surrounding project population is Hispanic/Latino followed by White (not Hispanic), Native American, Black and Asian. The poverty level is slightly higher than the state average as is the Census Data Population (CDP) of Ohkay Owingeh. Poverty levels for Santa Clara and San Ildefonso are below the state average.

The leading employment sectors in Rio Arriba County are education, health care, and social services (20.9 percent) and public administration (16.4 percent). Agriculture employs about four percent of the county's workers, while hospitality services and construction, each employs more than 10 percent of the workforce.

**Table 7 Española Valley 2015 population statistics.**

| **Española Valley** | **Total Population (individuals)** | **Race and Ethnicity** | | | | |
|---|---|---|---|---|---|---|
| | | **White, not Hispanic** | **Hispanic / Latino** | **Native American** | **Black** | **Asian** |
| New Mexico | 2,065,826 | 39.4% | 47.3% | 10.4% | 2.5% | 1.6% |
| Rio Arriba County | 40,371 | 13.2% | 71.4% | 18.0% | 0.9% | 0.8% |
| Santa Fe County | 144,532 | 43.5% | 51.1% | 4.0% | 1.1% | 1.4% |
| Ohkay Owingeh CDP | 1,143 | 1.9% | 19.7% | 76.8% | 0.09% | 0.2% |
| Santa Clara CDP | 1,018 | 2.8% | 23.6% | 71.9% | 0.3% | 0.3% |
| San Ildefonso Pueblo CDP | 524 | 9.4% | 31.9% | 57.4% | | |

** Respondents may have multiple answers to census survey resulting in numbers greater than the total population.*

**Table 8 Española Valley 2015 population and poverty statistics.**

| **Española Valley** | **Total Number** | **Age** | | | **Below Poverty Level** | |
|---|---|---|---|---|---|---|
| | | **0-17 years** | **18-64 years** | **65 and older** | **Under 18 years** | **All ages** |
| New Mexico | 2,065,826 | 265,580 | 145,523 | 93,680 | 7.3% | 21.2% |
| Rio Arriba County | 40,371 | 6,466 | 573 | 1,697 | 7.8% | 24.5% |
| Santa Fe County | 144,532 | 12,412 | 775 | 6,025 | 5.4% | 18.2% |
| Ohkay Owingeh CDP | 1,143 | 334 | 673 | 136 | | 25.7% |
| Santa Clara CDP | 1,018 | 251 | 631 | 136 | | 15.3% |
| San Ildefonso Pueblo CDP | 524 | 138 | 311 | 75 | | 11.9% |

### 2.8.1 Environmental justice

Executive Order 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (11 February 1994) was designed to focus the attention of Federal agencies on the human health and environmental conditions of minority and low-income communities. It requires Federal agencies to adopt strategies to address environmental justice concerns within the context of agency operations and proposed actions. The 1995 Environmental Protection Agency (EPA) guidance document, Environmental Justice Strategy: Executive Order 12898, defines the approaches by which the EPA will ensure that disproportionately high environmental and/or socioeconomic effects on minority and low-income communities are identified and addressed. Further, it establishes agency wide goals for all Native Americans with regard to environmental justice issues and concerns.

The goals expressed by the Pueblos of Ohkay Owingeh and Santa Clara have included local Native American environmental justice issues and concerns.

### 2.8.2 Future with-out project condition

No significant changes to socioeconomic trends or to environmental justice are expected within the analyzed life of the project (Appendix I, Section 5.6).

# 3 - Plan Formulation and Evaluation for FRM

Plan formulation is the process of building plans that meet planning objectives and avoid planning constraints (Section 1.6.3). It requires knowledge, experience, and judgments of many professional disciplines. Planners define the combination of management measures that comprise an alternative plan (alternative) in sufficient detail that realistic evaluation and comparison of the alternative's contributions to the planning objectives and other effects can be identified, measured, and considered. Plan formulation requires the views of stakeholders and others in agencies and groups outside USACE to temper the process with different perspectives. Plan formulation capitalizes on imagination and creativity wherever it is found, across technical disciplines and group affiliations.

In most cases, there will be more than one alternative that will meet the planning objectives, although they meet them to varying degrees. Good planning eliminates the least suitable alternatives while refining the remaining alternatives fairly and comprehensively.

Sometimes, the formulation process emphasizes structural details, costs, outputs, safety, reliability, and other technical matters. Nonetheless, plan formulation must be balanced with environmental, social, institutional, and other considerations that are often less quantifiable and less comfortable to consider in plan formulation and evaluation.

## 3.1 Development of Alternative Plans

Alternatives were formulated in consideration of current Federal, State, and local planning and environmental guidance, laws, and policy concerning ecosystem restoration, FRM, recreation, water quality, and related purposes.

Preliminary alternatives required further analysis to determine whether they addressed the specified problems and opportunities, and planning objectives and constraints. Through modeling and best professional judgment, alternatives were compared against each other in order to arrive at the recommended plan. Following the completion of the integrated feasibility report / EA, public feedback, and project authorization by Congress, if such action occurs, additional detailed design analysis and preparation of plans and specifications will take place.

### 3.1.1 Measures and alternatives development and evaluation process

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

- **Completeness –** Does the plan include all necessary parts and actions to produce the desired results?
- **Effectiveness –** Does the alternative substantially meet the objectives? How does it measure up against constraints?

- **Efficiency –** Does the plan maximize net NER and/or NED benefits?
- **Acceptability –** Is the plan acceptable and compatible with laws and policies?

In the initial phase of the study, the team developed measures to satisfy the four feasibility criteria.

## 3.2 Preliminary Management Measures

A measure is defined as a means to an end; an act, step, or proceeding designed for the accomplishment of an objective. The definition of a management measure (or "measure") is a feature (structure) or activity that can be implemented at a specific geographic site to address one or more planning objectives. Measures are the building blocks of which alternative plans are made. Measures become more specific and better defined as planning progresses.

All management measures are considered to have an approximate 50-year life of project individually, or in combination with other management measures. FRM measures considered in this study are listed in Table 9. Each measure is identified as either meeting a specific study objective or failing to meet a specific planning objective. They are described in the following sections.

**Table 9 FRM management measures, goals and objectives matrix.**

| Measure Name | Reduce flood risk to private property and public infrastructure | Reduce flood risks to human health and safety | Contributes to the NED |
|---|---|---|---|
| Emergency Preparedness | Yes | Yes | No |
| Flood Forecast and Warning System | Yes | Yes | No |
| Relocation | Yes | Yes | No |
| Buyout or Acquisition | Yes | Yes | No |
| Wet Flood proofing | Yes | Yes | No |
| Ring Levees or Floodwalls | Yes | Yes | Yes |
| Levees | Yes | Yes | Yes |

### 3.2.1 <u>Non-structural</u>

Non-structural FRM measures are most often defined by a list of examples. The P&G [1.6.1(f)(1)] described them as "complete or partial alternatives to traditional structural measures. Non-structural measures include modifications in public policy, management practice, regulatory policy and pricing policy."

*3.2.1.1 Emergency preparedness plans*

Each of the non-Federal sponsors have been encouraged to prepare flood response plans for their populations, to include Tribal 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. Non-Federal sponsors should develop 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.

*3.2.1.2 Flood forecast and warning*

Forecasting floods and providing a warning to the community provides the opportunity to respond. This response might be enacting formal emergency response plans or directing ad hoc actions to reduce damages and save lives.

*3.2.1.3 Wet floodproofing*

Per FEMA's *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 includes properly anchoring the structure, using flood resistant materials below the base flood elevation (Base), protection of mechanical and utility equipment, and use of openings or breakaway walls. The Base is approximately the elevation of the mean 1% ACE event.

*3.2.1.4 Dry floodproofing*

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

*3.2.1.5 Elevation of structures*

When a structure is properly elevated, the living or commercial area will be above all but the most severe floods (such as the 0.2% ACE event). Several elevation techniques are available.

*3.2.1.6 Acquisition and / or relocation of existing 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. If space and ground elevations allow, a structure may be moved to another location on the same piece of property.

3.2.2 Structural

In 1993, USACE prepared a report titled *Assessment of Structural Flood-Control Measures on Alluvial Fans*. This document defines structural FRM measures as debris barriers or basins, detention basins, channels, diversions or bypasses, floodwalls, dikes and levees. For the purposes of this study, levees and dikes are considered to be the same kind of structure. This study looked at floodwalls, levees and a special type of levee called a ring levee.

#### *3.2.2.1 Floodwalls*

Floodwalls are vertical walls, usually made with reinforced concrete, oriented parallel to a water way to prevent overflows from entering into developed areas. Floodwall heights for Alignment A were evaluated for the Base and Base + 1 ft elevations.

#### *3.2.2.2 Levees*

For the purposes of this study, a levee is an earthen embankment whose primary purpose is to furnish flood protection from high water and which is therefore subject to water loading for periods of only a few days or weeks a year. Levee alignment is generally dictated by flood management requirements.

Even though levees are similar to small earthen dams they differ from earthen dams in the following important respects: (a) a levee embankment may become saturated for only a short period of time beyond the limit of capillary saturation, (b) levee alignment is dictated primarily by flood protection requirements, which often results in construction on poor foundations, and (c) borrow is generally obtained from shallow pits or from channels excavated adjacent to the levee, which produce fill material that is often heterogeneous and far from ideal. For this study, it was assumed that new materials for the construction of levees would be purchased off-site and transported on-site.

Levee heights evaluated were the Base and Base + 1 ft elevations. All alignments tie into high ground at either end.

#### *3.2.2.3 Ring levees*

This type of levee completely or partially encircles, or “rings” an area subject to inundation from flood flows from one or more directions.

For this study, partial ring levees would have been built around a single structure or group of structures and then tied into high ground. For this study, it was assumed that new materials for the construction of levees would be purchased off-site and transported on-site. Ring levee heights for all alignments were evaluated for the Base – 1 ft, Base, and Base + 1 ft elevations.

All floodwall and ring levee alignments tie into high ground at either end.

## 3.3 Preliminary Management Measures Eliminated From Further Study

The PDT and sponsors conducted a preliminary screening of management measures to evaluate the applicability of each measure, and the potential for each measure to contribute to the study’s specific planning objectives consistent with planning constraints.

### 3.3.1 Non-structural

The following non-structural FRM measures were eliminated from further consideration for the reasons indicated below:

#### *3.3.1.1 Emergency preparedness*

The non-Federal sponsor should collaborate with City of Española, NM, non-Tribal persons with property within Tribal boundaries, their county emergency managers and the New Mexico Department of Homeland Security and Emergency Management to create a seamless flood response plan.

#### *3.3.1.2 Flood forecast and warning*

The high residual damages suggest that a flood warning system is ineffective and incomplete on its own. Further, relative to the structural alternative presented it's impossible for a flood warning system to provide greater net benefits.

#### *3.3.1.3 Abiquiu Emergency Action Plan*

The Albuquerque District Operations Division and the Dam Safety Coordinator have a yearly emergency action plan with emergency contact information (24-hour phone numbers and / or email addresses) for each of the Tribal sponsors in case of high flows or emergency releases through Abiquiu dam.

#### *3.3.1.4 Wet floodproofing*

Of the structures identified by the non-Federal sponsors as being critical to the community and economically assessed, only 5 were considered to have good construction quality. Of those five, none had either a crawl space or basement.

#### *3.3.1.5 Dry floodproofing*

Of the structures identified by the non-Federal sponsors as being critical to the community and economically assessed, only 5 were considered to have good construction quality. Of those five, three structures are part of the San Juan Elementary School complex and meet all of the requirements for dry floodproofing except the requirement of impermeable soils. The other two structures lie within Santa Clara Pueblo boundaries and are the Española City Plaza and a day care center. After discussions, the day care was removed from further consideration as not being critical to the community. The City Plaza is the property of the City of Española and the final report generated from this study will be supplied to the City's government.

#### *3.3.1.6 Elevation of existing structures*

Of the structures identified by the non-Federal sponsors as being critical to the community and economically assessed, only 5 were of frame construction and were considered to have good construction quality. Of those five, three structures are part of the San Juan Elementary School complex (1. cafeteria / gym / library, 2) administration / classrooms, and 3) classrooms. The configuration of these buildings would require extensive structural modifications to maintain the building's structural integrity during elevation. The other two structures lie within Santa Clara Pueblo boundaries and are the Española City Plaza and a day care center. After discussions, the day care was removed from further consideration as not being critical to the community. The City Plaza is the property of the City of Española and the final report generated from this study will be supplied to the City's government.

##### *3.3.1.7 Acquisition*

This technique 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. As stated previously 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.

##### *3.3.1.8 Relocation of existing structures*

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. The process involves lifting the house off its foundation, placing it on a heavy-duty flatbed trailer, hauling it to the new site, and lowering it onto a new, conventional foundation.

#### 3.3.2 Structural

All structural FRM measures were carried forward for additional analysis.

### 3.4 *Description of Preliminary Alternatives

This section describes how the management measures carried forward for further analysis were used in the formulation of preliminary alternative plans.

#### 3.4.1 Ohkay Owingeh - floodwalls or ring levees around San Juan Elementary School

Floodwall and levee heights were evaluated at the Base Flood Elevation – 1 ft, Base, and Base + 1 ft. All floodwall and ring levee alignments tie into high ground at either end (Figure 15).

Alignment A (floodwall or ring levee) begins to the west of the San Juan Elementary School compound and runs generally counter clock-wise for approximately 2,738 feet. The south – southwest side of the school complex would require a flood wall, rather than a ring levee, due to the width limitations between NM Highway 74 and the parking lots. Because the PDT believed that both a floodwall or ring levee would not be economically justified based only upon the school's structures, the alignment also included approximately three private homes and three outbuildings just to the west of the school.

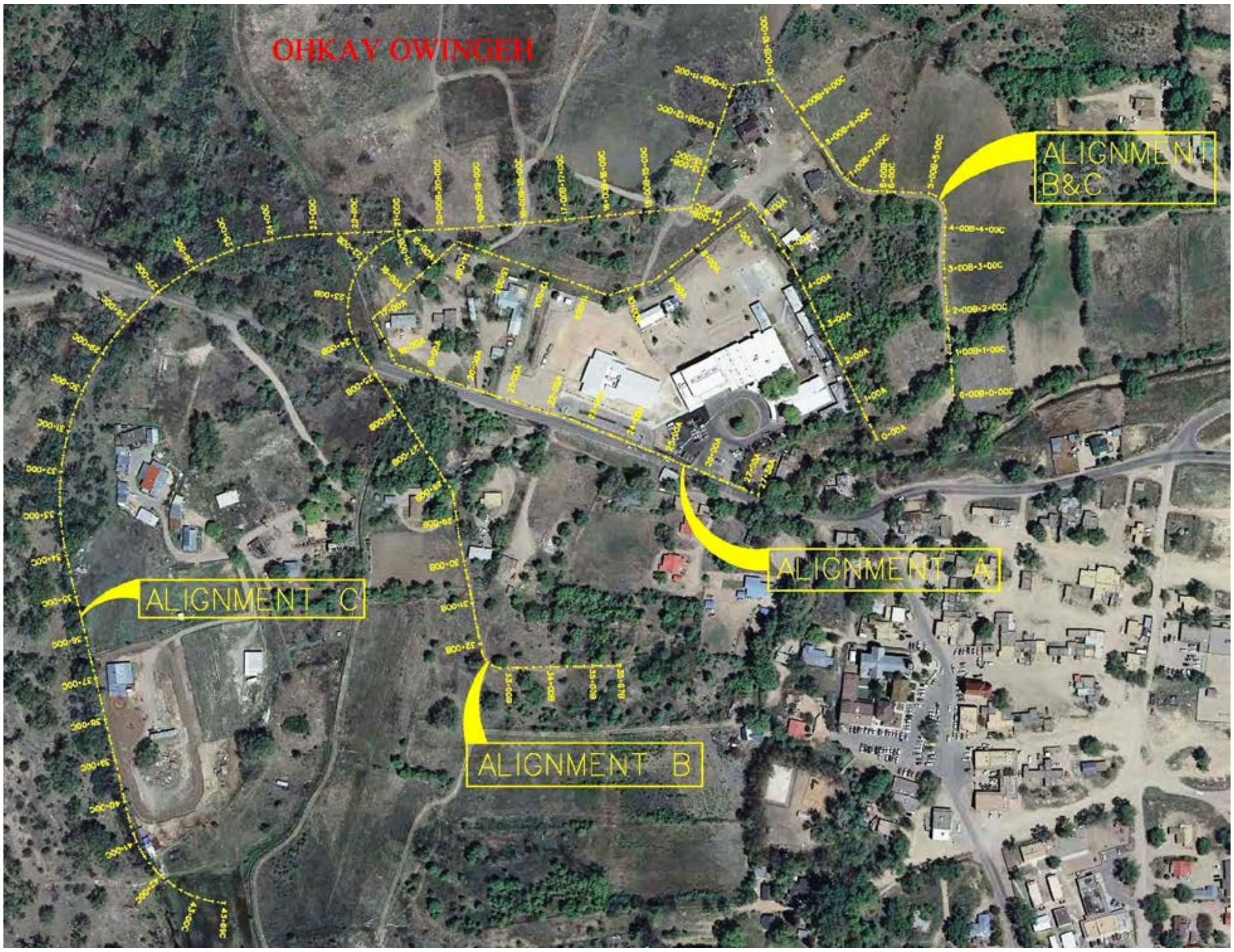



**Figure 15 Floodwall and ring levee alignments around San Juan Elementary School.**

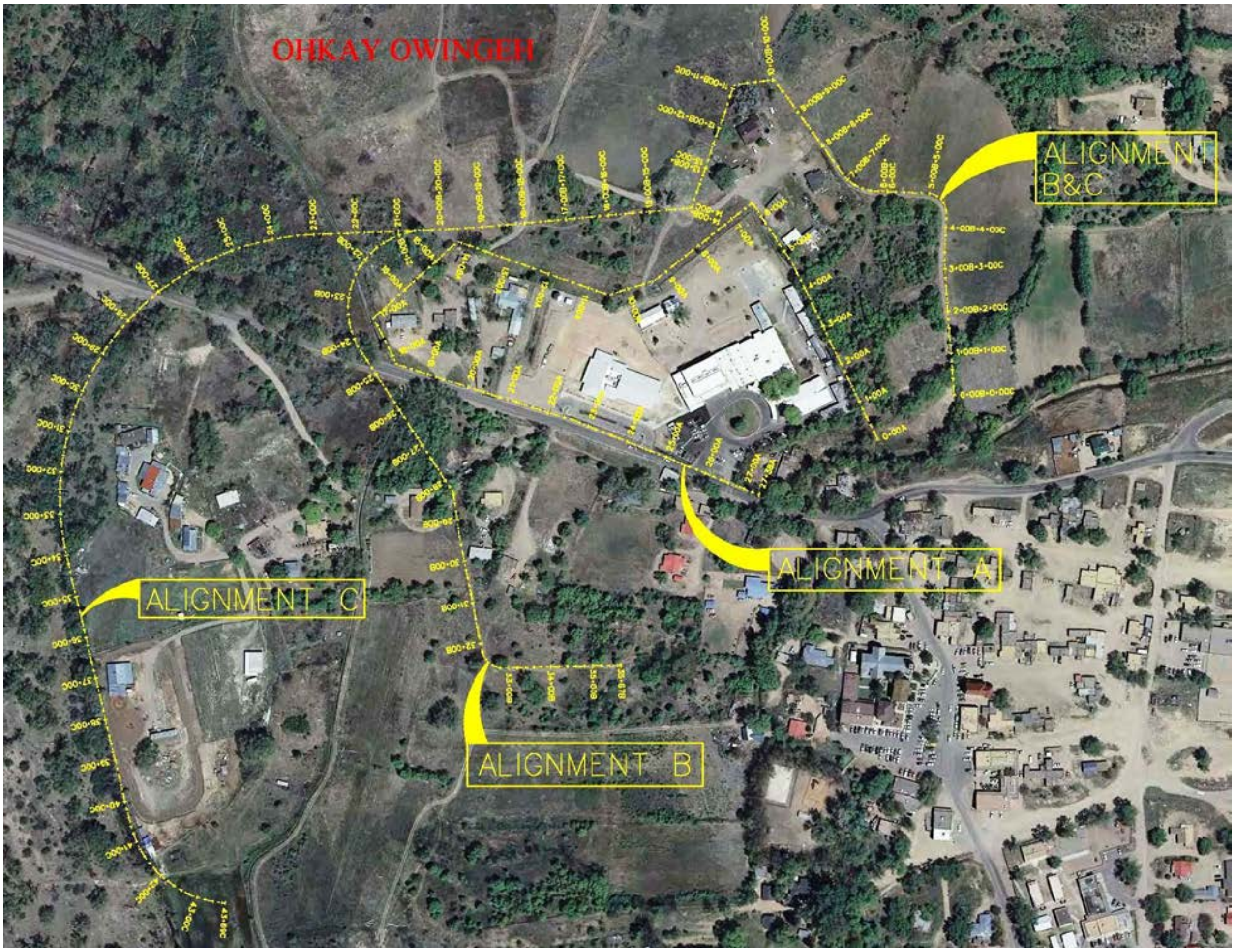



**Figure 16 Floodwall and ring levee alignments around San Juan Elementary School.**

Alignment B (ring levee) begins to the west of the San Juan Elementary School compound and runs generally counter clock-wise for approximately 356,700 feet. Because the PDT believed that neither a floodwall nor ring levee would be economically justified based only upon the school's structures, this alignment also included three private homes and three outbuildings just to the west of the school and two more homes to the south west.

Alignment C (ring levee) begins to the west of the San Juan Elementary School compound and runs generally counter clock-wise for approximately 356,700 feet. Because the PDT believed that neither a floodwall nor ring levee would be economically justified based only upon the school's structures, this alignment also included three private homes and three outbuildings just to the west of the school and two more homes to the south west. This alignment would also protect approximately an additional six homes and 12 out buildings.

### 3.4.2 Santa Clara levees along the Santa Cruz River and Rio Grande

Levee heights evaluated were Base Flood Elevation and Base + 1 ft. All alignments tie into high ground at either end (Figure 11).

Levee Alignment A begins at its tie-in to the south edge of Fairview Lane (NM Highway 584) west of the bridge over the Rio Grande. The levee extends south along the west bank of the Rio Grande approximately 840,000 feet to its tie-in just to the west of the El Paseo de Oñate (US Highway 285) bridge.

Levee Alignment B begins at its tie-in to high ground northeast of the Santa Claran Hotel and Casino parking lot. The approximately 431,100 feet levee extends west towards the Rio Grande and then south on the east bank of the Rio Grande along, or on top of, an existing dirt access road on top of a slight ridge line above the Rio Grande floodway. The levee would be built intermittently to fill in between areas where the topography is already at the Base and Base + 1 ft elevations.

Levee Alignment C begins at its tie-in to high ground northwest of the junction of US Highway 285 and Stanley A. Griego Bridge Road and runs west along the north bank of the Santa Cruz River. This approximately 172,700 foot levee makes a northern dog-leg and ties into the high ground of the El Paseo de Oñate (US Highway 285).

Levee Alignment D begins at its tie-in to high ground on the southern edge of Corlett Road approximately 1,620 feet southwest of its junction with NM Highway 76. This levee measures approximately 335,700 feet west along the north bank of the Santa Cruz River towards its junction with the Rio Grande where it ties-in to high ground at South Riverside Drive (US Highway 285).

Levee Alignment E begins at its tie-in to high ground on the south side of Stanley A Griego Bridge Road north of the Santa Clara Pueblo waste water treatment plant. The levee extends west along Stanley A. Griego Bridge road towards the Rio Grande, south and then back around to the east to high ground partially encircling the waste water treatment plant. The levee measures approximately 210,000 feet in length.

Levee Alignment F begins at its tie-in to high ground on the south side of Stanley A Griego Bridge Road just east of that roads junction with the Los Alamos Highway The levee runs south on the west bank of the Rio Grande to Levee Service Road (There’s no levee.) and the west on the north bank of the Guachupangue Arroyo where it ties-in to high ground. The levee measures approximately 2,920 feet in length.

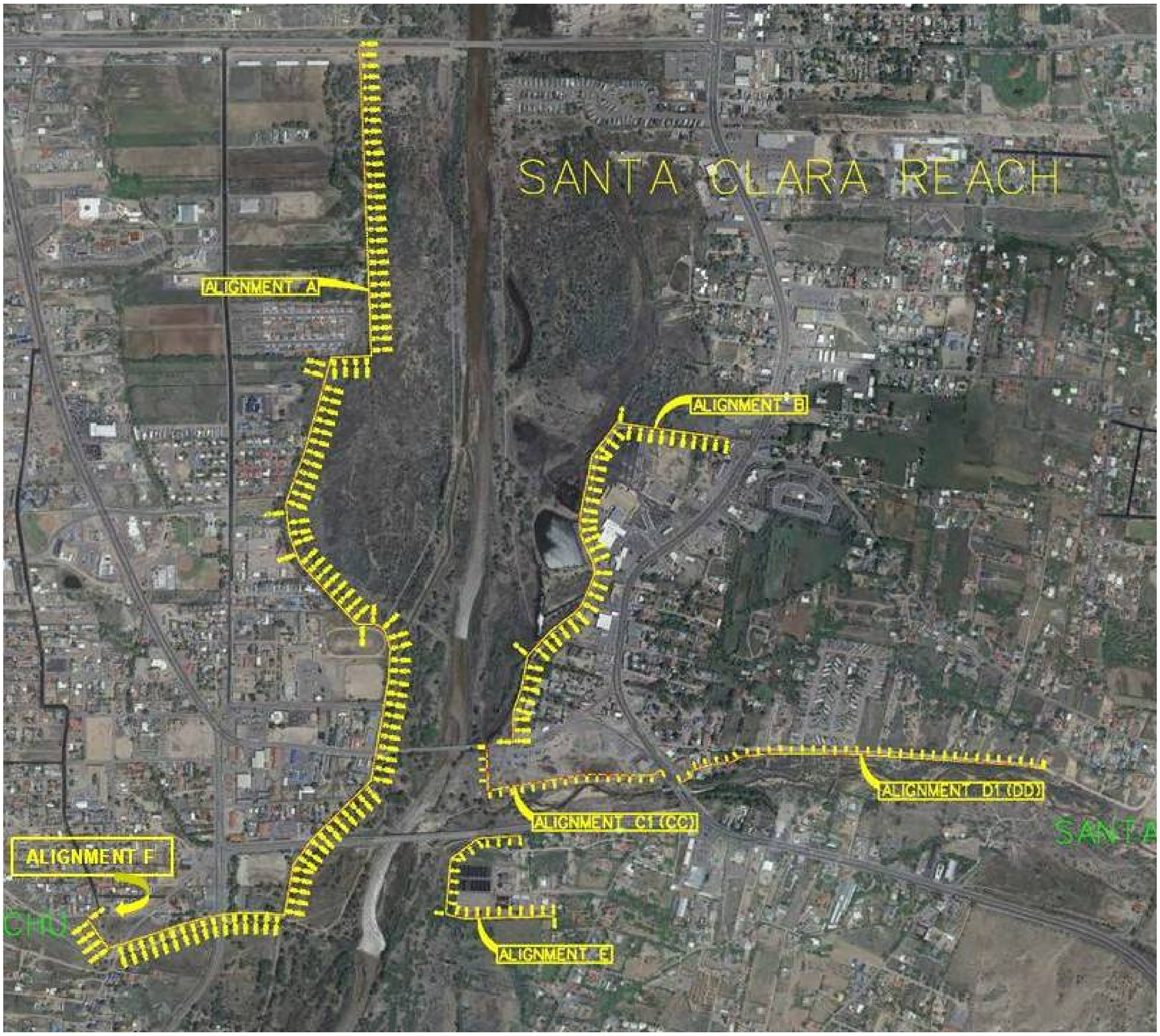



**Figure 17 Santa Clara levee alignments along the Rio Grande, Santa Cruz River and Guachupangue Arroyo.**

#### 3.4.3 San Ildefonso – levees along the Rio Pojoaque

Levee heights evaluated were Base Flood Elevation and Base + 1 ft. All alignments tie into high ground at either end (Figure 18 and Figure 19).

Levee Alignment A ties-in to high ground on the south bank of the Rio Pojoaque at Decimal Degree (DD) 35.8956 by -106.1043 and runs west towards the Rio Grande along the north bank of an irrigation ditch until it meets the bridge approach at Tunyo Po Road and follows the road north until it meets the bridge over the Rio Pojoaque. The levee follows the side of Tunyo Po Road north because it was believed that the road embankment was not engineered well enough to act as a levee and therefore also needed flood protection. The levee measures approximately 3,680 feet in length.

Levee Alignment B begins at its tie-in to high ground at the junction of Evergreen Lane and Rancho del Alamo Road and runs west along the south bank of the Rio Pojoaque towards the Rio Grande. This levee measures approximately 6,470 feet and is located along the north side of Rancho del Alamo Road and then Gonzales Lane until it ties-in to high ground at approximately 35.8948 by -106.1029 (DD).

Levee Alignment C is along the south bank of the Rio Pojoaque and begins at its tie-in to high ground at approximately 35.8906 by -106.0759 (DD) on an unnamed dirt road. The levee runs from that point north to Tribal Road CR-84A, west towards the Rio Grande along north side of Tribal Road CR-84A to Evergreen Lane, and then approximately 400 feet south along the east of Evergreen Lane to high ground. The levee measures approximately 3,010 feet in length.

Levee Alignment D begins at its tie-in to high ground on the north side of San Ildefonso's Tribal Offices on North Kiva Road and runs west towards the Rio Grande. The levee extends to the southwest corner of the old wastewater treatment plant and then back around to the southeast to high ground partially encircling the plant. The levee measures approximately 3,200 feet in length.

Levee Alignment E begins at the Tunyo Po Bridge over the Rio Pojoaque and runs west towards the Rio Grande, crossing San I Senior road, following the north verge of Poh-see-Buu Road and tying in to high ground. The levee measures approximately 1,900 feet in length.

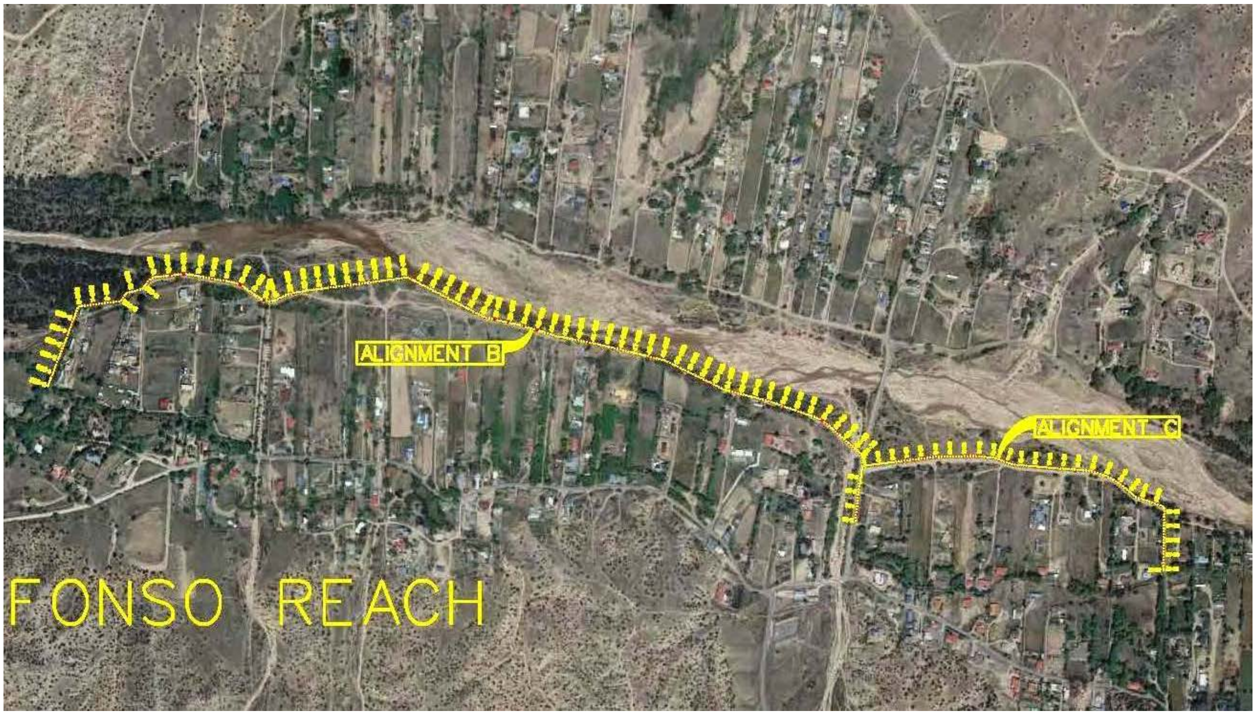



**Figure 18 San Ildefonso levee alignments B and C along the Rio Pojoaque.**

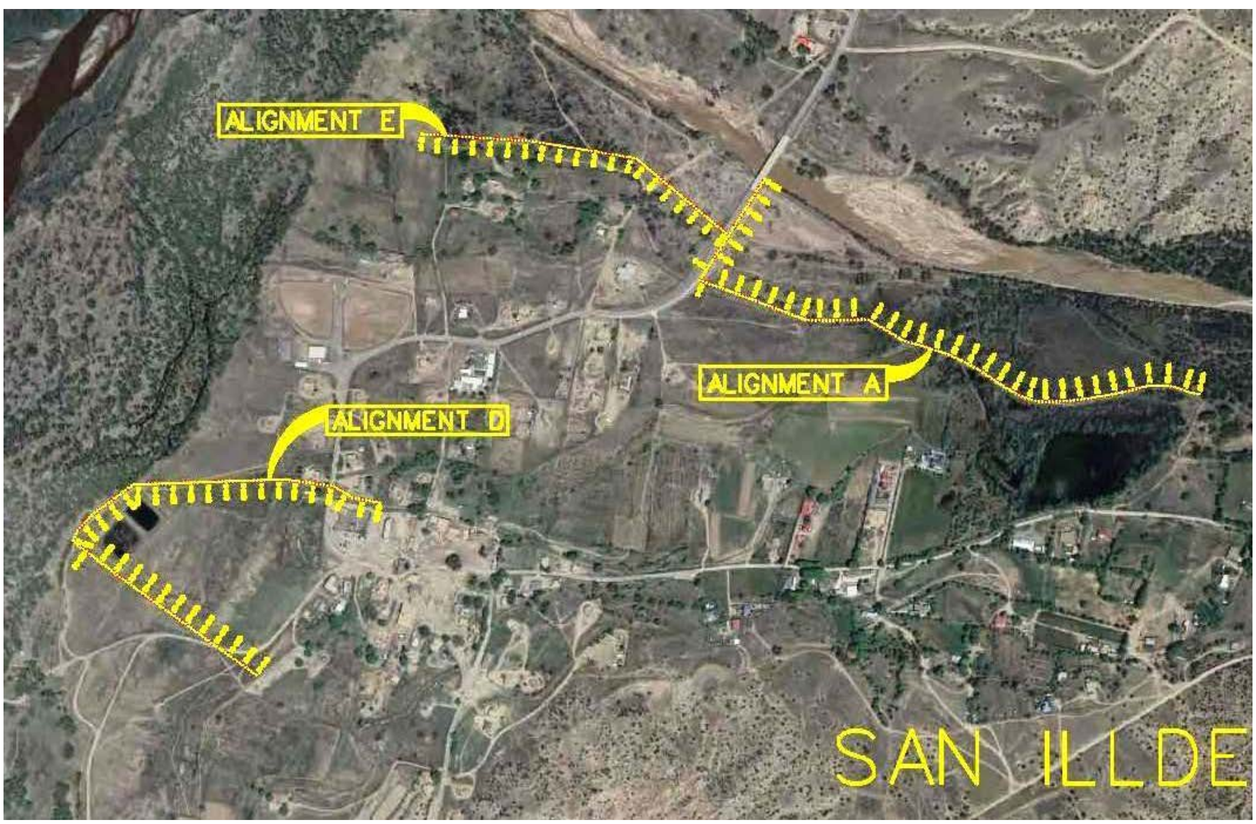



**Figure 19 San Ildefonso levee alignments A, D and E along the Rio Pojoaque.**

## 3.5 *Evaluation and Screening of Preliminary Alternatives

For this study, it was assumed that new materials for the construction of levees would be purchased off-site and transported to the-site.

Prior to analyzing the levees found in Table 13 using FDA, the project cost for each alignment was compared to the justifiable construction result for each alignment. The justifiable construction figure is a means to determine if any structural fix might be cost effective, where the benefit-cost ratio (BCR) for the structure is greater than 1.0. The justifiable construction figure was determined by multiplying the EAD of the alignment by the output of the (MS Excel) formula =PMT(x, y,-1), where x = current interest rate (3.375% in FY 2015) and y = proposed project life (50 years). If that final result was less than the proposed construction figure, the alignment was removed from consideration. The alignments that remained included: Alignment B earthen levee for Ohkay Owingeh (Base + 1 ft), Alignment F for Santa Clara (Base + 1 ft). Alignments E and F (along the Guachupangue) for Santa Clara were deemed not acceptable by the local sponsor due to added cost due to real estate issues and as a result were removed from consideration. All levee alignments were screened out at San Ildefonso (Table 15).

The remaining alignments were evaluated using HEC-FDA 1.2.5 to determine the with-project condition, and how much of the EAD is actually captured by the proposed structures. All results were based off the current interest rate of 3.375% and used the 50 year period of analysis. The results are only based on the construction cost generated and don't include estimated cost for operations, maintenance, repair, replacement and rehabilitation costs, real estate, and pre-engineering and design. The estimated cost was conservative and it is believed that the actual cost would decrease the net benefits and reduce the benefit/cost ratio (BCR). The final results of the economic analysis shows that, other than a levee along Arroyo de Guachupangue (that was already eliminated by a project sponsor due to real estate issues), no levee alignment for the Española Valley is economically justified and moving below Base -1 ft would not significantly reduce the flood threat enough to justify constructing a project. First construction costs are not annualized and do not include:

First construction costs do not include:

- Mitigation costs.
- Real estate costs (LERDDS).
- Pre-Engineering and Design (PED) costs.
- Interest during construction costs.
- Operations, maintenance, repair, replacement, and rehabilitation (OMRR&R) costs.

### 3.5.1 Ohkay Owingeh Pueblo - Floodwalls or ring levees around the San Juan Elementary School

On Ohkay Owingeh, Alignment A (floodwall or levee) followed the left bank of the Rio Grande above the Rio Grande/ Rio Chama confluence. The primary purpose was to protect an elementary school. Alignments B and C, also following the east bank of the Rio Grande above the confluence, were proposed to be implemented primarily to protect a sparsely populated area of single family housing and residential outbuildings (sheds, detached garages, etc).

The PDT, using best professional judgment gained from prior FRM studies, did not believe that there were enough economic benefits to justify either a floodwall or a ring levee around the San Juan Elementary School. In order to show due diligence, not only the Base and Base + 1 ft heights were evaluated, but also the Base – 1 ft heights.

The economically justifiable construction dollar amount (Table 10) is not based solely upon the amount of damages that would be prevented for those structures inside of each floodwall or ring levee alignment, but for all damages caused by flooding on the east bank of the Rio Grande upstream of its confluence with the Rio Chama.

Therefore, no FRM alternative was possible based upon only those structures that would have been nominally protected by either floodwalls or ring levees.

**Table 10 First construction costs vs. economically justifiable construction (Ohkay Owingeh).**

| Description | Project Cost | Justifiable Construction | Initial Result | Average Annual Cost ($1,000's) | Average Annual Benefits ($1,000's) | BCR |
|---|---|---|---|---|---|---|
| **Floodwalls** | | | | | | |
| Alignment A* | | | | | | |
| Base -1 | $1,511,653 | $1,791,775 | Carried forward for additional evaluation | $64.45 | $18.40 | 0.3 |
| Base | $2,007,277 | $1,791,775 | Project cost exceeds total damage capture | --- | --- | - |
| Base +1 | $2,419,043 | $1,791,775 | Project cost exceeds total damage capture | --- | --- | - |
| **Earthen Levees** | | | | | | |
| Alignment A* | | | | | | |
| Base -1 | $399,480 | $1,791,775 | Carried forward for additional evaluation | $22.99 | $18.42 | 0.8 |
| Base | $618,018 | $1,791,775 | Carried forward for additional evaluation | $35.57 | $36.12 | 1.0 |
| Base +1 | $857,959 | $1,791,775 | Carried forward for additional | $57.38 | $65.17 | 1.1 |

| **Description** | **Project Cost** | **Justifiable Construction** | **Initial Result** | **Average Annual Cost ($1,000's)** | **Average Annual Benefits ($1,000's)** | **BCR** |
|---|---|---|---|---|---|---|
| | | | evaluation | | | |
| Alignment B | | | | | | |
| Base -1 | $562,955 | $1,791,775 | Carried forward for additional evaluation | $32.40 | $18.40 | 0.6 |
| Base | $842,228 | $1,791,775 | Carried forward for additional evaluation | $48.47 | $36.10 | 0.7 |
| Base +1 | $1,141,188 | $1,791,775 | Carried forward for additional evaluation | $65.68 | $79.20 | 1.2 |
| Alignment C | | | | | | |
| Base -1 | $875,708 | $1,791,775 | Carried forward for additional evaluation | $50.40 | $10.40 | 0.2 |
| Base | $1,237,141 | $1,791,775 | Carried forward for additional evaluation | $71.20 | 36.10 | 0.5 |
| Base +1 | $1,763,187 | $1,791,775 | Carried forward for additional evaluation | $101.48 | $79.20 | 0.8 |

** Alignment A follows the same alignment whether for a floodwall or a ring levee*

### 3.5.2 Santa Clara levees

On Santa Clara Pueblo, Alignments A and B were proposed to be aligned along both banks of the main stem Rio Grande (below the Rio Grande/Rio Chama Confluence) within the pueblo boundary. Alignments C, D and E were proposed to be aligned along both banks of the Santa Cruz River. Alignment F was proposed to be aligned along Arroyo de Guachupangue (right bank). Levees A-F were proposed to protect a more heavily populated area of the Española Valley, which consists of residential, public and commercial properties (Table 11).

**Table 11 First construction costs vs. economically justifiable construction (Santa Clara).**

| **Description** | **Project Cost** | **Justifiable Construction** | **Initial Result** | **Average Annual Cost ($1,000's)** | **Average Annual Benefits ($1,000's)** | **BCR** |
|---|---|---|---|---|---|---|
| Alignment A | | | | | | |
| Base | $3,162,244 | $548,861 | Project cost exceeds total damage capture | --- | --- | - |
| Base +1 | $4,100,001 | $548,861 | Project cost exceeds total damage capture | --- | --- | - |
| Alignment B | | | | | | |
| Base | $395,045 | $588,267 | | | | |
| Base +1 | $565,769 | $588,267 | Project cost exceeds total damage capture | | | |
| Alignment C | | | | | | |
| Base | $821,351 | $915,942 | Carried forward for additional evaluation | $35.02 | $31.10 | 0.9 |
| Base +1 | $935,699 | $915,942 | Carried forward for additional evaluation | $39.89 | $37.40 | 0.9 |
| Alignment D | | | | | | |
| Base | $959,327 | $2,375,585 | Carried forward for additional evaluation | $46.90 | $69.89 | 1.4 |
| Base +1 | $1,301,277 | $2,375,585 | Carried forward for additional evaluation | $55.48 | $55.48 | 1.0 |
| Alignment E | | | | | | |
| Base | $193,098 | --- | Removed from consideration at sponsor request | --- | --- | - |
| Base +1 | $272,482 | --- | Removed from consideration at sponsor request | --- | --- | - |
| Alignment F | | | | | | |

| Description | Project Cost | Justifiable Construction | Initial Result | Average Annual Cost ($1,000's) | Average Annual Benefits ($1,000's) | BCR |
|---|---|---|---|---|---|---|
| Base | $636,661 | $1,989,271 | Removed from consideration at sponsor request | $27.14 | $82.40 | 3.0* |
| Base +1 | $791,046 | $1,989,271 | Removed from consideration at sponsor request | $33.73 | $110.14 | 3.3* |

**Local sponsor requested that this alternative not be carried forward for additional analysis.*

### 3.5.3 San Ildefonso levees

On San Ildefonso, all alignments (A-E) were proposed to be along the left bank of the Rio Pojoaque. The five alignments of these levees were proposed to protect mostly residential structures and a few public structures (Table 12).

**Table 12 First construction costs vs. economically justifiable construction (San Ildefonso).**

| Description | Project Cost | Justifiable Construction | Initial Result | Average Annual Cost ($1,000's) | Average Annual Benefits ($1,000's) | BCR |
|---|---|---|---|---|---|---|
| Alignment A | | | | | | |
| Base | $2,227,789 | $0 | Project cost exceeds total damage capture | --- | --- | - |
| Base +1 | $2,648,586 | $0 | Project cost exceeds total damage capture | --- | --- | - |
| Alignment B* | | | | | | |
| Base | $3,390,672 | --- | Removed from consideration at sponsor request | --- | --- | - |
| Base +1 | $4,115,897 | --- | Removed from consideration at sponsor request | --- | --- | - |
| Alignment C* | | | | | | |
| Base | $1,502,110 | --- | Removed from consideration at sponsor request | --- | --- | - |
| Base +1 | $1,794,192 | --- | Removed from consideration at sponsor request | --- | --- | - |

| Description | Project Cost | Justifiable Construction | Initial Result | Average Annual Cost ($1,000's) | Average Annual Benefits ($1,000's) | BCR |
|---|---|---|---|---|---|---|
| Alignment D** | | | | | | |
| Base | $2,139,112 | --- | Removed from consideration at sponsor request | --- | --- | - |
| Base +1 | $2,551,222 | --- | Removed from consideration at sponsor request | --- | --- | - |
| Alignment E | | | | | | |
| Base | $1,569,893 | $0 | Removed from consideration as Alignment A is needed for Alignment E to be effective | --- | --- | - |
| Base +1 | $1,893,357 | $0 | Removed from consideration as Alignment A is needed for Alignment E to be effective | --- | --- | - |

**Alignments B and C would require multiple real estate acquisitions with minimal benefit to Tribal interests.*

***The wastewater treatment plant that would have been protected by Alignment D is in the process of being decommissioned.*

## 3.6 FRM Plan Formulation Conclusion

As a result of working through the USACE planning process with each of the local sponsors, no FRM alternatives remained that met both USACE and sponsor goals and objectives. There are no FRM measures in the final array of alternatives.

# 4 - Plan Formulation and Evaluation for Ecosystem Restoration

Plan formulation for ecosystem restoration measures followed a similar process to flood risk management (Chapter 3). Numerous ecosystem restoration measures identified by the sponsors, federal and state agencies were considered for development of alternatives in the planning process.

Ecosystem restoration alternatives were formulated meet planning objectives and avoid planning constraints (Section 1.6.3). First, restoration measures were developed then screened to eliminate measures that would not meet objectives, were not implementable or not feasible using knowledge, experience, and judgments of many professional disciplines. The remaining management measures were evaluated in different combinations and scales that comprise alternative plans. In most cases, there will be more than one alternative that will meet the planning objectives, although they meet them to varying degrees. Good planning eliminates the least suitable measures or alternatives while refining the remaining alternatives fairly and comprehensively. Selection of the recommended restoration plan or National Ecosystem Restoration (NER) plan is based on identifying the plan that meets Federal and study objectives as well as reasonably maximizes ecosystem restoration benefits compared to costs, considering the cost-effectiveness and incremental cost of implementing other restoration options. The economic comparison of cost per unit of ecosystem output provides a metric allowing for the ultimate identification of the NER Plan. In addition to considering the ecosystem benefits and costs, the recommended plan also takes into consideration information that cannot be quantified, such as environmental significance and scarcity, socioeconomic impacts, and traditional cultural properties information.

## 4.1 Development of Alternative Plans

As discussed in section 3.1 for FRM alternative formulation, the process for formulating ecosystem restoration alternatives also involves successive iterations of alternative solutions to the defined problems and to meet study that have been previously defined (Section 1.6.3). The same general feasibility criteria must be met for ecosystem restoration alternatives. These are:

- **Completeness –** Does the plan include all necessary parts and actions to produce the desired results?
- **Effectiveness –** Does the alternative substantially meet the objectives? How does it measure up against constraints?
- **Efficiency –** Does the plan maximize net NER and/or NED benefits?
- **Acceptability –** Is the plan acceptable and compatible with laws and policies?

In the initial phase of the study, the team developed measures to satisfy the four feasibility criteria. Development of ecosystem restoration plans for the Española Valley, Rio Grande and Tributaries, New Mexico Study involved successive iterations of alternative solutions to address the ecosystem degradation issues identified by the sponsors. The key to long-term success for Española Valley project riparian restoration is to reconnect rivers and their floodplains.

A habitat team was formed for guiding development and analysis of habitat restoration measures for the Española Valley Study. A large suite of ecosystem restoration measures were considered by the habitat team for development of alternatives in the planning process.

## 4.2 Preliminary Management Measures

The habitat team developed preliminary ecosystem management measures (Appendix C) based on previous Middle Rio Grande projects by Federal and State agencies (Reclamation 2012; USACE 2011). The habitat team recognized the proposed measures would require variable implementation to support development of a habitat mosaic. The suitability and effectiveness for a suite of measures at a site are a function of the inherent properties of the method and the physical characteristics of each reach and/or site. The measures have been adapted here for local conditions in the Española Valley Project area.

The habitat team suggested potential ecosystem measures located throughout the study area that mimic historic, natural conditions that exhibited gently sloping banks with backwater areas, overbank flooding, off-channel wetlands; facilitated water infiltration; provided for native plant regeneration and nutrient cycling in the bosque; and, reconnected the river channel to the floodplain. Existing vegetation communities would be enhanced with supplemental plantings, invasive species control, and creation of wetland habitats that are now rare in the bosque. The restored habitat should improve vegetation structure, and promote an increase in the number and diversity of wildlife species in the area. This approach to restoration focuses on restoration of community functions and processes via the rehabilitation of geomorphological processes and vegetation structure. This redirects future trends away from further habitat degradation to a more natural, sustainable system that will uphold or increase in habitat value.

The most cost-effective way to improve floodplain connectivity in the interior portions of the bosque, and to restore the sediment movement and river meandering needed for long-term sustainability of natural bosque habitat, is reconnecting the river to former channels that were cut off when the river was channelized in the 1950s. However, water levels in the Rio Grande at all but peak flows are now lower than the bottom elevations in the former channels at the points where they approach the river. A combination of two techniques may be implemented to improve floodplain connectivity. First, structures could be constructed to raise water surface elevations at select locations in the river and arrest further down-cutting which together would raise the water surface elevation in the river channel. Second, variable length channels could be excavated from the river to allow surface flows from the river back into former river channels within the bosque. Improving floodplain connectivity would increase the area and quality of wetland and native riparian habitat in the bosque, and allow some degree of point bar deposition and soil scour so that new vegetation could become established.

The PDT and sponsors conducted a preliminary screening of management measures to evaluate the applicability of each measure for each reach, and the potential to contribute to the planning objectives consistent with planning constraints. All management measures are considered to have an approximate 50-year life of project individually, or in combination with other management measures.

These measures (Table 13) include floodplain reconnection with the river, habitat management along the channel perimeter, in-channel structures to deflect flow, changing the sediment supply in the river, invasive plant species control, and riparian vegetation management (Reclamation 2012).

**Table 13 Types of ecosystem measures considered by the habitat team.**

| Ecosystem Measure | Function |
|---|---|
| Boulder Weirs | Manage channel incision by controlling the bed elevation to improve or maintain current flood plain connectivity |
| Grade Restoration Facilities (GRFs) | Manage channel incision by controlling the bed elevation to improve or maintain current flood plain connectivity |
| Deformable Riffles | Manage channel incision by controlling the bed elevation to improve or maintain current flood plain connectivity |
| Rock Sills | Manage channel incision by controlling the bed elevation to improve or maintain current flood plain connectivity |
| Riprap Grade Control | Manage channel incision by controlling the bed elevation to improve or maintain current flood plain connectivity |
| Low Head Stone Weirs | Manage channel incision by controlling the bed elevation to improve or maintain current flood plain connectivity |
| Terrace Lowering | Increase floodplain connectivity by excavation of islands, bars, or terraces to create lower floodplain surfaces |
| High-Flow Channels | Increase floodplain connectivity by excavation of channels across terraces or abandoned river channels. |
| Willow Swale / Wetlands / Ponds | Increase native riparian vegetation by excavation to ground water and replanting with native species |
| Bank Line Embayment | Increase floodplain connectivity by excavation of features adjacent to the river channel |
| Bendway Weirs | Increase slack water habitat and protect bank line features |
| Boulder Groupings | Increase complex aquatic habitat with variable depth and velocity |
| Bioengineering, Large Woody Debris and Root wads | Increase complex aquatic habitat with variable depth and velocity |
| Change Sediment Supply | Manage channel incision by adding sediment into the river |
| Invasive Species Control | Increase native riparian vegetation and reduce invasive plant species using multiple control techniques |
| Riparian Vegetation Re-Establishment | Increase native riparian vegetation by replanting with native plant species following excavation or invasive plant species control |
| Vegetation Management For Dynamic Bank Formation | Increase native riparian vegetation and floodplain connectivity for sediment retention |

## 4.3 Preliminary Management Measures Eliminated From Further Study

The habitat team completed several iterations of the ecosystem restoration formulation process for Ohkay Owingeh and Santa Clara Pueblos. During brain-storming sessions, the habitat team initially proposed about 200 individual measures (techniques and locations) for screening analysis including irrigation, acquisition of private land, zoning, trails and other recreation.

The team discussed the effectiveness of a number of channel stabilization measures (similar to a value-engineering analysis) for addressing the channel headcut. The team determined that the GRFs were the most effective habitat measure for halting the headcut, and eliminated the other proposed channel stabilization measures that did not support the goals and objectives of the study from further consideration (Table 14). This early evaluation of measure effectiveness for an important objective partially reduced effort on cost analysis.

**Table 14 Preliminary ecosystem measures eliminated from consideration for further study.**

| Ecosystem Measure | Reason for Excluding Measure from Consideration |
|---|---|
| Boulder Weirs | Measure considered less effective than the GRFs with minimal contribution to floodplain connectivity |
| Deformable Riffles | Measure considered less effective than the GRFs with minimal contribution to floodplain connectivity |
| Rock Sills | Measure considered less effective than the GRFs with minimal contribution to floodplain connectivity |
| Riprap Grade Control | Measure considered less effective than the GRFs with minimal contribution to floodplain connectivity |
| Low Head Stone Weirs | Measure considered less effective than the GRFs, requireing a larger number of features to match GRFs. |
| Bank Line Embayment | Habitat measure with minimal contribution to floodplain connectivity does not contribute to objectives |
| Bendway Weirs | Measure considered less effective than the GRFs with minimal contribution to floodplain connectivity |
| Boulder Groupings | Habitat measure produces minimal floodplain connectivity and does not contribute to objectives. |
| Bioengineering, Large Woody Debris and Root Wads | Habitat measure produces minimal floodplain connectivity and does not contribute to objectives. |
| Change Sediment Supply | Requires other features to benefit from large volume of material |
| Vegetation Management for Dynamic Bank Formation | Habitat can be created by terracing with more predictable results |

Proposed measures with external dependencies require action by the sponsors (irrigation, zoning), other local governments (zoning), or private individuals (land acquisition) prior to further consideration by the sponsors. Non-construction measures with external dependencies (land acquisition, zoning) were segregated from the initial screening, while recreation measures were evaluated separately.

The team members identified restoration measures that have been successfully implemented in the Middle Rio Grande (USACE 2014b). The team's focus on ecosystem measures with demonstrated success for increasing floodplain connectivity and riparian vegetation (Table 15) improves the likelihood of successful implementation within the projected budget.

## 4.4 *The No Action Alternative

Under the no action alternative, there would not construct any ecosystem restoration measures. For comparison with other alternatives, the 465 acre footprint for the complete suite of measures is evaluated for the future without project (Table 15). The trend illustrated by the no action alternative is declining habitat unit values for the location of proposed habitat measures.

**Table 15 Habitat unit values without project for the footprint of all the proposed measures.**

| | Ohkay Owingeh | Santa Clara | Total |
|---|---|---|---|
| **No Action Alternative** | | | |
| Measures (acres) | 243.5 | 221.5 | 465.1 |
| AAHUs | 1586.2 | 1902.7 | 3488.9 |

## 4.5 *Description of Preliminary Alternatives

The ecosystem measures were condensed down to types of features that have been successfully implemented on the Rio Grande that could be located across the landscape based on topography. The habitat team identified multiple locations for each type of measure to quantify the footprint area as independent features. Each measure was assigned a unique identification label for estimating the existing and future with project habitat values independently. This real estate screening eliminated a few measures with unknown increased costs for buying private land. The habitat team summarized measures into specific actions that increase floodplain connectivity and riparian vegetation throughout the project area. The suite of potential habitat restoration measures retained for analysis is summarized in Table 16.

The grade restoration facilities (GRFs) would stabilize the channel bed and reduce the gradient of the river channel for two purposes. The GRFs are proposed to halt channel headcutting and improve floodplain connectivity adjacent to the GRFs. High-flow channels are proposed to improve floodplain connectivity. Willow swales are constructed by removal of vegetation and soil excavation to provide microenvironments in which native plants can thrive due to moist soils and the decreased depth to the water table. Wetlands and ponds would be excavated deeper into the water table to support wetland plants. Terrace lowering would improve floodplain connectivity by the removal of vegetation and excavation of soils adjacent to the main channel to enhance the potential for overbank flooding.

Vegetation management is proposed as standalone measures and combined with all excavation measures.

In order to evaluate the remaining measures, we need a method to compare the increase in habitat value with the costs to identify alternatives that are efficient and effective. CHAP was used to estimate current habitat values across the project area. The proposed measures were mapped onto locations to estimate the area for each measure. The existing habitat values for each measure were assigned from the existing CHAP mapping for the current conditions. The target habitat types identified by the habitat were assigned to the measures, and projected into the future vegetation types. Average values for each target habitat type were based on the current values for those types in the project area.

The existing and future habitat values were estimated using CHAP (Appendix C). CHAP is an accounting and appraisal method based on a habitat evaluation framework (approved for this project January 16, 2014) that satisfies the objectives of Engineer Regulation 1105-2-100. CHAP uses an inventory of habitat, species, and functions (O'Neil et al., 2005) to assess habitat values at multiple scales. CHAP is a habitat-based approach to assess ecosystems and provide a mechanism for quantifying changes in habitat quality and quantity over time under proposed alternative scenarios. CHAP provides an objective, quantifiable, reliable and well-documented process to generate environmental outputs for all levels of proposed projects and monitoring operations in the natural resources arena. CHAP provides an impartial look at environmental effects, and delivers measurable products to the decision-maker for comparative analysis. CHAP was developed in the Pacific Northwest to estimate habitat impacts for mitigation.

The 2002 vegetation mapping (Hink and Ohmart 1984, USACE 2007) delineated distinct vegetation polygons based on species and structure for field surveys and analysis in GIS (Appendix C). The vegetation mapping was ground-truthed in 2010-2011 during the field inventory of key environmental correlate parameters for CHAP (Appendix C, 1.5.1).The habitat team reviewed the species list for habitat valuation using CHAP to estimate habitat value for existing vegetation types and project habitat value into the future without project. The habitat values were projected into the future based on observed trends of invasive plant species described by the habitat team.

These habitat values were transferred to the measure footprints using GIS to estimate the future without-project values. The future with-project habitat was forecast based on the Hink and Ohmart vegetation classification for each measure type, and habitat values were estimated. The future with-project habitat values were based on current habitat values for target vegetation types anticipated from implementation of the measures. The future habitat values (25 and 50 years) were averaged for each measure with and without project for the cost-effectiveness analysis. The first iteration of cost analysis eliminated less efficient measures from further consideration. The second iteration of cost analysis ranked the measures for the tentatively selected plan.

The restoration measures proposed by the habitat team were refined by each sponsor based on current land ownership prior to incremental cost analysis. This real estate screening eliminated a few measures with unknown increased costs for buying private land. The habitat team summarized measures into specific actions that increase floodplain connectivity and riparian vegetation throughout the project area. The suite of potential habitat restoration measures retained for analysis is summarized in Table 16.

**Table 16 Proposed types of ecosystem restoration measures and their effect on vegetation. The maximum area for proposed measures is 465 acres.**

| Description | Action | Effect |
|---|---|---|
| Grade restoration facility (GRF) | Excavate/harden channel | Prevent loss of upstream floodplain connectivity,<br>Increase proximal floodplain connectivity<br>Increase cottonwood / willow density |
| In-channel Rock Weirs | Excavate/harden channel | Prevent loss of upstream floodplain connectivity,<br>Increase proximal floodplain connectivity<br>Increase cottonwood / willow density |
| High-flow Channel | Excavate, re-vegetate CW/W | Increase seasonal water connectivity<br>Increase cottonwood / willow density |
| Moist Meadow | Excavate , re-vegetate | Increase groundwater connectivity<br>Increase moist meadow vegetation |
| Pond | Excavate | Increase aquatic habitat |
| Vegetation Management | Remove exotic vegetation<br>Re-vegetate with native species | Increase cottonwood / willow / native tree density |
| Willow Swale | Excavate , re-vegetate | Increase groundwater connectivity<br>Increase cottonwood / willow density |
| Terrace Lowering | Excavate , re-vegetate | Increase groundwater connectivity<br>Increase cottonwood / willow density |
| Wetland | Excavate , re-vegetate | Increase groundwater connectivity<br>Increase wetland vegetation |

The 20 acres of grade restoration facilities (GRFs) would stabilize the channel bed and reduce the gradient of the river channel for two purposes. The GRFs are proposed to halt channel head cutting and improve floodplain connectivity for up to 80 acres adjacent to the GRFs. High-flow channels (22 acres) are proposed to improve floodplain connectivity. Under historic flood flow regimes, high-flow channels were once an integral part of the river form and function.

Vegetation management consists of two treatment phases: partial to complete removal of invasive plants and subsequent revegetation with native plant species. The CHAP habitat values were used to calculate the Annual Average Habitat Unit (AAHU) values for proposed measures as input for the incremental cost and cost-effectiveness analysis (CE/ICA) analyses with the cost estimates for construction. CE/ICA was used for screening the initial suite of proposed measures, with a second iteration to rank measures for the tentatively selected plan.

USACE policy, presented in Engineer Regulation 1105-2-100, Planning Guidance Notebook, requires that potential ecosystem restoration projects be analyzed for cost effectiveness and incremental benefits gained from various restoration alternatives. The plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the federal objective, is selected and identified as the National Ecosystem Restoration (NER) Plan. Incremental cost and cost-effectiveness analysis (CE/ICA) is the technique used by the USACE to evaluate cost-effective restoration projects. Analysis of cost effectiveness, in general, compares the relative costs and benefits of alternative plans. The most efficient plans that provide the greatest increase in output for the least increase in cost are called the Best Buys. The least expensive Best Buy alternative, which fully meets all restoration objectives, is usually selected as the recommended plan.

Specifically, cost-effectiveness analysis compares the costs and expected environmental outputs among various alternative plans. If different alternative plans can produce the same level of output, only the least expensive (least-cost) choice makes economic sense for that level of output; economically inefficient alternative plans can be eliminated from further consideration. Similarly, if one alternative plan can produce a greater level of output for the same or less cost than others (cost-effective), only the greater output choice makes economic sense; economically ineffective alternative plans can be eliminated. After elimination of inefficient and ineffective alternative plans, there remain several least-cost, cost-effective alternative plans offering a range of output values from which to identify the means of meeting the ecosystem restoration objectives. All price levels as it relates to ecosystem restoration are in November 2014 price levels.

The first iteration of cost-effectiveness analysis was used to eliminate measures that produced fewer habitat units per unit cost at the preliminary screening stage. An alternative plan consists of a system of structural and/or non-structural measures, strategies, or programs formulated to meet, fully or partially, the identified study planning objectives subject to planning constraints.

Restoration measures to enact the proposed improvements for this project include: a) high-flow channels, b) swales/wetlands, c) terrace lowering, d) vegetation removal/re-vegetation, e) wetland ponds and f) GRFs. Alternative plans for habitat restoration could include one or more of the above measures and also include the No Action option for each restoration measure.

| Best Buy's Santa Clara Pueblo | Sum of Acres | Sum of Cost |
|---|---|---|
| AA | 2.51349 | $ 538,865.07 |
| 3164 | 2.51349 | $ 538,865.07 |
| High-flow channel | 2.51349 | $ 538,865.07 |
| 68.25067909 | 2.51349 | $ 538,865.07 |
| Santa Cruz - Entire River | 2.51349 | $ 538,865.07 |
| D | 3.33853 | $ 617,851.89 |
| 3020 | 3.33853 | $ 617,851.89 |
| Bankline lowering (3.5 acre bank lowering next to shrub / scrub & mixed deciduo | 3.33853 | $ 617,851.89 |
| 90.65360899 | 3.33853 | $ 617,851.89 |
| Lower Rio Grande West - Start of SC to end of SC (west bank) | 3.33853 | $ 617,851.89 |
| E | 38.96218 | $ 3,886,638.00 |
| 3021 | 38.96218 | $ 3,886,638.00 |
| Vegetation Removal (Invasive plant species removal) | 38.96218 | $ 3,886,638.00 |
| 1057.969295 | 38.96218 | $ 3,886,638.00 |
| Lower Rio Grande West - Start of SC to end of SC (west bank) | 38.96218 | $ 3,886,638.00 |
| HH | 1.65732 | $ 193,773.48 |
| 3032 | 1.65732 | $ 193,773.48 |
| Vegetation Removal (Invasive plant species removal) | 1.65732 | $ 193,773.48 |
| 45.00245295 | 1.65732 | $ 193,773.48 |
| Lower Rio Grande East - Start of SC to end of SC (east bank) | 1.65732 | $ 193,773.48 |
| J | 7.44354 | $ 761,946.41 |
| 3026 | 7.44354 | $ 761,946.41 |
| Vegetation Removal (Invasive plant species removal) | 7.44354 | $ 761,946.41 |
| 202.1200243 | 7.44354 | $ 761,946.41 |
| Lower Rio Grande West - Start of SC to end of SC (west bank) | 7.44354 | $ 761,946.41 |
| K | 9.53039 | $ 1,428,788.12 |
| 3035 | 9.53039 | $ 1,428,788.12 |
| Vegetation Removal (Invasive plant species removal) | 9.53039 | $ 1,428,788.12 |
| 258.7858275 | 9.53039 | $ 1,428,788.12 |
| Lower Rio Grande West - Start of SC to end of SC (west bank) | 9.53039 | $ 1,428,788.12 |
| N | 20.58576 | $ 4,691,348.11 |
| 3046 | 20.58576 | $ 4,691,348.11 |
| Swale | 20.58576 | $ 4,691,348.11 |
| 558.9805806 | 20.58576 | $ 4,691,348.11 |
| Lower Rio Grande West - Start of SC to end of SC (west bank) | 20.58576 | $ 4,691,348.11 |
| NN | 17.00987 | $ 3,775,364.44 |
| 3054 | 17.00987 | $ 3,775,364.44 |
| Swale (Wetland / marsh / wet meadow swale) | 17.00987 | $ 3,775,364.44 |
| 461.8817575 | 17.00987 | $ 3,775,364.44 |
| Lower Rio Grande East - Start of SC to end of SC (east bank) | 17.00987 | $ 3,775,364.44 |
| P | 5.75432 | $ 594,079.45 |
| 3047 | 5.75432 | $ 594,079.45 |
| Vegetation Removal (Invasive plant species removal) | 5.75432 | $ 594,079.45 |
| 156.2513667 | 5.75432 | $ 594,079.45 |
| Lower Rio Grande West - Start of SC to end of SC (west bank) | 5.75432 | $ 594,079.45 |
| PP | 3.15832 | $ 585,935.00 |
| 3144 | 3.15832 | $ 585,935.00 |
| Bankline lowering (Remove spoil bank) | 3.15832 | $ 585,935.00 |
| 85.7602317 | 3.15832 | $ 585,935.00 |
| Lower Rio Grande East - Start of SC to end of SC (east bank) | 3.15832 | $ 585,935.00 |
| Q | 21.7556 | $ 4,847,540.17 |
| 3049 | 21.7556 | $ 4,847,540.17 |
| Swale | 21.7556 | $ 4,847,540.17 |
| 590.7461235 | 21.7556 | $ 4,847,540.17 |
| Lower Rio Grande West - Start of SC to end of SC (west bank) | 21.7556 | $ 4,847,540.17 |
| QQ | 5.1945 | $ 1,173,214.01 |
| 3146 | 5.1945 | $ 1,173,214.01 |
| Swale | 5.1945 | $ 1,173,214.01 |
| 141.0501544 | 5.1945 | $ 1,173,214.01 |
| Lower Rio Grande East - Start of SC to end of SC (east bank) | 5.1945 | $ 1,173,214.01 |
| SS | 1.62941 | $ 366,359.02 |
| 3154 | 1.62941 | $ 366,359.02 |
| High-flow channel | 1.62941 | $ 366,359.02 |
| 44.24459179 | 1.62941 | $ 366,359.02 |
| Lower Rio Grande East - Start of SC to end of SC (east bank) | 1.62941 | $ 366,359.02 |
| T | 1.20849 | $ 242,253.36 |
| 3145 | 1.20849 | $ 242,253.36 |
| Bank destabilization (Bank destabilization along shrub / scrub) | 1.20849 | $ 242,253.36 |
| 32.81503534 | 1.20849 | $ 242,253.36 |
| Lower Rio Grande West - Start of SC to end of SC (west bank) | 1.20849 | $ 242,253.36 |
| TT | 1.75004 | $ 392,829.19 |
| 3155 | 1.75004 | $ 392,829.19 |
| High-flow channel | 1.75004 | $ 392,829.19 |
| 47.52014865 | 1.75004 | $ 392,829.19 |
| Lower Rio Grande East - Start of SC to end of SC (east bank) | 1.75004 | $ 392,829.19 |
| U | 3.32798 | $ 729,208.01 |
| 3151 | 3.32798 | $ 729,208.01 |
| High-flow channel | 3.32798 | $ 729,208.01 |
| 90.36713693 | 3.32798 | $ 729,208.01 |
| Lower Rio Grande West - Start of SC to end of SC (west bank) | 3.32798 | $ 729,208.01 |
| UU | 3.7857 | $ 793,756.55 |
| 3161 | 3.7857 | $ 793,756.55 |
| High-flow channel | 3.7857 | $ 793,756.55 |
| 102.7959514 | 3.7857 | $ 793,756.55 |
| Lower Rio Grande East - Start of SC to end of SC (east bank) | 3.7857 | $ 793,756.55 |

| | | | |
|---|---|---|---|
| **W** | **3.10427** | **$** | **688,438.50** |
| **3158** | **3.10427** | **$** | **688,438.50** |
| High-flow channel | 3.10427 | $ | 688,438.50 |
| **84.29257151** | **3.10427** | **$** | **688,438.50** |
| Lower Rio Grande West - Start of SC to end of SC (west bank) | 3.10427 | $ | 688,438.50 |
| **X** | **3.0912** | **$** | **672,541.78** |
| **3159** | **3.0912** | **$** | **672,541.78** |
| High-flow channel | 3.0912 | $ | 672,541.78 |
| **83.937672** | **3.0912** | **$** | **672,541.78** |
| Lower Rio Grande West - Start of SC to end of SC (west bank) | 3.0912 | $ | 672,541.78 |
| **Z** | **10.27807** | **$** | **2,015,843.98** |
| **3034** | **10.27807** | **$** | **2,015,843.98** |
| Vegetation Removal (Invasive plant species removal) | 10.27807 | $ | 2,015,843.98 |
| **279.0881433** | **10.27807** | **$** | **2,015,843.98** |
| Lower Rio Grande West - Start of SC to end of SC (west bank) | 10.27807 | $ | 2,015,843.98 |
| **Grand Total** | **165.07898** | **$** | **28,996,574.54** |

Figure 20 summarizes each of the restoration measures used in this study. Each of the restoration measures were entered into the USACE Institute for Water Resources (IWR) Planning Suite (IWR-Plan) software. Each measure included the No Action option, which describes the option that an ecosystem restoration measure would not be implemented in the study area. IWR-Plan Decision Support Software assists with the formulation and comparison of alternative plans by conducting cost effectiveness and incremental-cost analyses, identifying the plans which are the best financial investments, and displaying the effects of each plan on a range of decision variables.

| Row Labels | Values Sum of Ac | Sum of Cost |
|---|---|---|
| ⊟ F | **9.03245** | **$1,252,520.06** |
| ⊟ Vegetation Removal (Invasive plant species removal) | **9.03245** | **$1,252,520.06** |
| ⊟ 3002 | 9.03245 | $1,252,520.06 |
| ⊟ 245.26 | **9.03245** | **$1,252,520.06** |
| Upper Rio Grande East - Top of study area to confluence (east bank) | 9.03245 | $1,252,520.06 |
| ⊟ FF | **2.96384** | **$643,492.45** |
| ⊟ Terrace lowering | **2.96384** | **$643,492.45** |
| ⊟ 3201 | 2.96384 | $643,492.45 |
| ⊟ 80.48 | **2.96384** | **$643,492.45** |
| Rio Chama East - Top of study area to confluence (east bank) | 2.96384 | $643,492.45 |
| ⊟ GG | **5.16736** | **$1,116,172.85** |
| ⊟ Terrace lowering | **5.16736** | **$1,116,172.85** |
| ⊟ 3203 | 5.16736 | $1,116,172.85 |
| ⊟ 140.31 | **5.16736** | **$1,116,172.85** |
| Rio Chama East - Top of study area to confluence (east bank) | 5.16736 | $1,116,172.85 |
| ⊟ H | **1.67706** | **$367,389.42** |
| ⊟ Terrace lowering | **1.67706** | **$367,389.42** |
| ⊟ 3115 | 1.67706 | $367,389.42 |
| ⊟ 93.04 | **1.67706** | **$367,389.42** |
| Upper Rio Grande East - Top of study area to confluence (east bank) | 1.67706 | $367,389.42 |
| ⊟ HH | **4.41582** | **$954,353.48** |
| ⊟ Terrace lowering | **4.41582** | **$954,353.48** |
| ⊟ 3209 | 4.41582 | $954,353.48 |
| ⊟ 119.91 | **4.41582** | **$954,353.48** |
| Rio Chama East - Top of study area to confluence (east bank) | 4.41582 | $954,353.48 |
| ⊟ JJ | **1.82759** | **$228,265.53** |
| ⊟ High flow channel | **1.82759** | **$228,265.53** |
| ⊟ 3213 | 1.82759 | $228,265.53 |
| ⊟ 49.63 | **1.82759** | **$228,265.53** |
| Rio Chama East - Top of study area to confluence (east bank) | 1.82759 | $228,265.53 |
| ⊟ KK | **1.59** | **$1,544,843.83** |
| ⊟ Channel Stabilization (URC) | **1.59** | **$1,544,843.83** |
| ⊟ 3211 | 1.59 | $1,544,843.83 |
| ⊟ 296.51 | **1.59** | **$1,544,843.83** |
| Rio Chama East - Top of study area to confluence (east bank) | 1.59 | $1,544,843.83 |
| ⊟ L | **0.83502** | **$186,972.11** |
| ⊟ Terrace lowering | **0.83502** | **$186,972.11** |
| ⊟ 3208 | 0.83502 | $186,972.11 |
| ⊟ 22.67 | **0.83502** | **$186,972.11** |
| Upper Rio Grande East - Top of study area to confluence (east bank) | 0.83502 | $186,972.11 |
| ⊟ LL | **19.23791** | **$4,148,736.58** |
| ⊟ Bankline lowering (Contouring) | **19.23791** | **$4,148,736.58** |
| ⊟ 3016 | 19.23791 | $4,148,736.58 |
| ⊟ 522.38 | **19.23791** | **$4,148,736.58** |
| Mid Rio Grande West - Below confluence to End of OO (west bank) | 19.23791 | $4,148,736.58 |
| ⊟ MM | **14.06737** | **$3,019,775.42** |
| ⊟ Terrace lowering | **14.06737** | **$3,019,775.42** |
| ⊟ 3123 | 14.06737 | $3,019,775.42 |
| ⊟ 403.22 | **14.06737** | **$3,019,775.42** |
| Mid Rio Grande West - Below confluence to End of OO (west bank) | 14.06737 | $3,019,775.42 |
| ⊟ NN | **0.75733** | **$1,700,623.04** |
| ⊟ Terrace lowering | **0.75733** | **$1,700,623.04** |
| ⊟ 3124 | 0.75733 | $1,700,623.04 |
| ⊟ 224.53 | **0.75733** | **$1,700,623.04** |
| Mid Rio Grande West - Below confluence to End of OO (west bank) | 0.75733 | $1,700,623.04 |
| ⊟ PP | **0.53268** | **$122,011.60** |
| ⊟ Terrace lowering | **0.53268** | **$122,011.60** |
| ⊟ 3125 | 0.53268 | $122,011.60 |
| ⊟ 15.27 | **0.53268** | **$122,011.60** |
| Mid Rio Grande West - Below confluence to End of OO (west bank) | 0.53268 | $122,011.60 |
| ⊟ SS | **11.6** | **$15,747,353.08** |
| ⊟ Channel Stabilization (combination of 4 GRF's) | **11.6** | **$15,747,353.08** |
| ⊟ 0 | 11.6 | $15,747,353.08 |
| ⊟ 2069.61 | **11.6** | **$15,747,353.08** |
| Mid Rio Grande West - Below confluence to End of OO (west bank) | 11.6 | $15,747,353.08 |
| ⊟ U | **2.9** | **$3,458,763.20** |
| ⊟ Channel Stabilization (URG) | **2.9** | **$3,458,763.20** |
| ⊟ 3212 | 2.9 | $3,458,763.20 |
| ⊟ 592.55 | **2.9** | **$3,458,763.20** |
| Upper Rio Grande East - Top of study area to confluence (east bank) | 2.9 | $3,458,763.20 |
| ⊟ W | **8.36898** | **$1,031,650.56** |
| ⊟ Vegetation Removal (Invasive plant species removal) | **8.36898** | **$1,031,650.56** |
| ⊟ 3014 | 8.36898 | $1,031,650.56 |
| ⊟ 227.25 | **8.36898** | **$1,031,650.56** |
| Rio Chama East - Top of study area to confluence (east bank) | 8.36898 | $1,031,650.56 |
| **Grand Total** | **84.97341** | **$35,522,923.21** |

| Best Buy's Santa Clara Pueblo | Sum of Acres | Sum of Cost |
|---|---|---|
| **AA** | **2.51349** | **$ 538,865.07** |
| **3164** | **2.51349** | **$ 538,865.07** |
| High-flow channel | 2.51349 | $ 538,865.07 |
| **68.25067909** | **2.51349** | **$ 538,865.07** |
| Santa Cruz - Entire River | 2.51349 | $ 538,865.07 |
| **D** | **3.33853** | **$ 617,851.89** |
| **3020** | **3.33853** | **$ 617,851.89** |
| Bankline lowering (3.5 acre bank lowering next to shrub / scrub & mixed deciduo | 3.33853 | $ 617,851.89 |
| **90.65360899** | **3.33853** | **$ 617,851.89** |
| Lower Rio Grande West - Start of SC to end of SC (west bank) | 3.33853 | $ 617,851.89 |
| **E** | **38.96218** | **$ 3,886,638.00** |
| **3021** | **38.96218** | **$ 3,886,638.00** |
| Vegetation Removal (Invasive plant species removal) | 38.96218 | $ 3,886,638.00 |
| **1057.969295** | **38.96218** | **$ 3,886,638.00** |
| Lower Rio Grande West - Start of SC to end of SC (west bank) | 38.96218 | $ 3,886,638.00 |
| **HH** | **1.65732** | **$ 193,773.48** |
| **3032** | **1.65732** | **$ 193,773.48** |
| Vegetation Removal (Invasive plant species removal) | 1.65732 | $ 193,773.48 |
| **45.00245295** | **1.65732** | **$ 193,773.48** |
| Lower Rio Grande East - Start of SC to end of SC (east bank) | 1.65732 | $ 193,773.48 |
| **J** | **7.44354** | **$ 761,946.41** |
| **3026** | **7.44354** | **$ 761,946.41** |
| Vegetation Removal (Invasive plant species removal) | 7.44354 | $ 761,946.41 |
| **202.1200243** | **7.44354** | **$ 761,946.41** |
| Lower Rio Grande West - Start of SC to end of SC (west bank) | 7.44354 | $ 761,946.41 |
| **K** | **9.53039** | **$ 1,428,788.12** |
| **3035** | **9.53039** | **$ 1,428,788.12** |
| Vegetation Removal (Invasive plant species removal) | 9.53039 | $ 1,428,788.12 |
| **258.7858275** | **9.53039** | **$ 1,428,788.12** |
| Lower Rio Grande West - Start of SC to end of SC (west bank) | 9.53039 | $ 1,428,788.12 |
| **N** | **20.58576** | **$ 4,691,348.11** |
| **3046** | **20.58576** | **$ 4,691,348.11** |
| Swale | 20.58576 | $ 4,691,348.11 |
| **558.9805806** | **20.58576** | **$ 4,691,348.11** |
| Lower Rio Grande West - Start of SC to end of SC (west bank) | 20.58576 | $ 4,691,348.11 |
| **NN** | **17.00987** | **$ 3,775,364.44** |
| **3054** | **17.00987** | **$ 3,775,364.44** |
| Swale (Wetland / marsh / wet meadow swale) | 17.00987 | $ 3,775,364.44 |
| **461.8817575** | **17.00987** | **$ 3,775,364.44** |
| Lower Rio Grande East - Start of SC to end of SC (east bank) | 17.00987 | $ 3,775,364.44 |
| **P** | **5.75432** | **$ 594,079.45** |
| **3047** | **5.75432** | **$ 594,079.45** |
| Vegetation Removal (Invasive plant species removal) | 5.75432 | $ 594,079.45 |
| **156.2513667** | **5.75432** | **$ 594,079.45** |
| Lower Rio Grande West - Start of SC to end of SC (west bank) | 5.75432 | $ 594,079.45 |
| **PP** | **3.15832** | **$ 585,935.00** |
| **3144** | **3.15832** | **$ 585,935.00** |
| Bankline lowering (Remove spoil bank) | 3.15832 | $ 585,935.00 |
| **85.7602317** | **3.15832** | **$ 585,935.00** |
| Lower Rio Grande East - Start of SC to end of SC (east bank) | 3.15832 | $ 585,935.00 |
| **Q** | **21.7556** | **$ 4,847,540.17** |
| **3049** | **21.7556** | **$ 4,847,540.17** |
| Swale | 21.7556 | $ 4,847,540.17 |
| **590.7461235** | **21.7556** | **$ 4,847,540.17** |
| Lower Rio Grande West - Start of SC to end of SC (west bank) | 21.7556 | $ 4,847,540.17 |
| **QQ** | **5.1945** | **$ 1,173,214.01** |
| **3146** | **5.1945** | **$ 1,173,214.01** |
| Swale | 5.1945 | $ 1,173,214.01 |
| **141.0501544** | **5.1945** | **$ 1,173,214.01** |
| Lower Rio Grande East - Start of SC to end of SC (east bank) | 5.1945 | $ 1,173,214.01 |
| **SS** | **1.62941** | **$ 366,359.02** |
| **3154** | **1.62941** | **$ 366,359.02** |
| High-flow channel | 1.62941 | $ 366,359.02 |
| **44.24459179** | **1.62941** | **$ 366,359.02** |
| Lower Rio Grande East - Start of SC to end of SC (east bank) | 1.62941 | $ 366,359.02 |
| **T** | **1.20849** | **$ 242,253.36** |
| **3145** | **1.20849** | **$ 242,253.36** |
| Bank destabilization (Bank destabilization along shrub / scrub) | 1.20849 | $ 242,253.36 |
| **32.81503534** | **1.20849** | **$ 242,253.36** |
| Lower Rio Grande West - Start of SC to end of SC (west bank) | 1.20849 | $ 242,253.36 |
| **TT** | **1.75004** | **$ 392,829.19** |
| **3155** | **1.75004** | **$ 392,829.19** |
| High-flow channel | 1.75004 | $ 392,829.19 |
| **47.52014865** | **1.75004** | **$ 392,829.19** |
| Lower Rio Grande East - Start of SC to end of SC (east bank) | 1.75004 | $ 392,829.19 |
| **U** | **3.32798** | **$ 729,208.01** |
| **3151** | **3.32798** | **$ 729,208.01** |
| High-flow channel | 3.32798 | $ 729,208.01 |
| **90.36713693** | **3.32798** | **$ 729,208.01** |
| Lower Rio Grande West - Start of SC to end of SC (west bank) | 3.32798 | $ 729,208.01 |
| **UU** | **3.7857** | **$ 793,756.55** |
| **3161** | **3.7857** | **$ 793,756.55** |
| High-flow channel | 3.7857 | $ 793,756.55 |
| **102.7959514** | **3.7857** | **$ 793,756.55** |
| Lower Rio Grande East - Start of SC to end of SC (east bank) | 3.7857 | $ 793,756.55 |

| | | | |
|---|---|---|---|
| **W** | **3.10427** | **$** | **688,438.50** |
| **3158** | **3.10427** | **$** | **688,438.50** |
| High-flow channel | 3.10427 | $ | 688,438.50 |
| **84.29257151** | **3.10427** | **$** | **688,438.50** |
| Lower Rio Grande West - Start of SC to end of SC (west bank) | 3.10427 | $ | 688,438.50 |
| **X** | **3.0912** | **$** | **672,541.78** |
| **3159** | **3.0912** | **$** | **672,541.78** |
| High-flow channel | 3.0912 | $ | 672,541.78 |
| **83.937672** | **3.0912** | **$** | **672,541.78** |
| Lower Rio Grande West - Start of SC to end of SC (west bank) | 3.0912 | $ | 672,541.78 |
| **Z** | **10.27807** | **$** | **2,015,843.98** |
| **3034** | **10.27807** | **$** | **2,015,843.98** |
| Vegetation Removal (Invasive plant species removal) | 10.27807 | $ | 2,015,843.98 |
| **279.0881433** | **10.27807** | **$** | **2,015,843.98** |
| Lower Rio Grande West - Start of SC to end of SC (west bank) | 10.27807 | $ | 2,015,843.98 |
| **Grand Total** | **165.07898** | **$** | **28,996,574.54** |

**Figure 20 Summary of the combined CE/ICA analysis.**

Most Federal agencies use annualization as a means to display benefits and costs, and ecosystem restoration analyses should provide data that can be directly compared to the traditional benefit/cost analysis. Because habitat value is difficult to express in monetary terms, the cost effectiveness of project features is measured in habitat units (HU). HUs are the product of the amount and value of the habitat. For instance, a particular habitat with a value that is determined to be 2.5 is equal to 2.5 HUs. HUs are annualized by summing HUs across all years in the period of analysis and dividing the total (cumulative HUs) by the number of years in the period, which is 50 years. The results of this calculation are referred to as Average Annual Habitat Units (AAHU) and can be expressed mathematically. Using AAHU as metric, plans can be compared over time based on the forecast conditions. In this way, it is possible to quantify a change in habitat by implementing the project and assess whether that change is cost effective.

## 4.6 *Alternative A

Alternative A would construct all proposed ecosystem restoration measures. Comparison with the no action alternative (Table 15) shows that alternative A increases habitat units at years 25 and 50 (Table 17). The proposed measures would increase habitat unit values for each location.

**Table 17 Estimated habitat units for all measures with project.**

| | Ohkay Owingeh | Santa Clara | Total |
|---|---|---|---|
| **Alternative A (All measures)** | | | |
| Measures (acres) | 243.5 | 221.5 | 465.1 |
| AAHUs | 4016.5 | 4431.6 | 8448.0 |

## 4.7 *Evaluation and Screening of Preliminary Alternatives

Evaluating the ecological benefits of proposed ecosystem restoration plans requires an assessment methodology that captures the complex ecosystem processes and patterns operating at both the local and landscape levels across multiple habitat types. USACE guidance on ecosystem restoration requires that benefits from the project meet the objectives listed in Engineer Regulation 1105-2-100, specifically, "The objective of ecosystem restoration is to restore degraded ecosystem structure, function and dynamic processes to a less degraded, more natural condition. Restored ecosystems should mimic, as closely as possible, conditions which would occur in the absence of human changes to the landscape and hydrology". The proposed ecosystem restoration measures were evaluated for cost effectiveness and incremental benefits during the formulation process. The recommended plan provides a reasonable approach to maximize ecosystem restoration benefits relative to the construction costs.

The habitat team selected the Combined Habitat Assessment Protocols (CHAP) method to estimate habitat units for economic analysis (approved 16 Jan 2014). CHAP relies on GIS for visualizing individual habitat patch values across the landscape in relation to hydrology, topography, land management and other factors. The Hink and Ohmart (USACE 2007) classification system was used to define habitat patches for the CHAP habitat functions inventory. The Biota Information System of New Mexico (BISON-M) provided a vertebrate species list for habitat valuation with CHAP. The detailed application of CHAP in this project is provided in Appendix C. A summary of its use is provided below.

The first iteration of economic analysis was used to eliminate measures that produced smaller increments in quality habitat per unit cost at the preliminary screening stage. This screening produced a competitive set of alternatives for each sponsor. The second iteration of economic analysis ranked the competitive alternatives across the entire project area for identifying the tentatively selected plan. In this step, CE/ICA was used to rank the array of competitive alternatives from the previous iteration in order to identify the recommended plan. As a result of this CE/ICA analysis, it was determined by the PDT and Pueblo sponsors to select Best Buy (BB) 36.

Sensitivity analyses of the CE/ICA results were conducted. They showed that the most significant and sensitive management measure was the six grade restoration facilities (GRFs) on Ohkay Owingeh Pueblo. The GRFs mitigate headcut and channel scour and ensures the river bed doesn't drop away from the present river banks. The GRFs are integral measures for halting the headcut and support success of other measures on Ohkay Owingeh Pueblo.

As a result of the cost-effectiveness analysis, there were 78 Best Buy plans carried forward as possible alternatives for incremental analysis (Figure 21). Highlighted, inside the darker green box, is the TSP (Best Buy 36) and the 24 Best Buys that were screened using incremental analysis. Plans 1 to 18, inside the red box, were screened from further consideration as these plans don't address grade restoration. Plans 44 to 78, inside the lighter green box, were screened from further consideration because compared to other Best Buys, they only obtain small marginal benefits at a very high cost. Best Buy plans 19 through 43 were further screened incrementally and 7 of these plans stood out as plans of interest to recommend as the TSP. These plans can be easily identified as they are the plan (green square marker) to the right of each "gap" between the cluster of plans, meaning that compared to the previous plan that plan provides much more benefit for very little increase in cost. In addition, each of these plans included all 6 GRFs, which was preferred by the Ohkay Owingeh Pueblo and was also considered by the PDT as necessary for overall project success. These plans also included a wide distribution of measures, particularly near the historic Pueblo of Santa Clara, which was preferred by the Santa Clara Pueblo since the measures within these plans play a significant role in their traditional, cultural and recreational practices.

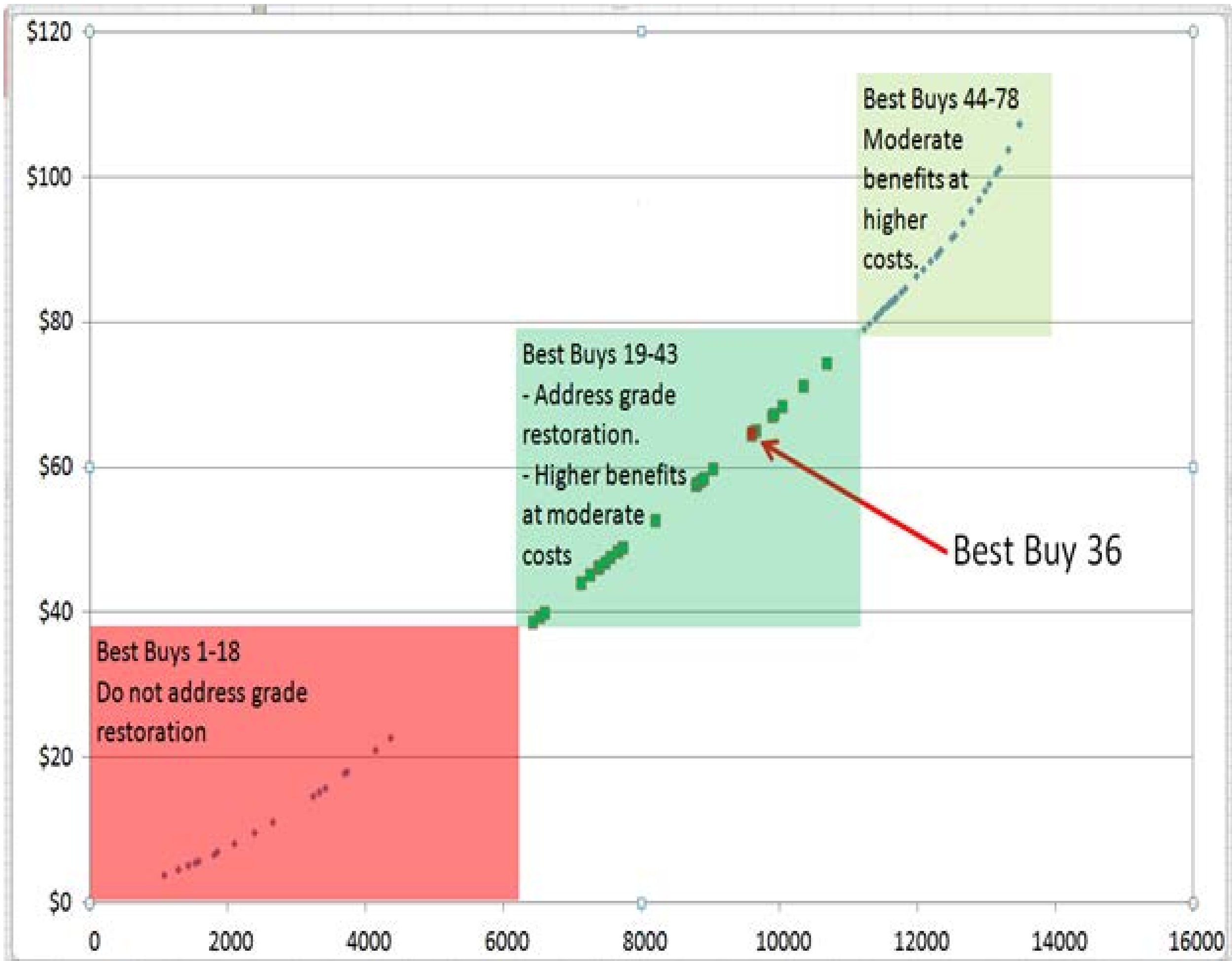



**Figure 21 Summary of the combined CE/ICA analyses. Costs are millions of dollars (y axis) for the output in habitat units (AAHU).**

It is important to emphasize that the reason why the curve doesn't have a clear cut breaking point is due to the fact that the preliminary models eliminated the obvious ineffective and inefficient measures, making future measures in future iterations of the modeling process more effective and efficient when combined into plans.

As a result of the CE/ICA analysis, it was determined by the PDT and Pueblo Sponsors to select Best Buy (BB) 36 as the preferred alternative.

The results show that the total cost for the project is expected to be $64.5 million. Of that, the management measures for Ohkay Owingeh are expected to cost $35.5 million and the management measures for Santa Clara are expected to cost $29.0 million. Within Ohkay Owingeh Pueblo, the management measures include: 6 GRFs (1 located along the Rio Chama, 1 located along the Rio Grande upstream of the Rio Grande/Rio Chama confluence, and 4 located below the Rio Grande/Rio Chama confluence), terrace lowering, non-native vegetation removal and high flow channels. For the Santa Clara Pueblo management measures include: vegetation removal, high-flow channels, swales, and bank line lowering. This plan was the first plan that meets the study objectives and sponsor goals for the study (detailed in the incremental cost section of Appendix B).

## 4.8 *Preferred Alternative (Best Buy 36)

The preferred alternative (Best Buy 36) would construct an economically efficient subset of the proposed ecosystem restoration measures. Comparison with the no action alternative (Table 15) shows that this alternative increases habitat units for the constructed measures (Table 18). This alternative was selected for development into the recommended plan following discussion with the vertical team.

**Table 18 Estimated habitat units for best buy 36.**

| | Ohkay Owingeh | Santa Clara | Total |
|---|---|---|---|
| **Proposed Alternative (BB 36)** | | | |
| Measures (acres) | 89.6 | 166.2 | 255.8 |
| AAHUs | 1807.1 | 3545.3 | 5352.4 |

## 4.9 *Description of the Recommended Plan

The recommended plan consists of ecosystem restoration measures to restore 255.8 acres of the bosque (Table 19) within the study area. The measures are designed for (1) improving hydrologic connectivity with the floodplain by constructing grade restoration facilities (GRFs), high-flow channels, terrace lowering, willow swales and wetlands, and (2) restoring native vegetation and habitat through exotic species reduction, and by riparian forest re-vegetation with native plant species. Each of these proposed measure types will be discussed below. Work would be phased over seven to ten years with an initial construction phase potentially in the fall of 2017.

The proposed GRFs would halt upstream migration of channel incision, and provide additional floodplain connectivity. The approximate 20 acres of GRFs to be constructed on Ohkay Owingeh Pueblo would improve floodplain connectivity for about 107 acres. Terrace lowering would provide over 57acres of connectivity with the river by excavating the banks. The proposed high-flow channels (22 acres) would transport much-needed water across the terraces to bosque vegetation and improve floodplain connectivity on both Pueblos. Willow swales (48 acres) provide microenvironments in which native plants can thrive due to the reduced depth to the water table and moist soils. The proposed swale/wetland measures (17 acres) focus on development of open water or marsh wetlands with fluctuating water levels and various vegetative species. These wetlands provide open water habitat for migrating and local waterfowl, and provide aquatic habitat for numerous species. The project would produce approximately 5352 AAHUs.

**Table 19 Summary of proposed ecosystem restoration measures.**

| | |
|---|---|
| Ohkay Owingeh Pueblo | 89.6 total acres |
| Grade restoration facilities (4 mainstem GRFs) | 16.2 |
| Grade restoration facilities (2 upstream GRFs) | 4.5 |
| High-flow channel | 1.8 |
| Terrace lowering | 49.7 |
| Vegetation management | 17.4 |
| Santa Clara Pueblo | 166.2 total acres |
| High-flow channel | 20.3 |
| Swale | 47.5 |
| Swale / wetland | 17.0 |
| Terrace lowering | 7.7 |
| Vegetation management | 73.6 |

Vegetation removal and replanting is a component of most measures. Grubbing the sites is the initial step for the excavation measures, followed by planting with native plant species. Vegetation management measures are also proposed as standalone measures on Ohkay Owingeh Pueblo (17 acres) and Santa Clara Pueblo (74 acres). Removal of invasive plants and planting of native species removal increases the habitat value and enhances the aesthetic aspects of the bosque.

The proposed measures in Best Buy 36 provide a cost-effective strategy to mitigate channel degradation, while increasing habitat heterogeneity, function and value throughout both Ohkay Owingeh and Santa Clara Pueblos. These ecosystem restoration measures would reconnect the Rio Grande to the floodplains throughout the bosque on both Pueblos with GRFs, high-flow channels, terrace lowering, willow swales and wetlands. The six GRFs are essential for halting current and future channel degradation to address the loss of floodplain connectivity on Ohkay Owingeh Pueblo are measures in Best Buy plans 21 and higher. Achieving significant bosque ecosystem heterogeneity, function and habitat value depends on locating measures throughout the project area with Best Buy plan 35 and higher. Best Buy 36 includes a side-channel on Santa Clara Pueblo that contributes important wetland habitat consistent with costs for other measures. The incremental cost per habitat unit increases significantly with Best Buy plans 37 and higher. The measures proposed in Best Buy 36 provide the broadest distribution of cost-effective habitat features.

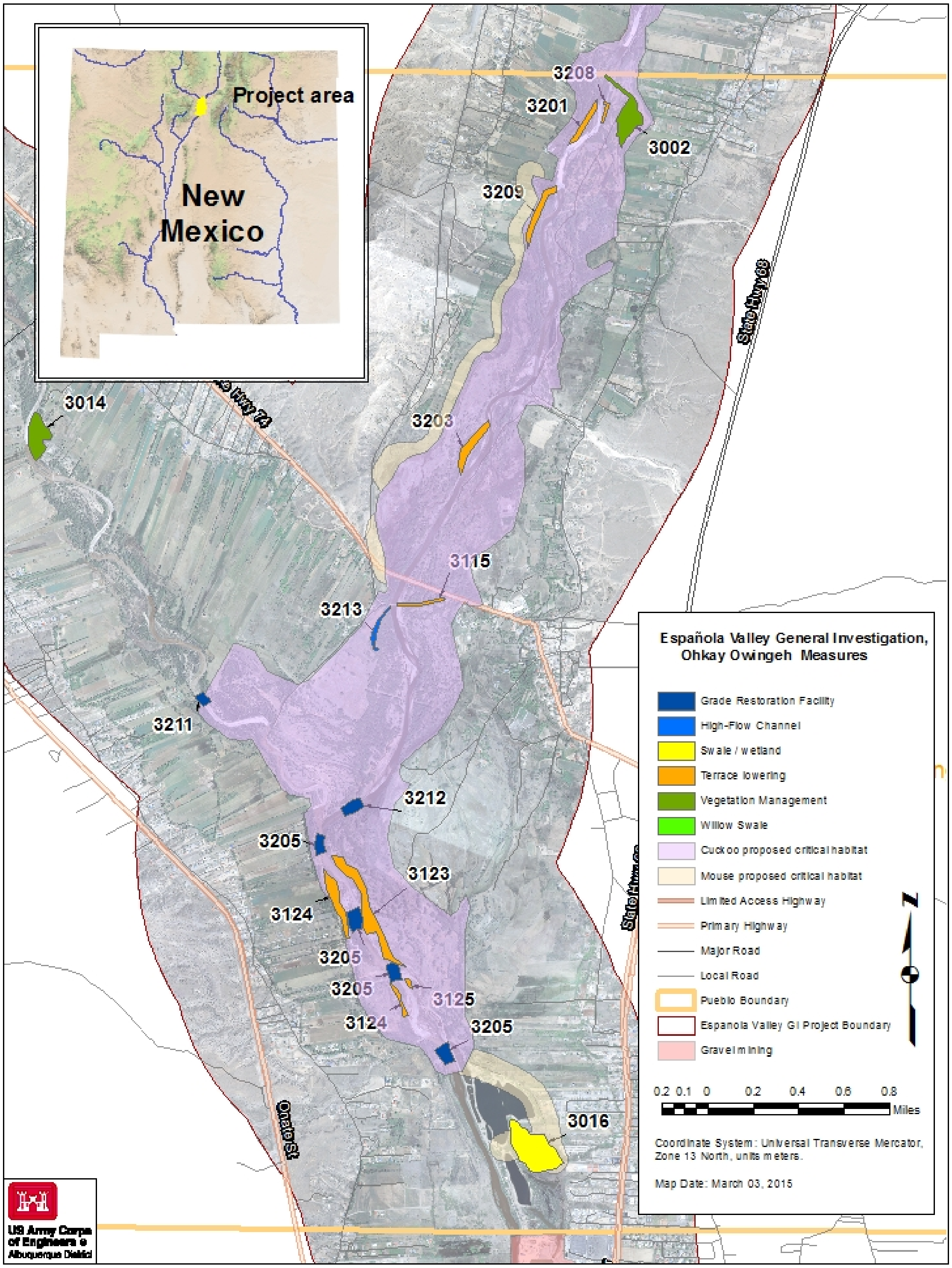



**Figure 22 Location of ecosystem measures on Ohkay Owingeh Pueblo.**

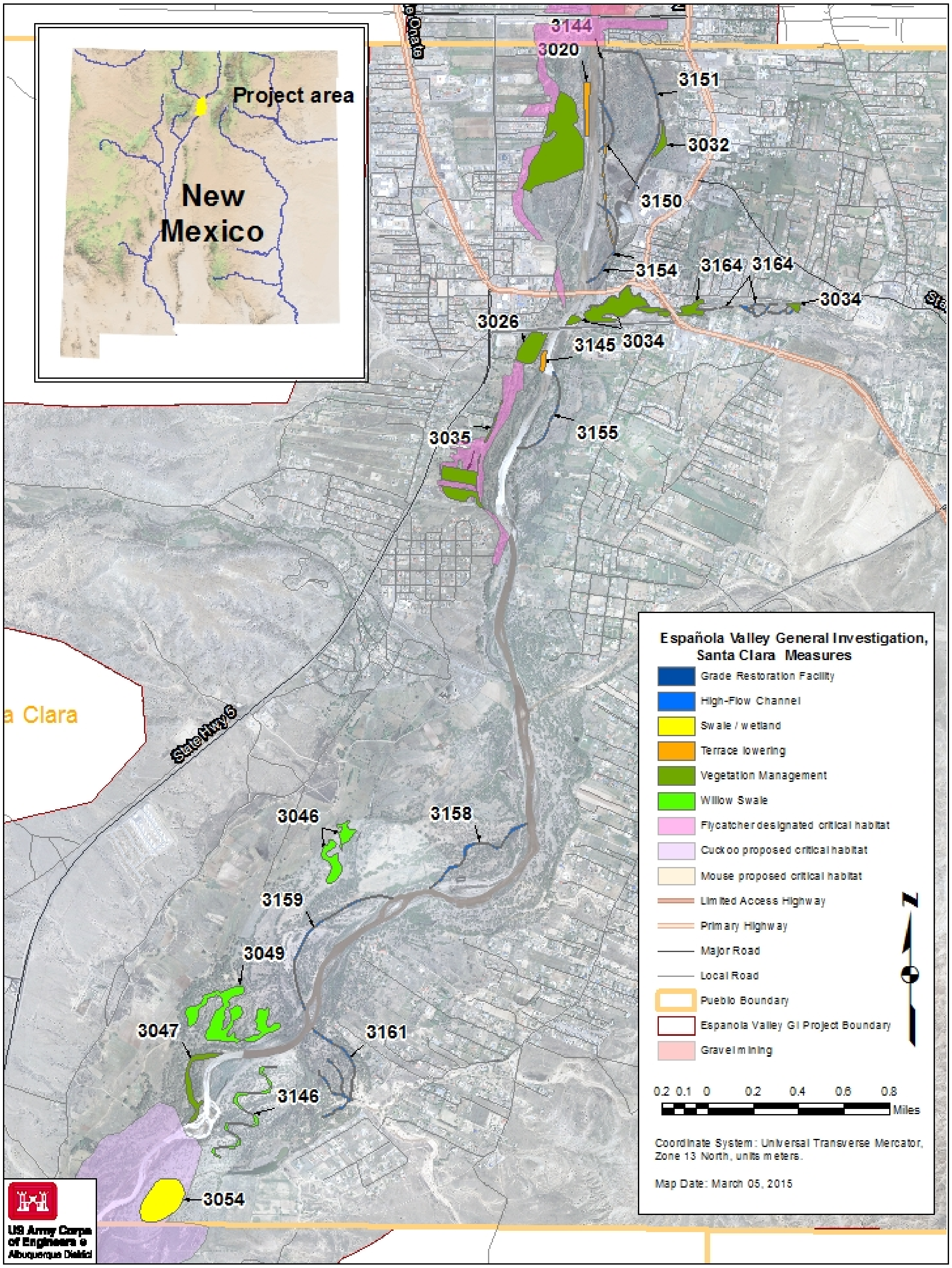



**Figure 23 Location of ecosystem measures on Santa Clara Pueblo.**

## 4.10 Recreation Addition to the Recommended Plan

Recreation is an incidental output and cannot be included as a feature of a FRM or ecosystem restoration plan until after it has been established that the FRM benefits exceed the cost of the protection or that an ecosystem restoration project is justified for construction. Recreational features can only be added if they are incrementally justified and they increase project costs by no more than 10 percent. It is important that proposed recreation features are appropriate in scope and scale to the opportunity provided by ecosystem restoration projects, and that the recreation development and anticipated use be compatible with the ecosystem restoration purpose of the project. The recreation potential may be satisfied only to the extent that recreation does not significantly diminish the ecosystem outputs that justify the ecosystem restoration project.

USACE participation is conditioned on provision of reasonable public access rights-of-way, consistent with attendance used in benefit evaluation and in accordance with local recreational use objectives.

The recreation should complement and not detract from the ecosystem restoration components. The recreation plan for the Espanola Valley General Investigation study was derived from a 2014 recreation master plan prepared by the USACE for the Santa Clara Pueblo. Recreational amenities would include formalized gravel trails, informational kiosk and shade structures and wildlife blinds for bird and wildlife observations. An amphitheater would also be included in the recreation plan. The proposed recreation plan selected those amenities that complement the restoration features without detracting from habitat. Where possible, gravel trails would follow existing primitive trails or access road alignments. Kiosks and benches would be placed at strategic locations along improved trails.

The USACE performed additional analysis to identify the benefit-cost ratio for the selected recreation plan. This analysis is presented in Appendix B.

The recreation plan is estimated to cost $227,513. A $227,513 recreation plan, with a period of analysis of 50 years and an interest rate of 3.375%, has a total annual cost of $11,566. Dividing the benefit of the proposed recreation facilities ($141.358) by the annual cost of the proposed project ($11,556) the Benefit Cost Ratio (BCR) exceeds 10 to 1.

## 4.11 Cost Apportionment

The costs of water resources studies and projects developed by USACE are shared between Federal and non-Federal sponsors as defined in laws and administrative provisions. WRDA of 1986 established new cost sharing rules for all studies and projects conducted by USACE. Post-study project costs, Planning and Engineering Design (PED) and construction, are cost shared between USACE and the local sponsor(s) 65% and 35% respectively. Costs for recreation included in ecosystem restoration projects is generally cost shared 50% and 50%.

For the Espanola Valley restoration project each sponsor is responsible for the cost of construction of measures that occur on their respective lands. Based on the costs of the measures developed to date, the total project is divided among the two sponsors with 50.4 % under the responsibility for Santa Clara and 49.6% under Okay Owingeh pueblo.

**Table 20 Pueblo of Ohkay Owingeh Cost Apportionment**

| Item | Ohkay Owingeh Pueblo (Phases 1-3, 9, 10) ($1,000's) | |
|---|---|---|
| | TOTAL FEDERAL (65%) | TOTAL NON-FEDERAL (35%) |
| Construction (Ecosystem Restoration) | 17,811 | 9,591 |
| LERRDs | 0 | 547 |
| PED | 2,415 | 1,301 |
| Construction Mgt | 1,676 | 903 |
| **Total First Cost (Ecosystem Restoration)** | 22,259 | 11,985 |
| IDC @ 3.375% interest rate | 4,928 | 2,653 |
| TOTALS** | 27,186 | 14,639 |
| *Percentage of Total Cost-Shared Amount* | 65% | 35% |
| **Total Project Cost ($41,825,000). The sponsor must provide 5% or $2,091,000 in cash. | | |

Unlike the project to be constructed within the tribal boundaries of Ohkay Owingeh, there will be recreation measures, in addition to ecosystem restoration measures, constructed within the tribal boundaries of Santa Clara. See row eight of Table 18.

**Table 21 Pueblo of Santa Clara Cost Apportionment**

| Item | Santa Clara Pueblo (Phases 4-8) ($1,000's) | |
|---|---|---|
| | TOTAL FEDERAL (65%) | TOTAL NON-FEDERAL (35%) |
| Construction (Ecosystem Restoration) | 18,095 | 9,743 |
| LERRDs | 0 | 545 |
| PED | 2,461 | 1,325 |
| Construction Mgt | 1,708 | 919 |
| **Total First Cost (Ecosystem Restoration)** | 22,617 | 12,179 |
| IDC @ 3.375% interest rate | 3,769 | 2,030 |
| TOTALS** | 26,387 | 14,208 |
| *Percentage of Total Cost-Shared Amount (non recreation)* | 65% | 35% |
| Recreation (50% Federal/50% non -Federal) | 155 | 155 |
| **Total Project Cost ($40,595,000). The sponsor must provide 5% or $2,029,756 in cash. | | |

# 5 - *Expected Future With-Project Effects

The expected future with-project condition is the most likely condition expected to exist in the future with the implementation of a particular water resources development project. Comparison of expected future with-project to conditions to expected future without-project condition will be performed to identify the beneficial and any adverse effects of the proposed alternatives. These with- and without-project comparisons provide the framework for the evaluation of alternative plans to the human environment.

## 5.1 Hydrology, Hydraulics and Sediment Transport

### 5.1.1 Hydrology

#### *5.1.1.1 Expected Future With-Project Conditions*

The recommended plan will provide for the movement of water from the Rio Chama, Santa Cruz River and Rio Grande into the currently disconnected floodplain. This change in the distribution of water into the water-starved riparian zone ensures the success of the implemented restoration measures. The less frequent large floods already spread across the floodplains so the recommended plan will not affect the occurrence of large flood inundation. Some of the proposed measure will actually improve the final draining of these large floods from the floodplains. The more frequent small floods will be slightly delayed as the flood wave moves down the valley through additional parallel channels and a wider main channel.

The recommended plan will have negligible impact of hydrology (Appendix A).

### 5.1.2 Geomorphology

#### *5.1.2.1 Expected Future With-Project Conditions*

Construction of the GRFs will quickly begin changing the shape of the Rio Chama and Rio Grande channel-forms immediately upstream. In time, the upstream channels should become shallower for a significant distance. If so, the Rio Chama and Rio Grande could again become braided in these areas.

Implementation of those ecosystem restoration measures, which include excavation outside of the river channels, will immediately improve flow conditions in the floodplain by increasing flow conveyance capacity (Appendix A).

### 5.1.3 Hydraulics

#### *5.1.3.1 Expected Future With-Project Conditions*

The recommended plan includes the implementation of following hydraulic structures (Appendix A):

- GRFs will raise upstream water surface profiles on the Rio Chama and Rio Grande for the more frequent flow events which will then be diverted into the high-flow channels. Eventually, the GRFs will also stabilize the upstream river banks and channel bottoms.

- High-flow channels will redirect water from the Rio Chama, Santa Cruz River and Rio Grande by diverting flows into and through newly excavated waterways and then returning the water back to its source. Diverting flows into these side channels will help stabilize the main channel between the diversion and the return.
- Terraces will be excavated to provide additional riverbank slope. The terrace excavation increases flow conveyance capacity. As a result of increased water conveyance, the river channel, for the length of the terrace, will have increased stability.
- Swales will connect existing and constructed low areas. Hydraulic effects are negligible.
- Wetlands will collect surface water and provide interaction with ground water. Hydraulic effects are negligible.
- Vegetation management will change water resistance in the floodplain. In some areas, this will mean a slowing of water flows for the duration of the overbank flow event. In other areas, this will mean an increase in water velocity for the duration of the overbank flow event.

#### 5.1.4 Sediment transport

##### *5.1.4.1 Future With-Project Conditions*

The GRFs are sizable structures that will immediately trap the coarser sediments upstream, such as sand and gravel. Over time, the entrapment area will spread upstream until sediment transport equilibrium is achieved. After channel bed equilibrium has been achieved, the banks of the Rio Chama and Rio Grande may stabilize from sediment deposition and revegetation. In addition, the GRFs on the Rio Grande will arrest the upstream migration of existing headcuts.

In the high-flow channels, on the terraces and in the areas of vegetation management, water velocities will decrease. When this occurs, fine sediment particles, such as clays and silts, will settle out of the water column. These fine sediments will eventually become new topsoil, where excavation occurs, or will add to already existing topsoil.

Locations of the swales and wetlands are end points for surface water runoff. These measures will most likely collect clays, silts and debris acting as sediment traps preventing these materials from entering the main channel.

### 5.2 Economics

The recommended plan has no with-project effect to economics over the life of the project. There is no significant difference, with regards to economics, between the future without-project and the future with-project conditions.

## 5.3 Environmental Resources

The recommended plan provides for the intent and, in many cases, the letter of several Federal environmental laws, directives, and executive orders concerning restoration and conservation efforts. The recommended plan also improves the resource needs as described in Section 1.5 and throughout the document. The recommended plan would improve the scarce native riparian habitat to a more pristine state, including a mosaic of habitat types. The recommended plan would provide habitat for the numerous migratory birds that use the area for nesting and stopover, provide additional potential habitat for listed species, and increase sustainability of the bosque by creating connections between the bosque and river. The recommended plan meets the goals of increasing habitat units.

### 5.3.1 Floodplains and wetlands

The recommended plan would increase floodplain connectivity using GRFs, high-flow channels, swales / wetlands, and terrace lowering. The 16.7 acres for GRF construction would increase floodplain connectivity for 107 acres. High-flow channels would increase connectivity for 22.2 acres, and terrace lowering would add about 45 acres. The swales / wetlands would increase floodplain connectivity with groundwater to support native riparian vegetation.

The excavation for the proposed high-low channels and terrace lowering would impact the existing floodplain. These features would be designed, however, so that there is no negative impact to existing flood control levees. Therefore, these measures may affect the floodplain, but these impacts are anticipated to be positive.

The excavation for the proposed swale / wetlands / ponds (83.2 acres) would impact the existing floodplain. These features would be designed, however, so that there is no negative impact to existing flood control levees. Wetlands within the Recommended Plan Area would be avoided during implementation. One wetland / swale measure is proposed to restore a previous wetland. The measure would improve groundwater connectivity for the wetland, and may create habitat that would potentially benefit the mouse. The existing wetland may be temporarily affected during excavation and re-vegetation. The tentatively selected plan would not have long-term impacts to existing wetland habitat. Therefore, these measures may affect the floodplain, but these impacts are anticipated to be positive.

Section 404 of the Clean Water Act (CWA) requires analysis under the EPA's 404 (b) (1) Guidelines if USACE proposes to discharge fill material into water or wetlands of the United States. A 404 (b) (1) Evaluation has been completed (Appendix C). All conditions under Nationwide Permits 33 (Temporary Construction, Access, and Dewatering) and 27 (Aquatic Habitat Restoration, Establishment, and Enhancement Activities) would be adhered to during construction. A water quality certification permit under Section 401 of the CWA would also be required. USACE would coordinate activities and schedule with the Ohkay Owingeh and Santa Clara Pueblos to allow water quality monitoring during project implementation. Therefore, the project would have no effect on existing wetlands during construction and would have a positive effect by creating wetland habitat.

The cumulative effects of the GRFs, high-low channels, terrace lowering, swale / wetlands / ponds would increase floodplain connectivity to surface and ground water.

### 5.3.2 Noxious weeds and invasive species

The recommended plan includes 104 acres of vegetation management to remove salt cedar, Russian olive, and other invasive species, followed by planting of native riparian vegetation in addition to the excavation measures.

### 5.3.3 Vegetation communities

Grubbing prior to excavation of the recommended measures (see Section 5.1.1) would remove invasive tree and plant species. All of these measures include planting with native plant species following excavation. The increased floodplain connectivity would provide soil conditions favorable to native riparian vegetation. Vegetation management over 104 acres (see Section 5.1.2) to replace invasive plants with native riparian vegetation creates additional habitat.

The cumulative effects of vegetation management in combination with the floodplain connectivity measures would increase native riparian and wetland vegetation. The increased riparian vegetation would increase habitat unit values over the life of the project (Figure 24 and Figure 25).

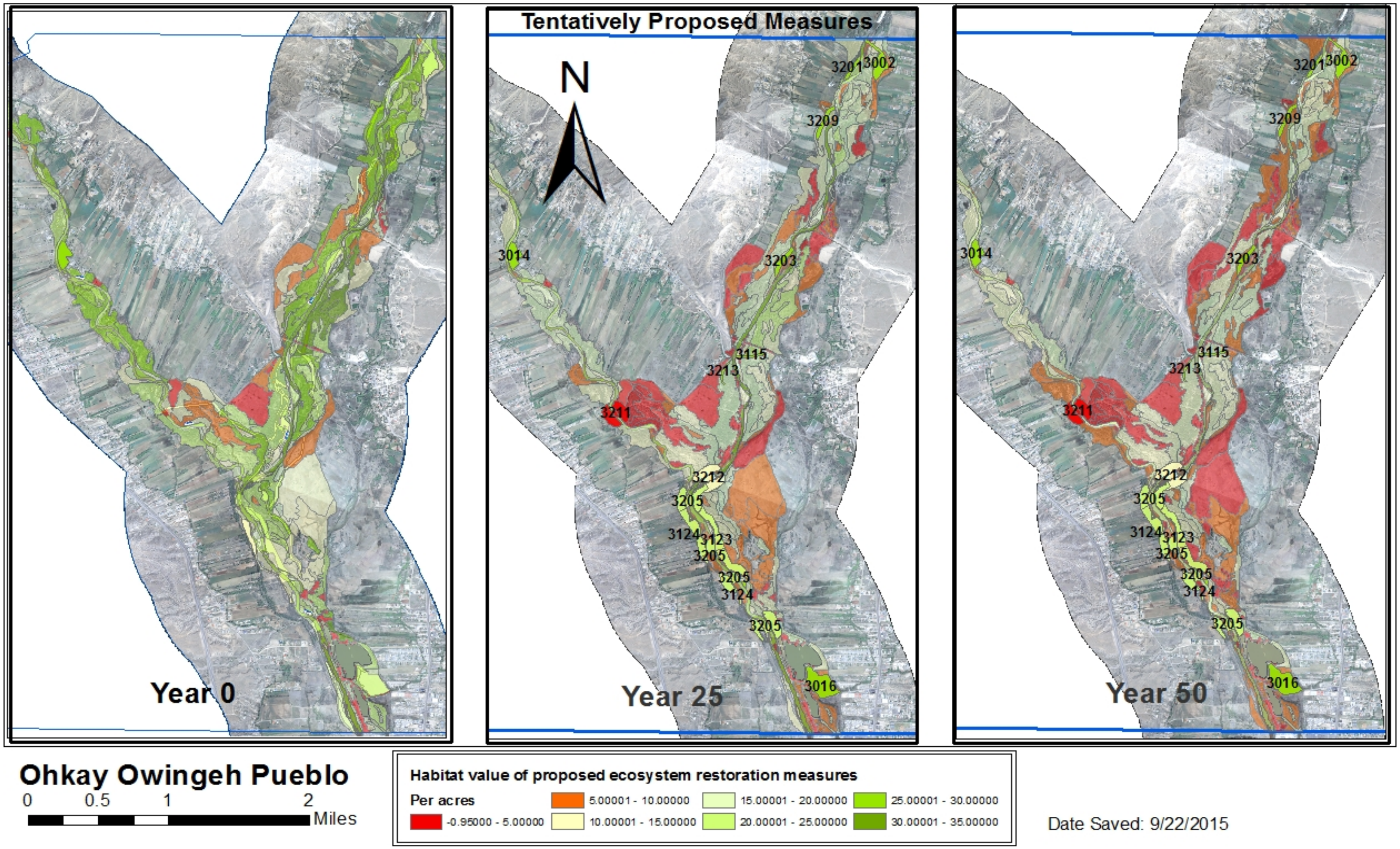



**Figure 24 Increase in habitat units with recommended measures on Ohkay Owingeh Pueblo.**

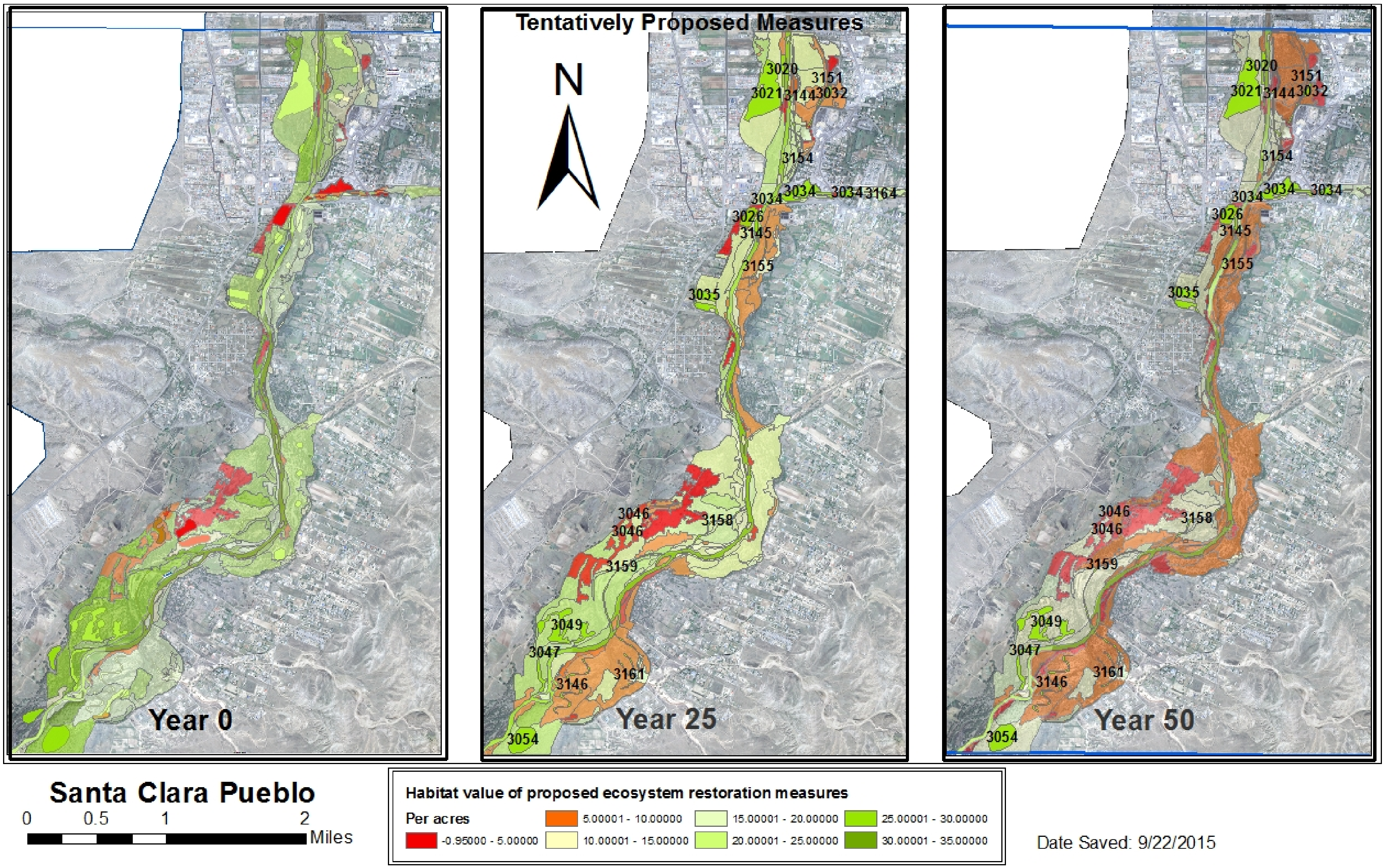



**Figure 25 Increase in habitat units with recommended measures on Santa Clara Pueblo.**

### 5.3.4 Fish and wildlife

The vegetation management strategy for each measure may be varied to support development of the riparian mosaic based on water demands. Replacing dead material and non-native vegetation with a mosaic of native vegetation should lead to a system of less water use, and increased diversity of native species for use by wildlife. Therefore, the long-term effects of replacing the non-native dominated vegetation system with native dominated species is proposed to outweigh the short-term effects during construction, which would be caused by the proposed action.

In order to minimize potential effects on nesting birds in the study area, clearing of live vegetation would only occur between August 15 and April 15. Per the Migratory Bird Treaty Act (MBTA), the proposed project would not entail the taking, killing or possession of any migratory birds listed under this Act. Since some raptors begin setting up nests as early as February, monitoring for bird nests would occur before construction to avoid any potentially active nests. The proposed project is in compliance with the requirements of the MBTA.

Recent studies done by Bateman et. al (2008) found that eastern fence lizards (*Sceloporus undulatus*) and New Mexico whiptails (*Cnemidophorus neomexicanus*) increased in relative abundance after non-native plants were removed. Another common species found in the 2008 study is Woodhouse's toad (*Bufo woodhousii*). The study indicated that perhaps, removing non-native plants in the understory allows more opportunities for heliothermic lizards to bask in areas where light does penetrate the cottonwood canopy.

Other wildlife such as arthropods, mammals, amphibians and reptiles would also be displaced during implementation of the proposed action. The Middle Rio Grande Ecosystem Restoration Project (USACE 2011) identified herbicide toxicity as a risk to amphibians that could be avoided by eliminating the use of herbicide use during the month of September. Therefore, herbicide use within the study area would only take place between October and April.

Since the ultimate goal is to re-vegetate with native species, which would create a healthier ecosystem in the long-term for native wildlife, these short-term effects of the project would be outweighed by the long-term benefits to all species. Therefore, the Recommended Plan would have short-term negative effects on wildlife with long-term positive benefits. The variability of habitat types would also provide different niches for different groups of wildlife (birds, herpetofauna, fish, small mammals and arthropods).

In accordance with the Fish and Wildlife Coordination Act, USACE has been and will continue to coordinate with the USFWS and seek their advice and recommendations on fish and wildlife resources during all phases of the project. USACE will coordinate with the USFWS (and other agencies as appropriate) on the more 'long-term' recommendations.

### 5.3.5 Special status species

The effects of the tentatively selected plan were evaluated for the Southwestern Willow Flycatcher, the Western Yellow-billed Cuckoo, and the New Mexico meadow jumping mouse in a Biological Assessment submitted to the USFWS (March 13, 2015).

#### *5.3.5.1 Southwestern Willow Flycatcher*

The Recommended Plan would create habitat that would potentially benefit the flycatcher. Creation of willow swales in the Recommended Plan would provide potential habitat for the flycatcher. Terrace lowering and high-flow channels should create natural willow and cottonwood stands. Over time, these cottonwood and willow stands would develop the preferred density and stature for flycatcher nesting.

Based on the surveys conducted by the sponsors within the Recommended Plan Area, flycatchers are likely to be present in the study area during the ten year construction period (2017 through 2027 or beyond). Surveys would be scheduled during each year of construction to verify presence or absence during the period of project implementation. It is very possible that migrants would be present in the study area in summer and fall. If nesting flycatchers are detected then consultation with USFWS would be reinitiated. Any nesting territories discovered would be avoided.

Therefore, USACE has determined that the Recommended Plan may affect, but are not likely to adversely affect, the flycatcher. The proposed ecosystem restoration measures may affect, but not likely to adversely modify designated or proposed critical habitat for the flycatcher. Construction of the measures described in the proposed action may provide beneficial habitat for the flycatcher.

#### *5.3.5.2 Yellow-Billed Cuckoo*

Disturbance of vegetation for the construction of measures would be outside the breeding season, avoiding effects to the cuckoo. Measures in the Recommended Plan would create habitat that would potentially benefit the cuckoo. Edge habitat adjacent to terrace lowering and high-flow channels should create ecotones that favor cuckoos. It is likely that migrants would be present in the study area in summer and fall. Surveys at the locations where migrants have been detected would continue each year as they have in the past. If nesting cuckoos are detected then consultation with USFWS would be reinitiated. Any nesting territories discovered would be avoided. If any occupied habitats are detected, these areas would also be avoided.

Therefore, USACE has determined that the proposed work may affect, but are not likely to adversely affect, the Western Yellow-billed Cuckoo. The proposed ecosystem restoration measures may affect, but not likely to adversely modify designated or proposed critical habitat for the Yellow-billed Cuckoo. Construction of the measures described in the proposed action may provide beneficial habitat for the cuckoo.

#### *5.3.5.3 New Mexico Meadow Jumping Mouse*

The New Mexico Meadow Jumping Mouse (*Zapus hudsonius luteus*; mouse) was listed as endangered on the June 10, 2014 (USFWS 2014). Proposed critical habitat for the mouse includes two marshes on Ohkay Owingeh Pueblo (USFWS 2013). Trapping surveys for the mouse in the Recommended Plan Area would confirm whether the action area remains unoccupied during the ten year construction period (2017 through 2027 or beyond). The pueblo and the Service should discuss monitoring strategies prior to construction in possible mouse habitat.

Therefore, USACE has determined that the proposed work may affect, but not likely to adversely affect, the New Mexico Meadow Jumping Mouse. The proposed ecosystem restoration measures may affect, but not likely to adversely modify designated or proposed critical habitat critical habitat for the New Mexico Meadow Jumping Mouse. Construction of the measures described in the proposed action may provide beneficial habitat for the mouse.

#### 5.3.6 Water quality

Soil disturbance would result from vegetation clearing, and excavation of wetlands, swales and high-flow channels. Denuded soils would be susceptible to erosion by wind and water. This erosion could result in introduction of sediment to the Rio Grande. The potential for storm water pollution during construction is minimal for this project. The contractor's work would be in accordance with the National Pollutant Discharge Elimination System permit as described below.

Mechanical equipment such as brush-clearing machines and excavators could potentially leak oil, fuel, or hydraulic fluid, which could and affect surface water quality if they reached the Rio Chama and Rio Grande. Spills of such materials could similarly contaminate surface water in the river or irrigation infrastructure. All equipment would be inspected daily to ensure that oil, fuel, hydraulic fluid, or other potential contaminants are not leaking. All petroleum products would be stored outside of the 1% ACE event floodplain and maintained to ensure that leaks or spills are contained and remediated at the storage site.

Section 404 of the Clean Water Act requires analysis under the EPA’s 404 (b)(1) guidelines if USACE proposes to discharge fill material into a water or wetlands of the United States. The 404 (b)(1) analysis has been completed for Nationwide 33 (Temporary Construction, Access, and Dewatering) due to the potential need to dewater at the bank of the river when constructing the high-flow channels, and Nationwide 27 (Stream and Wetland Restoration Activities) for work that would take place to restore wetland habitat function. All conditions under Nationwide Permits 33 and 27 would be adhered to during construction. A water quality certification permit under Section 401 of the CWA would be required. USACE would coordinate with the Pueblos of Ohkay Owingeh and Santa Clara regarding activities and schedules to allow the opportunity for monitoring water quality conditions during project implementation.

Section 402(p) of the CWA regulates point source discharges of pollutants into waters of the United States and specifies that storm water discharges associated with construction activity be conducted under National Pollutant Discharge Elimination System (NPDES) guidance. Some ground disturbance may take place. A Storm Water Pollution Prevention Plan (SWPPP) for the project is required for construction. This would be developed by the contractor who would be required to adhere to this plan and required to file a Notice of Intent (NOI) with the Environmental Protection Agency. Through this NOI the contractor performs all work in accordance with the Nationwide NPDES permit prior to commencement of construction activities. The SWPPP would also include a Spill Control Plan. Compliance with these requirements would ensure that the Preferred Alternative would have no significant effect on the water quality of the Rio Grande. Water quality would be monitored throughout the project. Silt fences (without lead weights) would be installed prior to construction in all areas and other standard BMPs would be implemented. All construction activities would be in compliance to all applicable Federal, state and local regulations.

There may be a short-term adverse effect on water quality during construction along the banks of the river but that portion of construction would take place during low flows of the river. Also, once the water features have been constructed, many of them would provide a benefit to water quality. Those water features where wetland plants are installed would provide improved water quality as the wetland plants take up materials in the water passing through the feature (such as storm water passing through wetlands constructed near these features, or sediment laden water passing through the high-flow channels). Therefore, there would be a minor short-term adverse effect on water quality during construction only and a positive long-term benefit to water quality by the Proposed Action.

### 5.3.7 Air quality

Air quality in the study area is generally good to excellent due to the lack of urban industrial development. Although high winds are common in and around the study area, blowing dust is generally not a problem except during extremely dry years. Airborne particulate and carbon monoxide concentrations from wood burning in the Rio Grande valley are occasionally high during winter months when temperature inversions and wood stove use are both more prevalent. All vehicles involved in construction at the project site would be required to have passed a current New Mexico emissions test and have required emission control equipment (if required).

Since there would be ground disturbance during construction of all features in the Proposed Action, BMPs to minimize air quality disturbance would be employed. These include covering trucks to avoid fugitive dust violations and wetting down work areas. Speed limits on access roads would be limited to 15 mph, which would also minimize dust.

All work areas would be continually wet down to minimize dust. Therefore, short-term adverse impacts to air quality are anticipated during construction but would be abated to the extent possible using BMPs as described above. There would be no long-term adverse effects to air quality by the recommended plan.

### 5.3.8 Noise

The Pueblos generally are quiet with limited background noise. The OSHA noise standard (29 CFR 1910.95) limits noise levels to 90 decibels (environmental sound intensity measured as dBA) averaged over an eight-hour day, although hearing damage can begin at levels as low as 80 dBA over an eight-hour day. No worker may be exposed to noise in excess of 115 dBA without protection which will reduce the exposure below 115 dBA.

Equipment to be used during construction would include pieces generating a fair amount of noise. This noise would be somewhat abated by the distance from construction sites to nearby housing. Travel on the access roads to and from work locations would also create noise during the project. The project would take place during normal work hours between 7:00am and 5:00pm in order to minimize disturbance. All OSHA and local municipality requirements (as described above) would be adhered to. Therefore, there would be minor, short-term noise impacts by the tentatively selected plan during construction, which would occur only during normal working hours. There would be no long-term adverse effects to noise by the recommended plan.

#### 5.3.9 Aesthetics

The aesthetics of the bosque may temporarily be affected during construction by the presence of construction equipment and excavation. Following construction and revegetation the disturbed area of the bosque would resume functioning as a healthy ecosystem. The ecosystem restoration measures in the recommended plan would benefit the aesthetic value of the bosque.

#### 5.3.10 Land use and classification

There would be no long-term adverse effects to land use outside the bosque by the tentatively selected plan. The ecosystem measures would support traditional cultural uses of the bosque. The cumulative effects of the tentatively selected plan would be beneficial.

### 5.4 Cultural Resources

The Area of Potential Effects (APE) for the project is defined in detail in section 2.4.1.3. As of September 18, 2015, archaeological survey and evaluation of historic properties within the Santa Clara portion of the APE is currently ongoing, and preliminary results suggest a smaller number of archaeological sites than originally expected within the Santa Clara APE, all of relatively recent age. At Ohkay Owingeh, consultation between the Corps, the Pueblo of Ohkay Owingeh, and the New Mexico SHPO is ongoing, with the goal of identifying an appropriate method and approach for avoiding effects to historic properties while maintaining the confidentiality of cultural information within the Pueblo. Specific determinations about impacts to cultural resources resulting from the proposed project must wait for the completion of inventories, determinations of NRHP eligibility and effects, and consultation with the SHPO, THPO, and Tribes on these determinations and the resolution of any adverse effects. The consultation process is described in greater detail in Section 2.4 and Appendix D.

### 5.5 Hazardous, Toxic, and Radioactive Waste (HTRW)

This study has recently reached the stage where one or more specific study areas will be selected for intensive investigation. At that time, existing conditions, future with- and future without-project, of that smaller subset of the initial study area, will be examined in significant detail in a Phase I Environmental Site Assessment (ESA) to determine the likelihood of the existence of Hazardous, Toxic & Radioactive Waste (HTRW) concerns; specifically, ASTM 2247-02, Phase I ESA Assessment for Forestland or Rural Property. The ESA will begin in February 2015 and will be completed prior to contract award.

The future with-project condition will not likely impact the existing HTRW conditions within the study area. If any HTRW issues are discovered, they will be avoided.

### 5.6 Geotechnical Engineering

It is expected that the soils present within the proposed areas for construction of the grade restoration features (GRFs) will be highly permeable and consist of boulders, cobbles, gravels, sands, silts, and clays. Depth to groundwater table is expected to be shallow within the proposed areas for construction of GRFs. Depth to bedrock is unknown but not expected to be within the proposed limits of the GRF foundations. There are no expected issues related to geotechnical engineering aspects of this project; therefore, the necessary information requiring collection and analysis can be performed once the project moves into design.

#### 5.6.1 Future With-Project Geology and Soils

No changes are anticipated in site geology and soils over the project lifetime.

### 5.7 Climate

There is anticipated to be no difference in the future without-project and future with-project climate conditions. The project will have no effect on climate change in the region. Project climate change impacts to the recommended plan can be found in Appendix G.

Climate change is very likely to result in smaller, earlier spring runoff flows in rivers, and reduced late summer base flows in the Rio Grande, the Rio Chama, and perennial tributaries. Drought is projected to occur more often, last longer, and be more intense. Higher temperatures are anticipated to increase soil moisture stress for plants. Climate change may result in stronger monsoons and/or summer thunderstorms, and with stronger storms interspersed with longer dry periods between, but the consensus on this is low. Larger summer floods are a potential result.

The ecosystem restoration features in the recommended plan are anticipated to be relatively resilient to these changes:

- Ecosystem restoration features, such as terrace lowering and high flow channels, will be designed and managed so that they function over a range of flows, including anticipated lower future peak flows.
- Although overbanking floods are likely to occur less frequently, these floods will continue to occur, providing opportunities for native seed germination and seedling establishment in riparian areas. Historically, overbank flooding was not an annual event, and native species are adapted to the intermittent nature of flooding in the riparian zone.
- High water tables in the riparian zone will remain within reach of dominant native woody species (willow, cottonwood), and once established, these plants should be resilient to changes in soil moisture stress and drought.
- Spring runoff flooding is likely to occur earlier in the year. It is unclear how this might impact project vegetation because it is not clear whether plants will adapt by reproducing earlier in the year, or whether soil moisture will remain high enough for later seed germination. This should have no effect on established vegetation (natural and planted) within the study area because these plants are drawing moisture from the water table year-round.
- The GRFs are designed to function under a wide range of future flows, and are unlikely to be damaged under future high or low flow conditions.

## 5.8 Socioeconomics

The population of the State of New Mexico is projected to increase by approximately 37% between the last official U.S. Census in 2010 and the year 2040. The population of Rio Arriba County is expected to remain fairly constant while the population of Santa Fe County may increase by approximately 28%. The Census Bureau does not have projected population numbers for the census designated populations of Ohkay Owingeh, Santa Clara or San Ildefonso Pueblo

**Table 22 Española Valley Population Projection Statistics for 2010 through 2040.**

| **Española Valley** | **Total Population (individuals)** | **Projections** | | | |
|---|---|---|---|---|---|
| | | **2020** | **2030** | **2035** | **2040** |
| New Mexico | 2,059,179 | 2,351,724 | 2,613,332 | 2,727,118 | 2,827,692 |
| Rio Arriba County | 40,246 | 41,026 | 40,872 | 40,509 | 40,008 |
| Santa Fe County | 144,170 | 164,006 | 178,124 | 182,410 | 184,832 |

* Respondents may have multiple answers to census survey resulting in numbers greater than the total population.

The recommended plan is not expected to have any influence on future demographics.

### 5.8.1 Environmental justice

The proposed ecosystem restoration and FRM measures seek to address disproportionate effects of previous actions on the bosque ecosystem and the Pueblo communities. The proposed ecosystem restoration measures will support the Pueblos of Ohkay Owingeh and Santa Clara in addressing environmental issues and concerns. Restoration of floodplain connectivity and revegetation is consistent with the cultural uses and values for the bosque. The proposed ecosystem restoration and FRM measures seek to address disproportionate effects of previous actions on the bosque ecosystem and the Pueblo communities.

## 5.9 Cumulative Effects

The project would provide valuable riparian habitat within the Rio Grande valley. Improving habitat quality in the project area would strengthen the wildlife corridor between several Wild and Scenic Rivers, national wildlife refuges, state parks and wildlife management areas. The project would complement the nearby Los Luceros Historic Area (152 bird species) and the Rio Grande Flyway.

# 6 - Real Estate

## 6.1 Alternative Facilities

There are no geographically suited alternative project facilities. There are no known sales of Pueblo lands and no sales anticipated.

## 6.2 Real Estate Requirements

At this time, all construction activities will be on tribal lands within the Pueblos of Ohkay Owingeh and Santa Clara.

## 6.3 Ownership of LERRD Required for the Project

The Sponsors already own land in fee. Staging areas, rights of ingress and egress, construction and remediation activities must be approved in advance in writing by each individual Pueblo's council. Public roads will be utilized for ingress and egress purposes to access Pueblo lands.

## 6.4 Non-Standard Estates

The use of non-standard estates is not required for this project.

## 6.5 Existing Federal Projects that Lie Within LER Required for the Project

There are no existing Federal projects within the LER required for this project.

## 6.6 Existing Federally-Owned Land within the LER Required

There is no Federally-owned land within the LER required for the project.

## 6.7 Navigation Servitude

Exercise of navigational servitude is not required for this project.

## 6.8 Potential Flooding Induced by Construction, Operation, or Maintenance of Project

No induced flooding is anticipated.

## 6.9 Application or Enactment of Zoning Ordinances

Application or enactment of zoning ordinances is not proposed in connection with this project.

## 6.10 Facility/Utility Relocations

No relocations of facilities or utilities within the project footprint are proposed in connection with this project.

## 6.11 Opposition to the Project

There is no known opposition to this project by any landowners in the vicinity.

# 7 - *Coordination and Public Views

## 7.1 Compliance with Environmental Requirements

### 7.1.1 USFWS Coordination Act

USACE has coordinated with the U.S. Fish and Wildlife Service to fulfill requirement of the Fish and Wildlife Coordination Act throughout the planning process. The Final FWCA report (13 July 2015) included in Appendix C was reviewed by the New Mexico Department of Game and Fish, and the Forestry Division of the New Mexico Energy, Minerals, and Natural Resources Department. The USFWS made recommendations for construction, vegetation management, and monitoring. Construction activities should occur outside the migratory bird nesting season of March through September. Vegetated areas should be clear outside the nesting season. Avoid disturbing nesting areas until young have fledged.

Protect mature cottonwood trees from damage during clearing of nonnative species or other construction activities using fencing, or other appropriate materials. Use local genetic stock wherever possible in the native plant species establishment throughout the riparian area. Scarify compacted soils or replace topsoil and revegetate all disturbed sites with suitable mixture of native grasses, forbs, and woody shrubs. Any use of backfill should be uncontaminated soils suitable for revegetation with native plant species.

Update the riparian and wetland inventory to guide the restoration efforts, develop a monitoring plan to examine the effectiveness of the restoration activities including wildlife, vegetation, and groundwater levels, and prepare a detailed geomorphic analysis of the area to identify where channel incision is affecting groundwater levels of the riparian zone.

### 7.1.2 ESA consultation and compliance

USACE submitted a draft Biological Assessment to the U.S. Fish and Wildlife Service on March 13, 2015. The draft Biological Assessment is included in Appendix C.

## 7.2 Public Involvement

Local experience with similar restoration projects and public concerns are considered during all phases of plan formulation (Appendix I). The initial public meetings were held in the Fall of 2007 at each of the Pueblos. Areas of concern included technical considerations based upon the specifics of the study, loss of riparian areas traditionally known as bosque, flood risk management, and opportunities for incidental recreation. Additional public meetings are being scheduled to correspond with release of the future draft feasibility report.

The planning effort included extensive involvement by the Pueblos of Ohkay Owingeh, Santa Clara, and San Ildefonso (Appendix I). Numerous plan formulation workshops and meetings are planned for the remainder of the feasibility phase. These workshops and meetings introduce the project to the public, give individuals and agencies an opportunity to identify issues for consideration in the feasibility report, and solicit input on the project. The study's PDT and tribal attorneys created a Communications Plan, which includes all legal requirements for the inclusion of public views and comments.

## 7.3 Non-Federal Views and Preferences

In general, the non-Federal views and preferences regarding ecosystem restoration measures, and the problems they addressed, were obtained through coordination with the local sponsors and with other various local and regional public agencies, community groups, resource conservation groups and the public. The New Mexico Department of Game and Fish and Audubon New Mexico provided input to the Habitat Team during evaluation of proposed measures. These coordination efforts consisted of public meetings held during the reconnaissance and feasibility phases, through the maintenance of points of contact that interested party could use for discussion, and a distribution list for notification of public meetings. Announcement of public meetings was made in local media providing the date, time, place, and subject matter.

## 7.4 Summary of Project Management, Coordination, Public Views and Comments

The responsibilities for this task are shared between the USACE and the three local sponsors. The sponsors have provided in-kind services to assist in completing this task (Appendix I). This effort has included developing a public involvement plan; developing a mailing list of all public and private interests (including federal, state, local and non-governmental agencies), who will be kept informed of study progress and results; and conducting multiple public workshops (as defined by the tribal sponsors) which have also served as NEPA scoping meetings to gather ideas and concerns regarding ecosystem restoration, possible flood risk management, and incidental recreational water issues in the study area. Future public meetings will be held to discuss alternative plans which the PDT will further formulate to address these same issues. Future public meetings will be held to discuss the preliminary selection of the best plan[s] and the anticipated report recommendations. A final public meeting will be conducted to present the study conclusions. Additional public meetings may be held as necessary to keep the public informed of the study progress. Oral testimony at the final public meeting as well as written comments received during the public review session will be considered official comments to the draft detail feasibility report. All comments will be addressed and responded to, prior to finalizing the report.

All interested parties will be kept apprised of the status of the feasibility investigations. This will be accomplished both through the public involvement program and personal contact by the PDT members. Stakeholders will be formally contacted according to the public involvement program discussed above. Informally, periodic phone calls, visits, letters, and e-mails will be provided to insure a continuous coordination program with the stakeholders. The stakeholders include Ohkay Owingeh Pueblo, Santa Clara Pueblo, San Ildefonso Pueblo, the City of Española, the U.S. Fish and Wildlife Service, and other parties that express an interest as the study continues to progress.

# 8 - *Preparers

| Name | Title | Organization |
|---|---|---|
| Alicia Austin Johnson | Project Manager | USACE |
| Mark Mendenhall | Project Manager | USACE |
| Howard Gonzales | Project Manager | USACE |
| Charlie Lujan | Project Manager | Ohkay Owingeh Pueblo |
| Dave Morgan | Consultant | Ohkay Owingeh Pueblo |
| John Perea | Project Manager, Contractor | Santa Clara Pueblo |
| Stephen Martinez | Project Manager | San Ildefonso Pueblo |
| Kathy Skalbeck | Study Planner | USACE |
| Anthony Apodaca | Study Planner | USACE |
| Ariane Pinson | Climate Science Specialist | USACE |
| Alan Schlindwein | Hydraulic Engineer | USACE |
| Tamara Massong | Hydrologist | USACE |
| Ryan Gronewold | Hydraulic Engineer | USACE |
| Grant Kolb | Hydrologist | USACE |
| Bruce Beach | Hydrologist | USACE |
| Bet Lotosky | Chief Hydrology / Hydraulics | USACE |
| Rob Browning | Economist | USACE |
| Robert Grimes | Economist | USACE |
| Michael Porter | Ecologist | USACE |
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| Naomi Archuleta | Environmental Department | Ohkay Owingeh Pueblo |
| Lawrence Cata | Environmental Department | Ohkay Owingeh Pueblo |
| Bruce Bauer | Environmental Department | Santa Clara Pueblo |
| J. Yepa | Environmental Department | Santa Clara Pueblo |
| Dino Chavarria | Environmental Department | Santa Clara Pueblo |
| Jeffrey Lyon | Environmental Department | Santa Clara Pueblo |
| Joseph Gutierrez | Environmental Department | Santa Clara Pueblo |
| Ray Florez | Environmental Department | San Ildefonso Pueblo |
| Neil Weber | Chief Environmental Dept. | San Ildefonso Pueblo |
| A. Garcia | Environmental Department | San Ildefonso Pueblo |
| Chris Moquin | Environmental Department | San Ildefonso Pueblo |
| Myron Gonzales | Environmental Department | San Ildefonso Pueblo |
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| Jonathan Van Hoose | Archeologist | USACE |
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| John Schelberg | Archeologist | USACE |
| Cheryl Fogle | Archeologist | USACE |
| Jennifer Denzer | Geologist | USACE |
| Suzi Hess | Geologist | USACE |
| Bruce Jordan | Geotechnical Engineer | USACE |
| Bruno Quirici | Geotechnical Engineer | USACE |
| Doug Walther | Geospatial Specialist | USACE |

| | | |
|---|---|---|
| Candice Kjobech | Geospatial Specialist | USACE |
| John Peterson | Lead Geospatial Specialist | USACE |
| Bruce Bauer | Geospatial Specialist | Santa Clara Pueblo |
| Michael Prudhomme | Cost Engineer | USACE |
| Diego Benavidez | Cost Engineer | USACE |
| Alan C de Baca | Cost Engineer | USACE |
| Ted Solano | Civil Engineer | USACE |
| Matthew Tafoya | Rights Protections | Santa Clara Pueblo |
| Ben Chavarria | Rights Protection | Santa Clara Pueblo |
| Michael Chavarria | OEA | Santa Clara Pueblo |
| Ben Miranda | Real Estate | USACE |
| Marvin Urban | Real Estate | USACE |
| Al Lopez | Real Estate | USACE |
| Don Luna | | USACE |
| Ron Kneebone | Tribal Liaison | USACE |
| Jessica Aberly | Attorney | Santa Clara Pueblo |
| Various | Tribal Council | Ohkay Owingeh Pueblo |
| Various | Tribal Council | Santa Clara Pueblo |
| Various | Tribal Council | San Ildefonso Pueblo |

## 8.1 District Quality Control Reviewers

| Name | Title | Organization |
|---|---|---|
| Mark Doles | Chief, Plan Formulation | USACE |
| Stephen Scissons | Chief, Hydrology and Hydraulics | USACE |
| Julie Alcon | Chief, Environmental Resources and Cultural Resources | USACE |
| Shelley Ramos | Chief, Geotechnical Engineering | USACE |
| Cecilia Horner | Chief, Environmental Engineering | USACE |
| Michael Prudhomme | Chief, Cost Engineering | USACE |
| Ondrea Hummel | Ecologist | USACE |
| Corina V. Chavez | Civil Engineer | USACE |
| Patty Phillips | Project Manager | USACE |

# 9 - District Engineer's Recommendation

Consideration has been given to all significant aspects in the overall public interest, including engineering feasibility, economic, social and environmental effects. The recommended plan for the Española Valley, Rio Grande and Tributaries, New Mexico meets all requirements for implementation under Federal and USACE regulations. The recommended plan includes:

The recommended plan is the NER plan.

The recommended plan is described in greater detail in Chapter 4, Section 4.6 *Description of the Recommended Plan.

I recommend that the ecosystem restoration improvements in the Española Valley, Rio Grande and Tributaries, New Mexico be constructed generally in accordance with the recommended plan herein and with such modifications thereof as at the discretion of the Chief of Engineers may be advisable at an estimated first cost of $64,928,000. Federal implementation of the recommended project would be subject to provision that the non-Federal sponsors and the Secretary of the Army shall enter into a binding Project Partnership Agreement (PPA) defining the terms and conditions of cooperation for implementing the Española Valley, Rio Grande and Tributaries, New Mexico project, and the non-Federal sponsors comply with applicable Federal laws and policies, including but not limited to:

1. Provide 35 percent of construction costs:
    a. For construction activities within the border of their Pueblo; and,
    b. In cash or by work-in-kind activities.
2. Provide, during the first year of construction, any additional funds necessary to pay the full non-Federal share of preconstruction engineering and design, and Phase 1 construction costs;
3. Provide, during construction, a contribution of funds equal to 5 percent of total project costs;
4. Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the project;
5. Provide, during construction, any additional funds necessary to make their total contribution equal to at least 35 percent of total construction costs;
    a. Shall not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefore, to meet any of the non-Federal obligations for the project unless the Federal agency providing the Federal portion of such funds verifies in writing that expenditure of such funds for such purpose is authorized;

b. Not less than once each year, inform affected interests of the extent of protection afforded by the project;

c. Agree to participate in and comply with applicable Federal floodplain management and flood insurance programs;

d. Comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 USC. 701b-12), which requires a non-Federal interest to prepare a floodplain management plan within one year after the date of signing a project partnership agreement, and to implement such plan not later than one year after completion of construction of the project;

e. Publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with protection levels provided by the project;

f. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the performance that the project affords, hinder operation and maintenance of the project, or interfere with the project's proper function;

g. Comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 USC 4601-4655), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way required for construction, operation, and maintenance of the project, including those necessary for relocations, the borrowing of materials, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;

h. For so long as the project remains authorized, operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, including any mitigation features, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government;

i. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsors own or control for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;

j. Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, rehabilitation, and replacement of the project and any betterments, except for damages due to the fault or negligence of the United States or its contractors;

k. Keep and maintain books, records, documents, or other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, or other evidence are required, to the extent and in such detail as will properly reflect total project costs, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20;

l. Comply with all applicable Federal and State laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 USC 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable Federal labor standards requirements including, but not limited to, 40 USC. 3141 - 3148 and 40 USC 3701 - 3708 (revising, codifying and enacting without substantial change the provisions of the Davis-Bacon Act (formerly 40 USC 276a *et seq.*), the Contract Work Hours and Safety Standards Act (formerly 40 USC 327 *et seq.*), and the Copeland Anti-Kickback Act (formerly 40 USC 276c *et seq.*);

m. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended (42 USC 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal sponsors with prior specific written direction, in which case the non-Federal sponsors shall perform such investigations in accordance with such written direction;

n. Assume, as between the Federal Government and the non-Federal sponsors, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project;

o. Agree, as between the Federal Government and the non-Federal sponsors, that the non-Federal sponsors shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, rehabilitate, and replace the project in a manner that will not cause liability to arise under CERCLA; and

p. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 USC 1962d-5b), and Section 103(j) of the Water Resources

Development Act of 1986, Public Law 99-662, as amended (33 USC 2213(j)), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project or separable element.

I certify that the planning activities have been implemented in accordance with USACE planning policy, design and construction standards and applicable Federal and State laws. The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a National Civil Works construction program nor the perspective of higher review levels within the Executive Branch.

Recommendations may be modified. However prior to transmittal to Congress, each of the non-Federal sponsors, the State of New Mexico, and stakeholders will be advised of any modifications and will be afforded an opportunity to comment further.

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| Date | PATRICK J. DAGON<br>LTC, EN<br>Commanding |

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