El Paso Rio Bosque Wetlands

Section 206 Aquatic Ecosystem Restoration

El Paso, Texas

U.S. Army Corps of Engineers

Albuquerque District

DRAFT
Detailed Project Report with Integrated Environmental Assessment

November 2020

US Army Corps of Engineers®
Albuquerque District

(*This page is intentionally left blank.)*

U.S. ARMY CORPS OF ENGINEERS

ALBUQUERQUE DISTRICT

DRAFT

FINDING OF NO SIGNIFICANT IMPACT

EL PASO RIO BOSQUE WETLANDS

SECTION 206 AQUATIC ECOSYSTEM RESTORATION PROJECT

EL PASO, TEXAS

The U.S. Army Corps of Engineers, Albuquerque District (USACE) has conducted an environmental analysis in accordance with the National Environmental Policy Act of 1969, as amended. The final Integrated Report and Environmental Assessment dated DATE [to be added], for the **El Paso Rio Bosque Wetlands Section 206 Project** addresses **aquatic ecosystem restoration** opportunities and feasibility in the **Rio Bosque Wetlands Park, El Paso, Texas**. The final recommendation is contained in Section 5 of the Integrated Report.

The final Integrated Report, incorporated herein by reference, evaluated various alternatives that would restore and enhance wetland habitats and provide a mosaic of diverse habitat types that would have been present prior to channelization and modification of the Rio Grande in the study area. The recommended plan is the National Ecosystem Restoration (NER) Plan and includes:

- Enhancing 55.1 acres of existing seasonal wetlands so that they would remain wet throughout the year;
- Creating 1.4 acres of new emergent wetlands and 34.3 acres of shallow marsh wetlands;
- Restoring 45 acres of cottonwood-willow riparian habitat;
- Planting native floodplain grasslands;
- Improving the Park's water delivery infrastructure, allowing for distribution of water essential to developing additional wetland areas; and
- Incorporating passive recreational features, such as improvements to existing access and trails, interpretative signage, and trail shelters.

In addition to the recommended wetland restoration plan, a "no action" plan was evaluated. Wetland restoration alternative plans that were considered (section 3.2) included **different wetland depths and different combinations or subsets of the proposed restoration features.**

For all alternatives, the potential effects were evaluated, as appropriate. A summary assessment of the potential effects of the tentatively selected plan (TSP) are listed in Table 1:

Table 1: Summary of Potential Effects of the Tentatively Selected Plan

	Insignificant effects	Insignificant effects as a result of mitigation*	Resource unaffected by action
Aesthetics	☒	☐	☐
Air quality	☒	☐	☐
Aquatic resources/wetlands	☒	☐	☐
Invasive species	☒	☐	☐
Fish and wildlife habitat	☒	☐	☐
Wildlife and migratory birds	☒	☐	☐
Vegetation and plant communities	☒	☐	☐
Threatened/Endangered species/critical habitat	☐	☐	☒
Historic properties	☐	☐	☒
Other cultural resources	☐	☐	☒
Floodplains	☐	☐	☒
Hazardous, toxic & radioactive waste	☐	☐	☒
Hydrology	☐	☐	☒
Land use	☒	☐	☐
Navigation	☐	☐	☒
Noise levels	☒	☐	☐
Public infrastructure	☐	☐	☒
Socio-economics	☐	☐	☒
Environmental justice	☐	☐	☒
Soils	☒	☐	☐
Tribal trust resources	☐	☐	☒
Water quality	☒	☐	☐
Climate change	☒	☐	☐
Prime and unique farmland	☐	☐	☒
Recreational resources	☒	☐	☐

All practicable and appropriate means to avoid or minimize adverse environmental effects were analyzed and incorporated into the recommended plan. Best management practices (BMPs) as detailed in the Integrated Report (Sections 4.4- 4.10) will be implemented, if appropriate, to minimize impacts and are listed below:

- Clearing of vegetation would occur between September and March, outside the migratory bird nesting season, to avoid direct and indirect effects to any birds that may nest, migrate through, or forage in the general vicinity of the project.
- A qualified biologist would monitor work and provide guidance to avoid or minimize impacts to stands of native vegetation and wildlife, including migratory birds.
- A 165-foot buffer around burrowing owl habitats would be established, with no activity or equipment allowed inside this buffer.
- Sediment and erosion controls would be in place during the construction period. Following construction, the soil would be stabilized, and all disturbed areas would be revegetated with appropriate native species.

- All construction equipment would be cleaned before entering and upon leaving the study area to prevent introduction or spread of invasive species. Equipment that was previously used in a waterway or wetland would be disinfected to prevent spread of aquatic disease organisms.
- Access roads and disturbed soil would be wetted. Stockpiles of debris, soil, sand, or other materials that could produce dust would be wetted or covered. All fill material, rubble, and spoil would be covered while being transported to or from the project site.
- All vehicles would have required emission control equipment.
- All servicing and fueling of equipment would be conducted in a designated area hydrologically isolated from surface waters. Emergency spill kits will be placed in the designated fueling area.
- A Spill Control Plan will be required for this project. All heavy equipment will carry a spill kit, and the operator shall be knowledgeable in the use of spill containment equipment.

No compensatory mitigation is required as part of the recommended plan.

Public and agency review of the draft Integrated Report and FONSI was completed on DATE [to be added]. All comments submitted during the public review period were responded to in the Final Integrated Report and FONSI.

Pursuant to section 7 of the Endangered Species Act of 1973, as amended, the U.S. Army Corps of Engineers determined that the recommended plan will have no effect on federally listed species or their designated critical habitat.

Pursuant to section 106 of the National Historic Preservation Act of 1966, as amended, the U.S. Army Corps of Engineers determined that there would be no historic properties affected by this project. The **Texas State Historic Preservation Officer** concurred with this determination on **22 February 2016** and on **3 November 2017.** The USACE received no expression of any Tribal concerns or objections during consultation.

Pursuant to the Clean Water Act of 1972, as amended, the discharge of dredged or fill material associated with the recommended plan has been found to meet the requirements of Nationwide Permit (NWP) 27 for Aquatic Habitat Restoration, Enhancement, and Establishment Activities, NWP 33 for Temporary Construction, Access, and Dewatering, or NWP 18 for Minor Discharges. Because the proposed action meets the conditions of these NWPs, the 404(b)(l) analyses have already been completed and additional 404(b)(l) analysis is not required. All conditions under the permits would be adhered to during construction. **Clean Water Act compliance is evaluated in Section 4.4.2.2 of the Integrated Report.**

Conditional water quality certification pursuant to section 401 of the Clean Water Act was issued for Nationwide Permits by the Texas Commission on Environmental Quality pursuant to Title 30, Texas Administrative Code, Chapter 279**.** All conditions of the water quality certification and regional conditions for the State of Texas shall be implemented in order to minimize adverse impacts to water quality.

All applicable environmental laws have been considered and coordination with appropriate agencies and officials has been completed. **No other issues were raised relative to other environmental laws and/or Executive Orders.**

Technical, environmental, and cost effectiveness criteria used in the formulation of alternative plans were those specified in the Water Resources Council's 1983 Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. All applicable laws, executive orders, regulations, and local government plans were considered in evaluation of alternatives. Based on this report, the reviews by other Federal, State and local agencies, Tribes, input of the public, and the review by my staff, it is my determination that the recommended plan would not cause significant adverse effects on the quality of the human environment; therefore, preparation of an Environmental Impact Statement is not required.

Date	Patrick M. Stevens V. Lieutenant Colonel, U.S. Army District Commander

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

Table of Contents

List of Figures

List of Tables

Appendices

Appendix A – Current Climate, Climate Trends and Future Climate Conditions: Southern New Mexico and West Texas

Appendix B – Cost Engineering

Appendix C – Fish and Wildlife Coordination Act Report

Appendix D – Cultural Resources

Appendix E – Economics

Appendix F – Real Estate

Appendix G – Clean Water Act Compliance

Appendix H – Monitoring and Adaptive Management Plan

Appendix I – Water Budget

List of Acronyms

ac	acres
AWPF	Advanced Water Purification Facility
bgs	below ground surface
CAA	Clean Air Act
CERM	Center for Environmental Resource Management (of the University of Texas El Paso)
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	Cubic feet per second (referring to stream flow)
CGP	Construction General Permit
CWA	Clean Water Act
DOI	Department of the Interior
EA	Environmental Assessment
EGM	Economic Guidance Memorandum
EO	Executive Order
EPCWID	El Paso County Water Improvement District
EPWU	El Paso Water Utilities
EQ	Environmental Quality
ER	Engineer Regulation (of the U.S. Army Corps of Engineers)
FONSI	Finding of No Significant Impact
GIS	Geospatial Information System
HTRW	Hazardous, toxic, and radioactive waste
IBWC	International Boundary Water Commission
ITA	Indian Trust Asset
LERRDs	Land, Easements, Right of Way, Relocations, and Disposal/Borrow Areas
MBTA	Migratory Bird Treaty Act
MCL	maximum contaminant levels
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NER	National Ecosystem Restoration (objective in planning studies)
NED	National Economic Development (objective in planning studies)
NHPA	National Historic Preservation Act
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places

OSE	Other Social Effects
P&G Studies)	Principles and Guidelines (for Water and Related Land Resources Implementation
PDT	Project development team
PM_{10}, $PM_{2.5}$ diameter	Particulate matter that measures 10 microns or less in diameter, 2.5 microns or less in
RED	Regional Economic Development
SIP	State Implementation Plan
SHPO	State Historic Preservation Office/Officer
TCEQ	Texas Commission on Environmental Quality
TCP	Traditional cultural property
TDS	Total dissolved solids
THC	Texas Historical Commission
THPO	Tribal Historic Preservation Office/Officer
TSP	Tentatively selected plan
TX	Texas
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
U.S.C.	U.S. Code
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
UTEP	University of Texas at El Paso
VOCs	Volatile organic compounds
WRDA	Water Resources Development Act
WWTP	Wastewater treatment plant

(This page is intentionally left blank.)

1 - Project Information

1.1 *Proposed Project

The proposed project is a product of the El Paso Rio Bosque Wetlands Aquatic Habitat Restoration Feasibility Study (Study) and the Environmental Assessment (EA). This Draft Integrated Report summarizes the results of the Study, and the EA is the National Environmental Policy Act (NEPA) document used by decision makers containing the environmental analysis of project impacts for each alternative. The proposed project addresses ecosystem restoration through the construction of new wetlands, modification of existing wetlands, construction of new wet marshes, enhancement of riparian habitat, construction of new grass meadow habitat, and saltcedar removal. A component of the project will address existing recreation at the park through trail improvements, additional signage, and environmental interpretive enhancements, amongst other items. The EA alternatives are variations on how ecosystem restoration and recreation are addressed at the Study area.

1.2 Project Authorization

The Study documented in this Draft Integrated Report is being conducted under the authority of Section 206 of the Water Resources Development Act (WRDA) of 1996 (Public Law 104-303, Section 206; 22 U.S.C. 2330), as amended. This law provides the U.S. Army Corps of Engineers (USACE) with the authority to undertake aquatic ecosystem restoration and protection projects provided that each project: 1) will improve environmental quality; 2) is in the public interest; and 3) is cost effective. The authority requires that a non-federal sponsor initiate each project. The non-federal sponsor for this project is El Paso Water Utilities (EPWU) of the City of El Paso, Texas (TX). The non-federal sponsor is responsible for 35% of the project costs, including Land, Easements, Right of Way, Relocations, and Disposal/Borrow Areas (LERRDs) and planning and construction of the project. The USACE provides 65% of the project costs up to a total federal investment of $10,000,000.

1.3 *Project Area

The Rio Bosque Wetlands Park (Park) is owned by the City of El Paso (City), El Paso County, TX, and is managed by University of Texas at El Paso (UTEP) through its Center for Environmental Resource Management (CERM). The Park is approximately 372 acres and is located in extreme southeast El Paso (Figure 1). Irrigation canals, drains, and a remnant river bend enclose the Park on the east, south, and northern sides. The western boundary of the Park lies adjacent to the Rio Grande, which forms the international border between the United States and Mexico in this area.

The City acquired ownership of the land where the Park is situated in December 1973 from the federal government with the stipulation that the property be used for the development of a park. Over the years, the concept for the Park's development changed from one of an active recreation site to that of a natural area and wildlife refuge with opportunities for educational and passive recreation activities.

In 1995, the International Boundary Water Commission (IBWC) undertook construction of the American Canal Extension, which serves as the primary way irrigation water is passed through the City to downstream irrigators. To mitigate for the loss of wetlands due to this project, IBWC proposed construction of 30 acres of wetlands at the project site. This mitigation commitment stimulated a larger proposal from the Texas Rio Grande Compact Commissioner and Ducks Unlimited that resulted in the creation of three wetland cells and a water delivery channel covering 183 acres of the 372-acre park. However, there was only enough water available at the time to seasonally inundate parts of these wetlands. In 2011, UTEP-CERM reported that “although up to 100 acres are flooded at Rio Bosque in late fall and early winter, the park supports just 1 acre of wetland habitat. During most of the year, including throughout the growing season, the park is almost completely dry” (Sproul 2011).

In 1996, the City entered into a 30-year cooperative agreement with CERM at UTEP whereby the City would retain ownership of the Park, and UTEP-CERM would oversee management and development of the Park. As stipulated in this agreement, management of the Park is to be focused on restoring and enhancing valuable riparian habitat along the Rio Grande in the Chihuahuan Desert while providing public open space and educational opportunities.

Consequently, the overarching goal for management of the Park is to re-create the mosaic of habitats characteristic of the Rio Grande and its floodplain before the Twentieth Century. This is a realistic undertaking in the Park because in arid ecosystems, the transition from obligate wetland species through riparian floodplain species to upland species often occurs within relatively short distances. By restoring native vegetation communities, the proposed project would provide habitat for displaced native animal communities like birds, fish, small mammals, amphibians, and reptiles.

The Park is hydrologically isolated from any connection with the natural Rio Grande floodplain, and from any other upstream drainage basin that might contribute to natural water flows into the Park. The established wetland ponds rely on treated effluent from a nearby water treatment plant during the non-irrigation season (mid-October through mid-February). In most years, the limited water supply has resulted in wetland desiccation during the irrigation season (mid-February through mid-October). Prior to 2015, with the exception of two years (2001-2002), there was an insufficient quantity of water available to be delivered to the wetland cells. Due to newly available, additional water supplies, accompanied by the possibility of lining wetland cells to reduce infiltration, the opportunity now exists to increase the areas that can be flooded and maintain a more diverse mix of healthy wetlands year-round within the Park.

In 2012, the City transferred management and control of the Park to the EPWU. One of the first actions of the EPWU Public Service Board was to approve a resolution to pursue design and construction of a pipeline for conveying either treated effluent or reclaimed water from the Bustamante Wastewater Treatment Plant (WWTP) to enable irrigation during all seasons independent of the availability of the Riverside Drain to convey water to the Park. Construction of the pipeline took place from October 2014 to March 2015, and the first deliveries took place in May 2015. Currently, under a Memorandum of Understanding between EPWU and El Paso County Water Improvement District No. 1 (EPCWID), 2,000 acre-feet can be delivered to the Park using the pipeline between May and September. The pipeline has also replaced the Riverside Drain as the preferred conduit for delivering water from the Bustamante WWTP to the Park during the non-irrigation season.

In 2017, EPCWID No. 1 offered to provide water to the Park by changing the classification of 304.03 acres of the Park land to irrigable land, subject to payment for the change in land classification. The EPWU Public Service Board approved a contract with EPCWID No. 1, paid the reclassification fee, and thereby acquired irrigation water rights to 1,216 acre-feet in a full-allocation year and 608 acre-feet in a 50%-allocation year. In addition, 44.23 acres within the Park were already classified as irrigable, making an additional 177 acre-feet available in a full-allocation year and an additional 88.5 acre-feet in a 50%-allocation year. Thus, in the immediate future, there will be sufficient treated effluent, reclaimed water and irrigation water to sustain year-round wetlands in the Park.

1.4 *Purpose and Need for Action

The Rio Grande in the El Paso region flows through the Chihuahuan Desert, recognized as one of the most biologically diverse ecoregions in the world (Dinerstein et al. 2000; Olson and Dinerstein 2002; Pronatura Noreste et al. 2004). The riparian and wetland habitats found within the Chihuahuan Desert, although they comprise only 1% of the ecoregion (Henrickson and Johnston 1986), contribute greatly to this diversity. Additionally, Chihuahuan Desert riparian and wetland habitats are identified as high priority for conservation and restoration in the Texas Conservation Action Plan (TPWD 2012).

Historical descriptions of the lower Rio Grande in the reach including the El Paso Valley indicate that the floodplain contained varied habitat types, including cottonwood forests, mesquite riparian woodlands, wetlands, wet meadows, and floodplain grass communities (Stotz 2000). High groundwater and/or periodic inundation of the floodplain, processes that create and sustain riparian communities and wet meadows, would have been common throughout much of this reach prior to the installation of the river levee and agricultural drain systems (Fullerton and Batts 2003).

Urbanization and alteration of the surrounding area has had an adverse effect on the Rio Grande riparian corridor in the El Paso Valley. In the 1930s, the IBWC undertook two projects to facilitate delivery of water to Mexico, and to stabilize the river, which serves as the international border: the Rio Grande Canalization Project from below Caballo Dam to El Paso, and the Rio Grande Rectification Project from El Paso to Fort Quitman (illustrated in Figure 2). To accomplish these goals, the river was channelized, confined to a floodway defined by levees, and a program of vegetation removal was initiated. In addition, in the El Paso Valley, the river's path was straightened, reducing the length of its path from about 250 to 138 kilometers (Stotz 2000). The Rectification Project reduced the channel sinuosity from nearly 2 to its current 1.1. (Fullerton and Batts 2003). These authors state that "The hydrologic status of this reach is so dramatically different today than in the period prior to irrigated agriculture that few remnant wetland areas remain" (Fullerton and Batts 2003:100).

Wetlands are an integral component of the Rio Grande ecosystem, not only increasing diversity, but also enhancing the value of surrounding plant communities for wildlife. Wetlands have experienced the greatest historical decline of any Rio Grande floodplain plant community. From 1918 to present, wetland-associated habitats have undergone a 93% reduction (Hink and Ohmart 1984; Scurlock 1998). Among the greatest needs of the Rio Grande riparian ecosystem are the preservation of existing wetlands and expansion or creation of additional wetlands (Crawford et al. 1993). Within the Chihuahuan desert, restoration or creation of wetland habitats is especially important due to their scarcity. However, the constraints of hydrologic alteration, levees, availability of surface water, and greater demands for both surface and groundwater make wetland restoration and creation especially challenging in the urbanized El Paso region. Any opportunity to provide these critical habitats should be taken advantage of.

Rio Bosque Wetlands Park "provides a unique opportunity to the El Paso area. Because past alterations to the Rio Grande resulted in the loss of native vegetation, the Park will become one of the few places in the region with a cottonwood-willow bosque, representative of the river's historic riparian vegetation" (Watts et al. 2002:1).

The overall project goal is to restore a mosaic of habitat types, with an emphasis on wetland habitats, within the El Paso Rio Bosque Wetlands Park; and to provide the diverse habitats that would have been present prior to channelization and modification of the Rio Grande. Because the Park is an educational and recreational resource for the community, providing easily accessible wetlands for public and educational group visitation is also a goal. The proposed project would address the loss and degradation of wetland and riparian habitats in the Chihuahuan Desert reach of the Rio Grande.

1.5 El Paso Rio Bosque Wetlands Aquatic Ecosystem Restoration Study Purpose

The Study is being conducted by the USACE, Albuquerque District, and EPWU. The purpose of this Study is to identify a federal interest in the implementation of a project at the Rio Bosque Wetlands Park, a wetland and riparian habitat area adjacent to the Rio Grande in southwest El Paso (Figure 3). This Study identifies aquatic and riparian ecosystem restoration and possibly incidental, passive recreation alternatives that are technically feasible, economically practicable, sound with respect to environmental considerations, and publicly acceptable. The non-federal sponsor, the EPWU, supports the proposed project purpose to provide ecosystem restoration and incidental, passive recreation.

This Integrated Report is intended to be a complete decision document that presents the results of the existing conditions and recommended alternatives resulting from the feasibility study effort. This Integrated Report describes the existing condition in the study area and the projected future conditions with and without the project (known as the "future with-project" and "future without-project" conditions). Conditions that exist at the time of the Study are collectively called the existing condition. The future without-project condition is the same as the No-Action alternative and describes what is expected to happen in the absence of federal action. The future with-project condition describes what is expected to happen after the completion of the proposed federal action. The significant natural, economic, and social resources described in the existing and future with- and without-project conditions are compared. Specifically, this Integrated Report:

- Provides a complete presentation of study results and findings, so that readers may reach independent conclusions regarding the reasonableness of future recommendations;
- Assures compliance with applicable statutes, Executive Orders, and policies, in accordance with budgetary priorities; and
- Provides a sound and documented basis for the evaluation and justification of the future, recommended solution(s).

Figure 1. Map showing the El Paso Rio Bosque Wetlands study area.

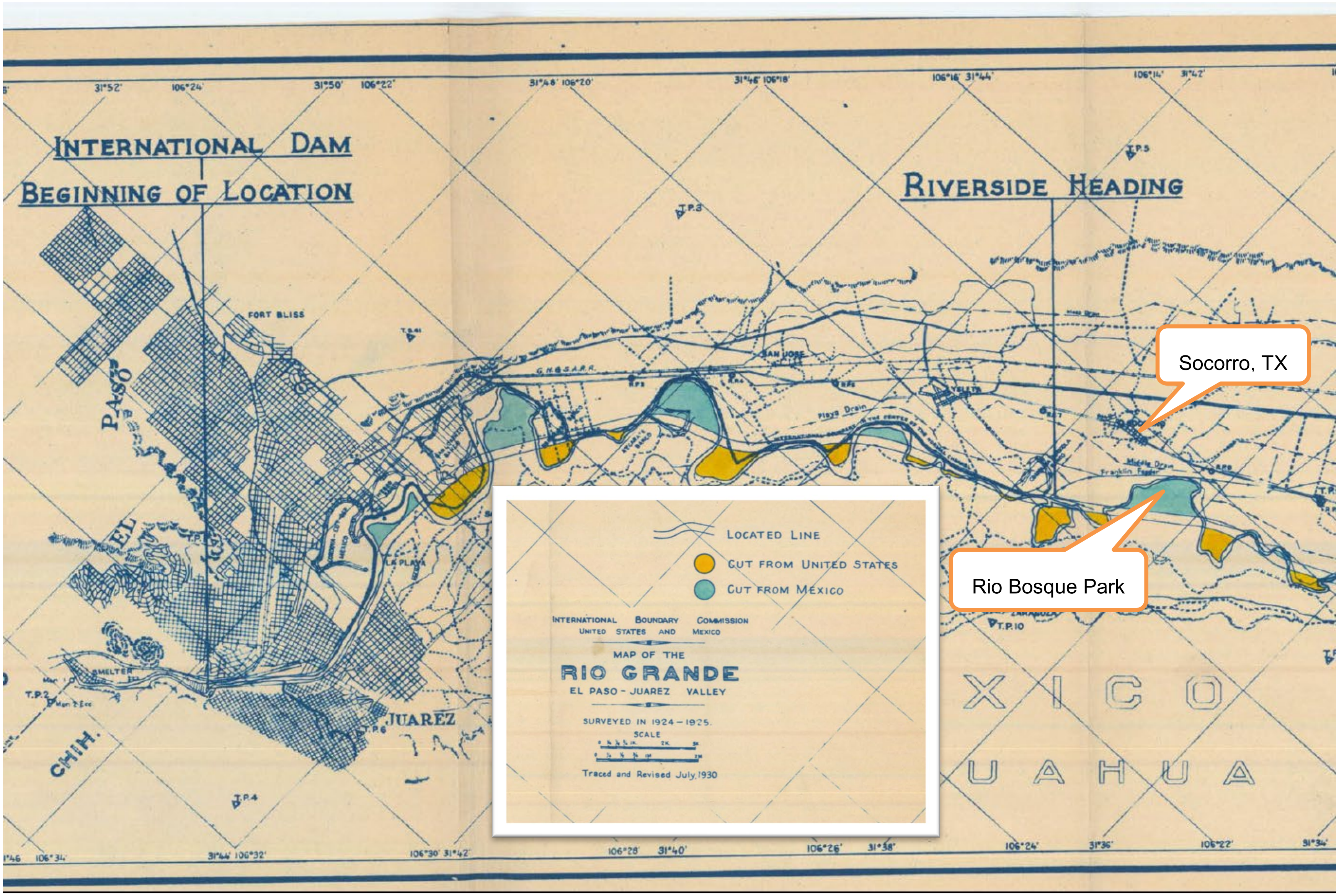

Figure 2. Partial map of the Rio Grande Rectification Project with current location of Rio Bosque Park.

1.6 Integrated Report

This report is an integrated USACE planning document, incorporating a Feasibility Report and an Environmental Assessment (EA) as required by the National Environmental Policy Act (NEPA). The report describes the planning process and the analyses used to identify the tentatively selected plan (TSP). This Integrated Report: (1) describes the existing conditions of the Rio Bosque Park; (2) evaluates a range of alternatives to restore ecosystem function; (3) describes measures to implement ecosystem restoration; (4) identifies a TSP for implementation; (5) describes coordination, consultation, and public involvement for the study; and (6) describes the status of compliance with federal and state laws, Executive Orders, and other requirements.

1.7 Federal Interest

A feasibility cost sharing agreement between El Paso Water Utilities (Sponsor) and USACE was signed on 17 January 2014 initiating the studies and analyses for the Integrated Report. This Integrated Report presents the results of these studies.

The purpose of Civil Works ecosystem restoration activities is to restore significant ecosystem function, structure, and dynamic processes that have been degraded. The intent of the proposed project is to reestablish the attributes of a natural, functional, and self-regulating ecosystem in an area that was previously an active part of the Rio Grande floodplain. In 2013, a preliminary analysis conducted by USACE determined that there is a federal interest in implementing an aquatic ecosystem restoration project and that project alternatives would restore a significant environmental resource, fall within established USACE expertise, and would involve cost-effective solutions.

1.8 Non-Federal Sponsor

The non-federal Sponsor is El Paso Water Utilities (EPWU) of El Paso, Texas.

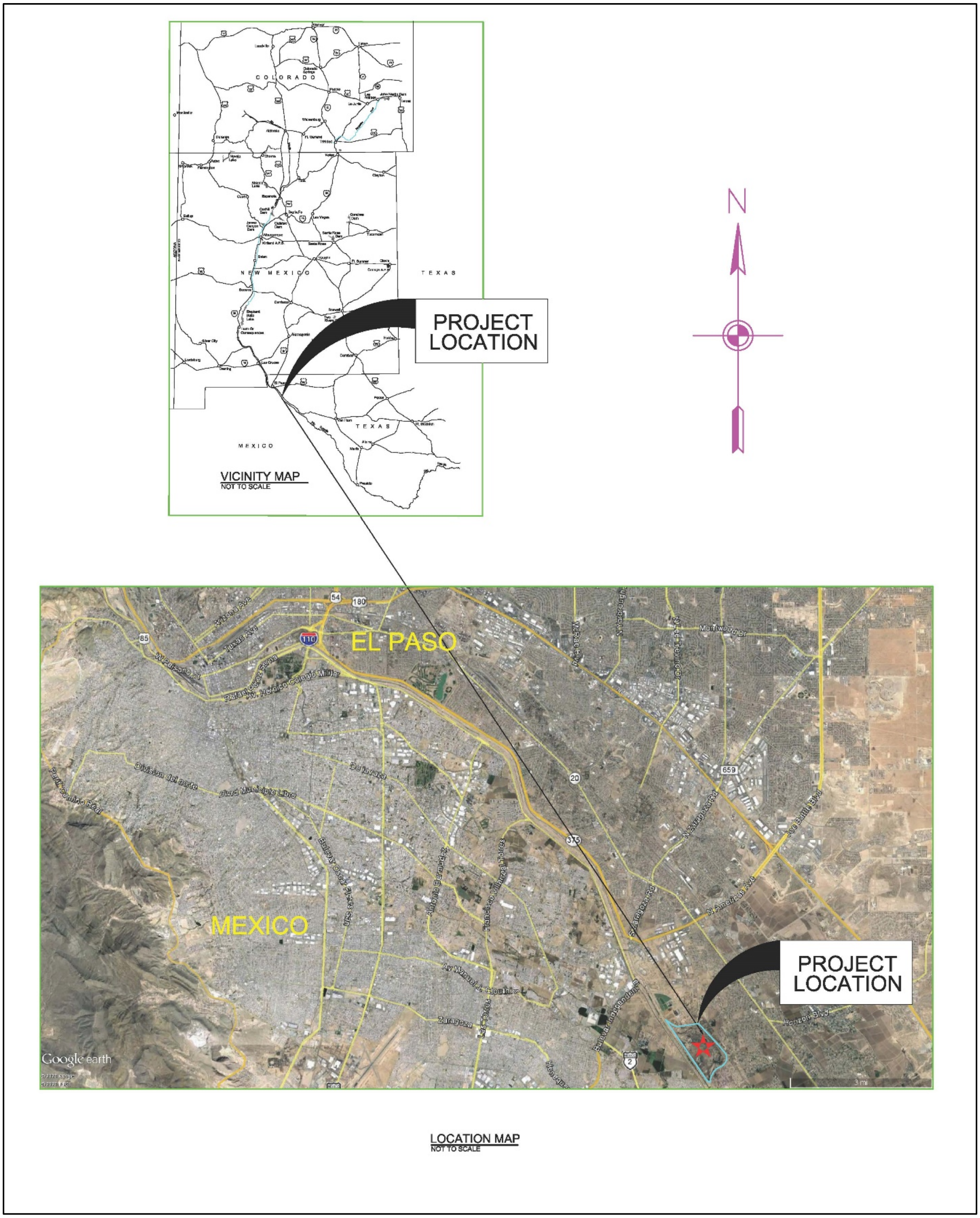

Figure 3. Project location.

1.9 Public and Agency Scoping

Scoping letters were mailed on February 20, 2015; March 15, 2015; and April 13, 2015, to appropriate federal, state, and local government agencies, as well as other entities who may have a potential interest in or who have expressed an interest in the proposed project. Coordination and consultation communications have taken place between USACE and the Friends of the Rio Bosque, Audubon Society of New Mexico, US Fish and Wildlife Service, US Bureau of Reclamation, US International Boundary Water Commission, Texas Parks and Wildlife Department, El Paso City Parks and Recreation, University of Texas El Paso CERM, Ysleta del Sur Pueblo, US Environmental Protection Agency, Texas Commission on Environmental Quality, US Army Corps of Engineers Las Cruces Regulatory Office, City of El Paso Public Works Department, Texas State Soil and Water Conservation Board, and the USDA Natural Resource Conservation Service. The US Bureau of Reclamation and US IBWC agreed to be cooperating agencies in the Project. Coordination and consultation occurred through meetings, site visits, presentations, and written and verbal correspondence.

1.10 Planning Process and Report Organization

1.10.1 Planning Process

The USACE plan formulation process was used to identify and develop an array of alternative solutions to ecosystem restoration at the Park, and to evaluate these alternatives in terms of efficiency, completeness, effectiveness, and acceptability, and their ability to meet project objectives. Through this process, described in greater detail in Chapter 4 of this report, alternatives are developed, screened, and evaluated to identify one alternative recommended for implementation.

The Integrated Report was prepared in accordance with the applicable Engineering Regulations (ER), including, but not limited to:

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

ER 1105-2-100, *Planning Guidance Notebook*, dated 22 April 2000, as amended, outlines the planning process used by the project delivery team (PDT) in this feasibility study. The project begins by listening to local concerns and identifying opportunities for USACE to assist the project Sponsor in addressing these concerns. This "problems and opportunities" step identifies those local problems that fall within USACE authorities for action, and the opportunity to fix these problems becomes the project purpose.

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

The next step in the process is the plan formulation step, presented in Chapter 3 - Plan Formulation and Evaluation. During plan formulation, management measures are identified that address all or part of the problem(s) being addressed. The goal of this step is to cast as wide a net as possible, so that potentially valuable solutions are not subsequently overlooked. The comprehensive list of alternatives is then screened using technical, economic, and environmental considerations and other criteria. Measures or alternatives found to be infeasible are removed from further consideration, and no further analysis is done with these alternatives.

The alternatives are also evaluated on the basis of economics. The economic analysis identifies the alternative that maximizes net ecosystem restoration benefits. This plan will be the National Ecosystem Restoration (NER) plan, provided that it has no significant detrimental environmental impacts relative to other alternatives.

After completing these screening steps, the remaining alternatives are then compared to each other, and to a future in which no action is taken (the No-Action Alternative). These remaining alternatives are evaluated using the criteria above to determine their ability to accomplish the project objectives. As part of this evaluation, potential impacts of each alternative on the natural environment, threatened and endangered species, cultural resources, local socioeconomic conditions, and other factors are identified. This information is presented in Chapter 4 - Foreseeable Effects of the Proposed Alternative.

The planning team then selects the plan that best meets all of the planning criteria. This tentatively selected plan (TSP) is then described in greater detail and subjected to a more detailed cost estimate.

The remaining chapters of the report summarize other aspects of the study, such as coordination and staffing. Once the report has gone through levels of review and received approval from USACE, South Pacific Division, the TSP becomes the recommended plan. The final product of this feasibility study is an integrated report that will serve as the basis for obtaining funding to implement the recommended plan. This report is the Draft Integrated Report.

1.10.2 *Public Concerns

A number of public concerns have been identified. Initial concerns were expressed in the study authorization, and additional input was received through coordination with the sponsor, EPWU, and some initial coordination with other agencies. This section describes concerns and needs expressed by the public and the sponsor in the context of problems, needs, and opportunities that can be addressed through water and related land resource management.

Problems, needs, and opportunities include:

- From 1918 to present, wetland-associated habitats have undergone a 93% reduction along the Rio Grande floodplain. Past alterations to the Rio Grande removed the hydrologic processes that create and sustain wetland and riparian communities, resulting in loss of native riparian vegetation and habitats.
    - An opportunity exists to restore native riparian habitats for breeding and migratory birds.
- Limited water during the irrigation season (mid-February to mid-October) and losses to seepage results in wetland drying.
    - An opportunity exists to identify and allocate water to the wetlands during the irrigation (growing) season.
    - An opportunity exists to deepen and seal the wetlands to create a permanently wetted refuge area for aquatic species.
- Encroachment of emergent vegetation in consistently wetted areas of the wetlands is causing a loss of open water areas.

  - An opportunity exists to deepen the wetlands to provide an open water area for waterfowl
  - An opportunity exists to increase the size of the wetland habitat.
- Invasion by non-native plants has created monotypic stands of non-native vegetation that precludes native vegetation establishment.
  - An opportunity exists to increase the diversity of native riparian and wetland plants.
  - An opportunity exists to reduce the abundance and extent of non-native invasive plant species.
- Low diversity of wetland plants results in lower quality wetland habitat and reduces wildlife diversity.
  - An opportunity exists to increase native plant diversity.
  - An opportunity exists to increase native wildlife diversity.
- Wetland vegetation growth is reduced due to the accumulation of sediment and plant detritus.
  - An opportunity exists to remove existing sediment and plant detritus buildup within wetland features.
  - An opportunity exists to plant wetland vegetation.
- The recently completed lining of the Riverside Canal is expected to reduce seepage into the wetland, which currently helps maintain the near-surface water table in the study areas.
  - An opportunity exists to formulate alternatives to move water into the Park to replace groundwater lost due to channel lining.
- Lack of defined recreational areas results in intrusive use (e.g., ATVs, voluntary trails).
  - An opportunity exists to focus recreation activities into defined areas.
  - An opportunity exists to improve the recreational features of the Park.
- Southeast El Paso lacks opportunities for outdoor and nature-based education.
  - An opportunity exists to increase natural resource education.

1.10.3 Planning Objectives and Constraints

Planning objectives and constraints provide a framework for the development of alternative plans. Planning objectives are statements about what a plan is attempting to achieve. Planning objectives communicate to others the intended purpose of the planning process. Constraints are limitations imposed on the scope of the study from physical, political, or social considerations. For instance, this restoration project hinges on the amount of water that flows through the study area, and yet, additional water cannot be provided because water is allocated per the Rio Grande Water Compact and EPCWID No.1 water delivery requirements. This study must focus on the effective use of water as it flows through the study area without impacting the delivery requirements downstream. Project specific objectives and constraints are listed in Section 1.10.3.

One purpose of this feasibility study is to determine if ecosystem restoration with incidental recreation is consistent with the federal objectives stated below.

1.10.3.1 Federal Objectives

As planning objectives for this investigation, it is in the Federal interest to:

- Contribute to the National Ecosystem Restoration (NER) objective through restoration, with contributions measured by changes in the amounts and values of habitat. Numerous Federal laws and executive orders exist that have established the National policy for, and Federal interest in, the protection, restoration, conservation, and management of environmental resources. The focus of NER projects is "the restoration of ecosystems and ecological resources and not restoration of cultural and historic resources, aesthetic resource or cleanup of hazardous and toxic wastes" (ER 1105-2-100, Appendix E). Ecosystem restoration projects implemented by USACE might not be capable of addressing every undesirable condition associated with an ecosystem, but rather, should focus on restoration of "degraded significant ecosystem structure, function and dynamic processes to a less degraded, more natural condition" (ER 1105-2-100, Appendix E).

- Contribute to the Regional Economic Development (RED) account to illustrate the effects that the proposed plans would have on regional economic activity, specifically regional income and regional employment.
- Contribute to the Environmental Quality (EQ) account to display the long-term effects the alternative plans could have on significant environmental resources.
- Contribute to the Other Social Effects (OSE) account, which includes long-term impacts to public facilities, health and safety, recreation, and community values.

For this study, alternatives are evaluated for identification of the NER plan, which addresses the EQ account. USACE and the Sponsor conducted a preliminary screening of measures to evaluate the applicability of each measure and the potential for each measure to contribute to the planning objectives consistent with planning constraints. All alternatives were evaluated based on their performance over a 50-year period of analysis.

1.10.3.2 Principles and Guidelines (P&G) criteria are applied to plans as part of plan formulation. The criteria are as follow:

- Completeness: The extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects. This may require relating the plan to other types of public or private plans if the other plans are crucial to realization of the contributions to the objective.
- Effectiveness: The extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities.
- Efficiency: The extent to which an alternative plan is the most cost-effective means of alleviating the specified problems and realizing the specified opportunities, consistent with protecting the Nation's environment.
- Acceptability: The workability and viability of the alternative plan with respect to acceptance by State and local entities and the public and compatibility with existing laws, regulations, and public policies.

1.10.3.3Objectives Performance Criteria

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 benefits?
- **Acceptability** – Is the plan acceptable and compatible with laws and policies?

Specific planning objectives that address identified problems are discussed in Section 1.10.3.4 with more detailed discussion of how those objectives will be met and how success can be determined. The study measures and alternatives were developed to contribute to study objectives and can be evaluated using the following criteria.

1.10.3.4 Specific Planning Objectives

The national objectives of National Economic Development (NED) and NER are general standards and not sufficiently specific for direct use in plan formulation. The water and related land resource problems and opportunities identified in this study are stated as specific planning objectives to provide focus for the formulation of alternatives. These planning objectives reflect the problems and opportunities and represent desired positive changes from the without-project conditions.

Ecosystem restoration projects require that the planning team develop objectives and constraints that apply to a systems approach and take into consideration “aquatic wetland and terrestrial complexes, as appropriate, in order to improve the potential for long-term survival as self-regulating, functioning systems” (ER 1105-2-100, Appendix E). Objectives and constraints must be specific to the ecosystem as well as realistic and attainable in order for the planning process to succeed.

Clear statements of specific planning objectives and constraints act as basic building blocks for developing alternative management measures and plans to alleviate stated problems and achieve opportunities. Through coordination with local and regional agencies, the public involvement process, site assessments, interpretation of prior studies and reports, and review of existing water projects, specific planning objectives were identified for this feasibility effort. The water and related land resource problems and opportunities identified in this study are stated as specific planning objectives to provide focus for the formulation of alternatives. Working from the problems and opportunities identified above (Section 1.10.2), the planning objectives for this feasibility study were developed and include:

- Within 5 years of construction, re-create the mosaic of habitats characteristic of the historic Rio Grande floodplain with an emphasis on wetlands of varying sizes, water regimes, and connectivity, and designed to endure.
- To increase the quantity and diversity of native wetland, riparian, and floodplain grassland habitats along with their associated native wildlife in the study area within 5 years of construction. Upon completion of the project, the study area should be comprised of approximately 25% wetlands, 15% cottonwood-willow riparian habitat, and 5% floodplain grassland.
- To increase the availability of passive recreational and educational opportunities at Rio Bosque upon completion of construction and continuing for at least the next 50 years.

1.10.3.5 Planning Constraints

Unlike planning objectives that represent desired positive changes, planning constraints represent restrictions that should not be violated. The planning constraints identified in the reconnaissance study and considered in this feasibility study are as follow:

- Water Ownership, Allocations, and Downstream Deliveries – Water laws in Texas and along the Rio Grande and its tributaries are many and complicated. Watershed management measures, such as those for restoration purposes, which require water to function, should be formulated to utilize water available in the study area and must not impair existing water rights.

- In addition, the Treaty of Guadalupe Hidalgo recognizes existing water rights on lands acquired from Mexico. The Mexican Water Treaty of 1906 requires the United States to deliver 60,000 acre-feet of Rio Grande water to Mexico each year.

- The existing design level of any current flood risk management structures must be maintained. The addition of vegetation must not compromise the level of flood risk management on the Rio Grande or its tributaries.

1.10.4 Formulation and Evaluation of Alternative Plans

(a) Planning Process

This section presents the rationale used in the development of this plan. The USACE six-step planning process specified in ER 1105-2-100 (Planning Guidance Notebook) is used to develop, evaluate, and compare the array of candidate plans that are considered. The plan formulation process includes the following steps, which are more fully described in Chapter 3 :

1. Identify problems and opportunities.
2. Inventory and forecast resources.
3. Formulate alternative plans.
4. Evaluate alternative plans.
5. Compare alternative plans
6. Select TSP.

(b) Development of Alternative Plans

Preliminary alternative plans were formulated in consideration of current federal, state, and local planning and environmental guidance, laws, and policy concerning aquatic ecosystem restoration. The alternative formulation process should:

- Comply with NEPA and other environmental laws and regulations;
- Produce ecosystem restoration benefits while positively contributing to national and regional economic development and other social effects; and
- Provide decision-makers with information that can be utilized to help determine the balance between construction costs, real estate costs, and social issues and concerns.

These preliminary alternatives require further analysis to determine whether they address the specified problems, opportunities, and planning objectives while avoiding constraints. As such, the alternatives as described in this feasibility report are not proposals for actual construction, nor are they of sufficient design detail to be constructed. Following the completion of the feasibility report, EA, public feedback, and project approval, if such action occurs, detailed design analysis and preparation of plans and specifications for construction would take place.

1.10.5 Prior Projects and Reports

1.10.5.1Prior Projects

The IBWC, following plans developed by Ducks Unlimited, completed construction of the wetlands and water delivery system by the end of 1997. Beginning in 1998, University of Texas, El Paso (UTEP) began restoration efforts including both native species establishment and control of exotic species. Those efforts continue today. Initial efforts concentrated along the historic river channel included planting Rio Grande cottonwood (*Populus deltoides var. wislizeni*), coyote willow (*Salix exigua*), Goodding's willow (*Salix gooddingii*), and Western honey mesquite trees (*Prosopis glandulosa var. torreyana*). Additionally, horsetail or scouring rush (*Equisetum hyemale*) and plots of native grasses were also planted, with mixed success. In subsequent years, other species planted have included sand pricklypear (*Opuntia arenaria*), fourwing saltbush (*Atriplex canescens*), seepwillow (*Baccharis salicifolia*), and Torrey wolfberry (*Lycium torreyi*). In most years, due to lack of water during the growing season, plantings were supported by water trucked to the site from the WWTP, a practice that was reduced only in recent years as growing-season water became available to the site. In 1999, UTEP established 28 permanent photographic stations to help document changes in the Park's plant communities. A recent Park newsletter shows an example of repeat photos: https://www.utep.edu/cerm/rio-bosque/newsletter/rb-news-18-01.pdf

UTEP's ongoing restoration efforts have included efforts to remove invasive species from the Park, including saltcedar (*Tamarix ramosissima*), Russian thistle (*Salsola tragus*) perennial pepperweed (*Lepidium latifiolium*), kochia or summer cypress (*Bassia scoparia*), tree tobacco (*Nicotiana glauca*), puncturevine (*Tribulus terrestris*), and Johnsongrass (*Sorghum halepense*).

In 2009, a water supply well (RB-13) was established at the northwest corner of the Park by UTEP under a North American Wetlands Conservation Act (NAWCA) Small Grant. In 2013, EPWU installed a second well (RB-12B) in the southeastern part of the Park, near the Park's visitor center. These two wells enabled watering of areas that were previously dry during the irrigation season, with the objective of being able to intermittently flood the 2-mile-long segment of historic river channel that serves as the Park's main water delivery channel as well as portions of the Park's wetland cells.

Also in 2013, EPCWID No. 1 installed a turnout on the Riverside Canal, and the IBWC completed a connecting channel from the turnout to the historic river channel within the Park, facilities necessary for deliveries of irrigation water to the Park. The Partners for Fish and Wildlife Program of the U.S. Fish and Wildlife Service funded this project.

In March 2013, the EPWU Public Service Board approved a resolution to pursue design and construction of a pipeline for conveying either treated effluent or reclaimed water from the Bustamante WWTP to enable irrigation during all seasons independent of the availability of the Riverside Drain to convey water to the Park. This pipeline was completed in March 2015.

1.10.5.2Prior Reports

Reports provided by the Sponsor and used to prepare this document include:

- City of El Paso. 2008. Ordinance 016832, An Ordinance Authorize the City of El Paso to Enter into a License Agreement with the University of Texas at El Paso for the Development and Maintenance of Rio Bosque Park; Superseding Ordinances 12982 and 014251; and Canceling the License Agreement Approved by Ordinance #12982. Dated 22 January 2008.
- El Paso City Council and El Paso Water Utilities Public Service Board. 2012. Joint Resolution Between the El Paso City Council and the El Paso Water Utilities Public Service Board on the Transfer of the Rio Bosque Park from the City to the Management and Control of the Public Service Board and the Assignment of the License Agreement Between the City and the University of Texas at El Paso from the City to the El Paso Water Utilities-Public Service Board, dated 27 November 2012.
- Watts, S.H., J. Sproul and E. Hamlyn. 2002. A Biological Management Plan for Rio Bosque Wetlands Park. Report prepared for the City of El Paso and University of Texas at El Paso.

1.11 *Regulatory Compliance

This Draft Integrated Report was prepared by the U.S. Army Corps of Engineers, Albuquerque District, and is in compliance with all applicable federal statutes, regulations, and Executive Orders, as amended, including, but not limited to, the following:

- Archaeological Resources Protection Act (16 U.S.C. 470aa *et seq.*)
- Clean Air Act (42 U.S.C. 7401 *et seq.*)

- Clean Water Act (33 U.S.C 1251 *et seq.*)
- Endangered Species Act (16 U.S.C. 1531 *et seq.*)
- Energy Independence and Security Act of 2007 (P.L. 110-140, Section 438; 121 Stat. 1492, 1620)
- Farmland Protection Policy Act (7 U.S.C. 4201 *et seq.*)
- Federal Noxious Weed Act (7 U.S.C. 2814)
- Fish and Wildlife Coordination Act (48 Stat. 401; 16 USC 661 *et. seq.*)
- Migratory Bird Treaty Act (16 U.S.C. 703, *et seq.*)
- National Environmental Policy Act (42 U.S.C 4321 *et seq.*)
- National Historic Preservation Act (54 U.S.C. 300101 *et seq.*)
- Native American Graves Protection and Repatriation Act (25 U.S.C. 3001 *et seq.*)
- Occupational Safety and Health Act of 1970 (29 U.S.C. 651 *et seq.*)
- CEQ Regulations for Implementing the Procedural Provisions of NEPA (40 CFR Part 1500 *et seq.*)
- U.S. Army Corps of Engineers' Procedures for Implementing NEPA (33 CFR Part 230; ER 200-2-2)
- Protection and Enhancement of the Cultural Environment (Executive Order 11593)
- Floodplain Management (Executive Order 11988)
- Protection of Wetlands (Executive Order 11990)
- Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (Executive Order 12898)
- Invasive Species (Executive Order 13112)
- Responsibilities of Federal Agencies to Protect Migratory Birds (Executive Order 13186)
- Safeguarding the Nation from the Impacts of Invasive Species (Executive Order 13751)

This Draft Integrated Report also reflects compliance with all applicable tribal, State of Texas, and local regulations, statutes, policies, and standards for conserving the environment and environmental resources, such as water and air quality, endangered plants and animals, and cultural resources.

2 - *Existing and Expected Future Without-Project Conditions

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

2.1 Climate and Climate Change

2.1.1 Existing Conditions

El Paso can be classified as arid, with average annual precipitation totaling 9.43 in. Daily high temperatures in January average 57.2°F (50-63.4°F), with minimum overnight temperatures averaging close to freezing (29.1-39°F). Average January precipitation is 0.45 in (0-1.34 inches). By contrast, daytime highs in July typically average 94.5°F (88.8-101.4°F) with overnight minimums averaging 72°F (68.7-76.5°F). Average July precipitation is 1.49 in (0.04-3.96 inches).

At 31.8° N latitude, El Paso lies south of the winter mid-latitude storm track, resulting in a pronounced dry season from November through May (Nielsen-Gammon 2011). From late June through early October, El Paso falls within the North American Monsoon region. The wet summer season is characterized by high daytime temperatures, advection of warm, humid air primarily from the Gulf of Mexico, and the formation of thunderstorms as this humid air rises over sun-baked land surfaces, nearby mountain ranges, and advancing fronts.

Monthly pan evaporation rates exceed precipitation by an order of magnitude. Annual pan evaporation at nearby Las Cruces, NM averages 92.91 in (Western Regional Climate Center n.d.). Pan evaporation rates are lowest in January at 3.0 inches and greatest in June at 12.91 inches and July at 12.05 inches. In El Paso in 1997, open pan evaporation totaled 98.11 inches, with January at 4.6 inches and July at 13.12 inches (Reclamation 2008).In the Rio Grande Basin below El Paso, TX, December-February average temperatures have increased approximately 4°F since 1960, particularly since about 1980 (Nielsen-Gammon 2011). A longer term trend is evident in Far West Texas (El Paso area), with larger negative temperature departures from the mean (comparatively more cool) early in the century and larger positive departures from the mean (comparatively more warm) towards century's end. Spring (March-April) and fall (October-November) average temperatures have shown no particular trend, indicating no significant change in the length of the growing season in this region (Nielsen-Gammon 2011). As in winter, temperatures in Far West Texas have a tendency to show a more definite trend than elsewhere in Texas, being relatively cooler early in the twentieth century and warmer towards the end. Summer (May-September) temperature trends are comparable to those of winter, with a definite warming trend evident beginning after 1970 (Nielsen-Gammon 2011). At a century-scale, Far West Texas is warming faster than any other region of Texas with temperatures increasing at 1.1 to 2.2°F per century (Nielsen-Gammon 2011 ; Vose et al. 2017). Because the study area is watered only through irrigation return flows and WWTP outflows, flows could not be analyzed using the USACE Climate Hydrology Assessment and Nonstationarity Tools as required by ECB 2018-14, *Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects*.

2.1.2 Future Without-Project Conditions

Climate change is anticipated to impact the study area primarily through temperature increases, which are projected to rise by 4- 8.0°F by 2100, with extreme temperatures as much as 11°F higher (Vose et al. 2017). Temperature increases are likely to drive evaporation increases. Precipitation is anticipated to decline by up to 10% in all seasons (Easterling et al. 2017).

The USACE Vulnerability Assessment Tool identifies loss of freshwater plant species as the major ecosystem risk in the Southwest. This project is designed to mitigate such losses.

The impacts to the study area of these changes are likely to be changes in water availability due to significant reductions in storage at Elephant Butte resulting in reduced water availability in El Paso; lower water tables as groundwater is increasingly used to replace lost surface water supplies; and increased water demand due to evaporative losses in wetland areas. Many western municipalities are currently exploring options for storm water runoff capture. Implementation of such reforms may affect water supply quantity and quality in the El Paso area. Broader scale impacts to plant community composition (drought and thermal tolerance), migratory bird species composition (changes in migration routes, species drought and heat tolerances, food availability, and migration routes), insects and other species are likely but not quantifiable at present.

2.2 Water Delivery System

2.2.1 Water Sources

Currently, there are three sources of water available to the Rio Bosque Wetlands Park: irrigation water, reclaimed wastewater, and groundwater. Irrigation water provided by EPCWID No. 1 is a new source that became available in 2017 when 304.03 acres of Park land was reclassified as irrigable, bringing the total acreage of irrigable land within the Park to 348.26 acres. The full allocation that the Park may receive during the irrigation season (mid-February through mid-October) is 4 acre-feet per acre or 1,393 acre-feet (453,911,040 gallons); the 50% allocation of 696.5 acre-feet is 226,955,520 gallons. In order to receive allocations of irrigation water, back fees have recently been paid equivalent to the amount that would have been charged had this land originally been classified as irrigable. The amount of water available to EPCWID No. 1 for irrigation varies from year to year, depending on volumes in storage in Elephant Butte Reservoir. In recent years, irrigators have often received 50% or less of their allocation, including just 6.1% in 2013. In the future, the combination of treated wastewater from the WWTP and irrigation water will enable the Park to maintain water in the wetlands during the growing season, when the wetlands previously have dried up, but the amounts available will vary from year to year.

The largest water source by flow rate, when available, is reclaimed wastewater at 2 million gallons per day (minimum guaranteed flow) or 730,000,000 gallons if provided year-round. Reclaimed wastewater is provided to the Park by the Bustamante WWTP, which is operated by EPWU. The plant, located immediately north of the Park, originally delivered water to the Park through underground conduits and open earth-lined canals. In 2014-15, a new, buried, 36-inch pipeline was constructed to convey water from the existing 48-inch WWTP west discharge line. Prior to completion of the pipeline, water deliveries from the WWTP were not consistent during the growing season in most past years. According to the managers of the Park, from the first water deliveries in 1998 through 2014, treated wastewater was not consistently available to the Park during the irrigation (growing) season (mid-February through mid-October). With the exception of years 2001 and 2002 and a few limited exceptions in other years, water was delivered to Rio Bosque only in late fall and early winter (the non-irrigation season, mid-October through mid-February).

The other main sources of water for the Park are two wells located within its boundary on opposite corners of the Park. The wells, designated RB-12B and RB-13, are each outfitted with submersible electric pumps and produce approximately 400 gallons per minute (gpm). The wells are operated throughout most of the year with only weekly or biweekly overnight rest periods, except during the portion of the non-irrigation season when water from the WWTP is delivered to the Park. Prior to completion of the new pipeline, groundwater was often the only source of water to the Park during the growing season.

An additional, very small quantity of water is provided from two windmills located adjacent to each of the main wetland cells in the Park. With a good wind, the windmills each produce less than 5 gpm. Because the windmills produce little water, they are excluded from the water budget and water quality analyses.

2.2.2 Water Delivery System

Prior to completion of the new pipeline, deliveries of reclaimed wastewater from EPWU's Bustamante WWTP to the Park were by underground pipe then open, earth-lined channel (Figure 4). Two large underground conduits discharge reclaimed water from the WWTP into the adjacent open-channel conduit system. One WWTP discharge pipe flows to the east and the other to the west. The pipe flowing east discharges into the Riverside Canal while the pipe flowing west discharges in the Riverside Drain. Both the Riverside Canal and the Riverside Drain flow from north to south. The Riverside Canal is on the east border of the Park while the Riverside Drain is on the west border. Both conveyances, where adjacent to the Park, are trapezoidal, earth-lined, open channels. The channels are owned and operated by EPCWID No. 1, which manages the delivery of reclaimed water through both channels.

A turnout with canal gate can provide flow from each canal into the Park. Operation of the gates and diversion of water into the Park is controlled by EPCWID No. 1. Prior to completion of the new pipeline, deliveries of water from the WWTP to the Park were by diversion from the Riverside Drain. Today, those deliveries are made via the new pipeline, though the option of using the Riverside Drain remains available. Irrigation water right deliveries are via the Riverside Canal turnout. Water from the Bustamante WWTP is delivered to the Park through cooperation between EPWU and EPCWID No. 1. The quantities, durations of flow, and times of year of discharge are determined by EPWU and EPCWID No. 1.

Within the Park, water is distributed through a series of open earth-lined channels controlled by canal gates. The main channel within the Park, following a circuitous route across the park from north to south, where it discharges to the Riverside Drain, is the recreated old river channel. Two additional channels convey flow from the old river channel to the two main wetland cells in the Park. A third channel carries water by gravity flow from the south wetland cell to a point where it is discharged to the Riverside Drain along with any flow from the south end of the old river channel. Currently, there is a series of seven canal gates that control the diversion of water within the Park. Depending on the quantity and source of the water, it does not always reach a wetland cell before seeping completely into the unlined channel bottom.

Both Wells RB-12B and RB-13 (Figure 4) discharge directly into the old Rio Grande River channel at different points. Well RB-13 discharges near its northern upstream end while Well RB-12B discharges into the channel approximately two thirds down its length where the channel turns to the west and flows along the south end of the Park. The 400 gpm flow produced by each well and discharged into the channel is not large enough for the flow to reach a wetland cell before seeping completely into the channel bottom.

A system for delivery of the Bustamante WWTP reclaimed water to the Park was constructed in 2014-15. The system consists of a new, buried, 36-inch pipeline connected to the existing, buried, 48-inch WWTP west discharge line. The existing 48-inch line conveys reclaimed water from the plant to the Riverside Drain. The new system diverts flow from the 48-inch WWTP discharge line directly to the Rio Bosque without the need to use and divert flow from the drain for making water deliveries. The new pipeline, located on the west side of the Park, provides a more direct and efficient means of delivering reclaimed water from the WWTP to the adjacent Park. The new pipeline system includes associated control valves and three alfalfa valves with risers for discharging water out of the system. One alfalfa valve is provided to discharge flow into the north, upstream end of the old river channel, and one valve each is provided to discharge flow into the two main wetland cells.

2.3 Hydrology and Hydraulics

2.3.1 Background and Setting

2.3.1.1 Hydrology

The Park is located in the former floodplain of the Rio Grande between the Rio Grande and the Riverside Canal. Within the Park is an old meander of the Rio Grande that is approximately two miles long. The levee on the left bank of the Rio Grande has cut off the wetland area from the natural floodplain of the Rio Grande. The Riverside Canal on the northeast side of the wetland cuts off any other upstream drainage basin from contributing to natural flood flows into the wetland. The wetland has lost any connection to the natural floodplain and has no opportunity to benefit from any Rio Grande flooding or upland runoff; native water input is limited to only onsite rainfall. This infrastructure would not change in the foreseeable future; in the future with or without the proposed project, there would be no floodplains within the proposed project site. Because of the limited rainfall/runoff onsite, inflow of water into the wetland cells is provided by various other sources as discussed above.

2.3.1.2 Existing Infrastructure

Water delivery to the existing wetland cells is controlled by relatively simple water control structures typical of those used in irrigation and farm pond systems. Prior to completion of the new pipeline, the main source of water was delivered from the WWTP through the Riverside Drain. Today, water from the WWTP is delivered via the pipeline. There are seven gates used to deliver water to the wetland cells (Figure 4).

Prior to completion of the pipeline, Gate #1 was used to divert water from the Riverside Drain. Gate #1 is operated by closing a 47” wide slide gate using a hand-wheel crank and backing the water to flow through a side culvert, which outfalls into the old meander stream bed. Gate #1 was normally kept in the closed position since the wetlands often needed as much water as could be delivered from the wastewater treatment plant. Gate #1 is not in use today but remains available for future occasions when water might be delivered to the Park using the Riverside Drain.

Gate #2 is located about one mile downstream of the upstream diversion into the old meander. Gate #2 diverts the flow from the stream bed into Existing Wetland Cell 1 (E1) through an 18” corrugated metal culvert. The gate is normally kept open but can be closed to keep water from entering the wetland cell by placing 47” wide metal stop logs down the Gate #2 well. The water is diverted into wetland E1 by backwater, which is controlled by the water level in the stream bed.

Gate #3 is located just downstream of Gate #2 and is used to divert water into Existing Wetland Cell 2 (E2). Gate #3 is operated by opening or closing a slide gate similar to Gate #1 to control the amount of water delivered by gravity flow to wetland E2.

Gate #4 is located just downstream of Gate #3 and controls the amount of water flowing through to the downstream portion of the old meander. Gate #4 is operated by opening or closing a slide gate similar to Gate #1. Closing the gate is necessary to back water into wetland E1 or to control the amount of flow being diverted or continuing downstream though the stream bed.

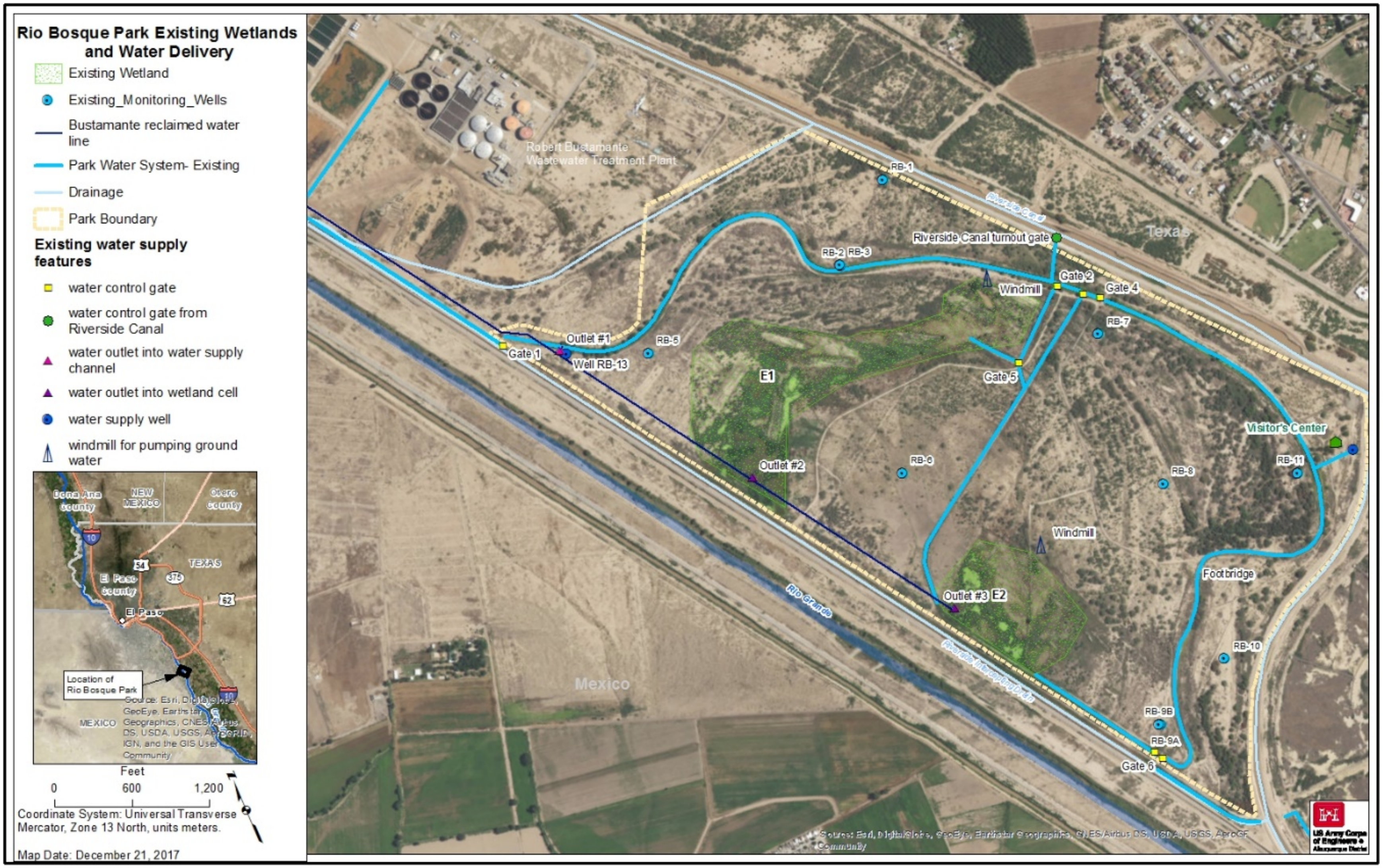

Figure 4. Map showing Rio Bosque Park water delivery system and groundwater monitoring wells.

Gate #5 is located off of the old meander stream bed in a channel that delivers water to wetland E1 and is used to divert water from E1 into E2. The gate consists of stop logs similar to Gate #2; the logs are normally in place to keep the gate closed. The stop logs do not seem to be very watertight since there seem to be leakage evident by water in the canal downstream of the gate.

Gates #6 and #7 are located at the downstream end of the old meander stream bed at the intersection of the road that follows the meander and the road that follows the Riverside Drain. Both gates consist of a slide gate operated by a hand-wheel crank that opens or closes the flow through corrugated metal culverts under the road and into the Riverside Drain. Gate #7 drains the old meander and Gate #6 drains wetland E2. The culvert draining wetland E2 seems to have seepage bypassing the culvert or piping along the side of the culvert which was evident by the presence of a sink hole near the road. A failure of this culvert would drain the wetland.

In addition to the existing system of gates that are used to control the delivery of water to the wetland cells, a turnout from the Riverside Canal can also deliver water to the system. The turnout has a slide gate that is operated by a hand-wheel crank with a culvert exiting into a ditch on the other side of the road that runs along the Riverside Canal. There are also groundwater pumping wells: Well RB-13 on the upstream end of the old meander near Gate #1, Well RB-12B near the Visitors' Center, and two windmill operated groundwater wells.

2.3.1.3 Future Without-Project Conditions

Currently, with the addition of the Park's irrigation water allotment, supply during a full allocation year is sufficient to keep large parts of the existing wetlands semi-permanently wet during the growing season. However, given that much of what is delivered is lost through infiltration into the soil and through evaporation, there is an insufficient quantity of water available to expand the wetland cells and riparian areas. These existing losses will continue to impact the system if the improvements proposed in the project are not implemented. In addition, the aging infrastructure could add to the losses with continued or increasing leakage at gates and culverts. In particular, at Gate #6, seepage along the culvert could increase to the point of failure, at which time losses could be significant at Wetland Cell 2. Finally, the lining of the Riverside Canal is expected to reduce infiltration from the canal into the groundwater, degrading the shallow aquifer supply used by the various wells. For the foreseeable future, without this project and with the new water supplies, wetland sustainability during the irrigation season will be limited to restricted portions of the wetland cells, especially during dry years. As noted in Section 2.1 (Climate and Climate Change), availability of surface water from the Rio Grande is likely to decline in the future. In dry years, with limited river water available, the Park would likely receive less water during the irrigation season from both the Riverside Canal and the WWTP. EPWU plans to build a 10-MGD Advanced Water Purification Facility (AWPF) that would take treated water from the Bustamante WWTP and send it through four additional treatment steps so it could be re-used as potable water. The AWPF would be operated when needed to meet peak demand, mainly in dry years with reduced availability of river water during the irrigation season. The non-federal Sponsor has committed to maintaining water deliveries to the Park from the Bustamante WWTP while simultaneously operating the AWPF, which is scheduled to be in operation by 2029.

2.4 Wetlands

There are currently two existing wetland areas in the Park, designated as E1 and E2 (Figure 5). Both areas are designed for shallow flooding to depths of 6-18 inches. From 2003 to 2014, these areas were typically flooded in late fall and early winter but were dry throughout the growing season. As a result, they lacked emergent wetland vegetation and were dominated in recent years by early successional vegetation, including Russian thistle, desert seepweed (*Suaeda suffrutescens*), Indian rushpea

(*Hoffmannseggia glauca*), lambsquarters (*Chenopodium album*), and tumbling saltbush (*Atriplex rosea*) (Figure 6). These wetlands lack wetland plants but nevertheless attract waterfowl.

Since 2015, portions of the two wetland areas have been flooded during the recent improvement with water delivered through the new pipeline from the WWTP, supplemented in 2017 by irrigation water delivered from the Riverside Canal. By itself, water from the WWTP can flood approximately 5-7 acres in each wetland area. When supplemented with irrigation water, up to 19 acres can be flooded in E1 and 16 acres in E2. Emergent wetland vegetation is now developing in the areas consistently flooded with water from the WWTP, predominantly southern cattail (*Typha domingensis*), with scattered pockets of hardstem bulrush (*Schoenoplectus acutus*), three-square bulrush (*Schoenoplectus pungens*), cosmopolitan bulrush (*Bolboschoenus maritimus*) and yellow nutsedge (*Cyperus esculentus*). Curltop smartweed (*Polygonum lapathifolium* var. *lapathifolium*) and Johnsongrass also occupy large portions of these flooded areas.

The *Biological Management Plan for Rio Bosque Wetlands Park* (Watts et al. 2002) recommended maintaining an approximately even mix of open water and emergent vegetation in emergent wetlands at the Park. The current emergent wetlands occupy areas designed for shallow flooding; for the most part, they lack deeper open water zones. As a result, emergent vegetation is steadily overtaking and eliminating areas of open water in these wetlands.

In the future without the proposed project, wetland vegetation should continue to develop in portions of the existing wetland cells as water deliveries become more consistent. However, the area of wetlands in the Park would not increase. The existing wetlands would lose most of their open water area as emergent wetland vegetation overtakes the consistently wetted areas, while intermittently wetted areas would continue to have mostly early successional vegetation. Therefore, under the No-Action alternative, there would be only minor long-term improvement in the status of wetlands in the study area. Active management of emergent vegetation would be needed in these areas on a regular basis to maintain an approximately even mix of open water and emergent vegetation.

Figure 5. Wetland vegetation consisting of flooded early-successional plants.


Figure 6. Photograph showing early successional vegetation in the Park (December 2016).

2.5 Air Quality, Sound, and Aesthetics

2.5.1 Air Quality

Texas air quality requirements are defined by the Clean Air Act (CAA) and the Texas Clean Air Act, Texas Health and Safety Code Section 382.014 (available at http://www.statutes.legis.state.tx.us/Docs/HS/htm/HS.382.htm). As required by the CAA, the U.S. Environmental Protection Agency (EPA) has set National Ambient Air Quality Standards (NAAQS) for six principal pollutants considered harmful to public health and the environment, which are called "criteria" pollutants. They are listed below (Table 1). El Paso County, the City of Socorro, and the City of El Paso are in attainment for most primary NAAQS.

The City of El Paso is classified as moderate non-attainment for particulate matter that measures 10 microns or less in diameter (PM_{10}) (USEPA 2017; TCEQ 2017). Because the site is located within a non-attainment area, the action is subject to the General Conformity Rule of the CAA, Section 176(c) that states that activities must not:

(a) cause or contribute to any new violation;

(b) increase the frequency or severity of any new violation; or

(c) delay timely attainment of any standard, interim emission reductions, or milestones in conformity to a State Implementation Plan (SIP).

Modeling of U.S. emissions indicated that the area would have been in attainment, if not for emissions transported from outside the United States. Based on §179B of the Clean Air Act, which provides that an area does not have to meet the moderate nonattainment deadline if the state demonstrates attainment if not for emissions from another country, there was no requirement for a reasonable further progress demonstration. The EPA approved the El Paso PM_{10} SIP revision, effective February 17, 1994.

The Texas Commission on Environmental Quality (TCEQ) maintains an air quality monitoring station, Socorro Hueco, about 2 miles northeast of the Rio Bosque study area. This station records ozone (O_3), PM_{10}, $PM_{2.5}$, volatile organic compounds (VOCs), and weather data. The 24-hour PM_{10} standard was exceeded on one day during 2016. The City of El Paso Environmental Services Department maintains an air monitoring station for PM_{10} at Benito Juarez Police Station in Ciudad Juarez, Mexico, also about 2 miles from Rio Bosque Park. Air monitoring stations and the El Paso moderate nonattainment area are illustrated in Figure 7.

In the future without-project scenario, air quality is expected to remain in attainment for most pollutants and moderate non-attainment for PM_{10}. The General Conformity Rule of the CAA mentioned above would prevent new or increased air quality violations.

Table 1: El Paso current attainment status for criteria pollutants. Data from TCEQ, (2017)

Pollutant	**Primary NAAQS**	**Averaging Period**	**Designation**	**Counties**	**Attainment Deadline**
Ozone (O_3)	0.070 ppm (2015 standard)	8-hour	Pending		
	0.075 ppm (2008 standard)	8-hour	Unclassifiable/ Attainment	El Paso	
Lead (Pb)	0.15 µg/m^3 (2008 standard)	Rolling 3-Month Avg	Unclassifiable/ Attainment		
Carbon Monoxide (CO)	9 ppm	8-hour	Attainment (Maintenance)	Portion of City of El Paso	
	35 ppm	1-hour	Unclassifiable/ Attainment		
Nitrogen Dioxide (NO_2)	0.053 ppm	Annual	Unclassifiable/ Attainment		
	100 ppb	1-hour	Unclassifiable/ Attainment		
Particulate Matter (PM_{10})	150 µg/m^3	24-hour	Moderate Nonattainment	City of El Paso	December 31, 1994
Particulate Matter ($PM_{2.5}$)	12.0 µg/m^3(2012 standard)	Annual (Arithmetic Mean)	Unclassifiable/ Attainment		
	35 µg/m^3	24-hour	Unclassifiable/ Attainment		
	0.03 ppm*	Annual (Arithmetic Mean)	Unclassifiable/ Attainment		
Sulfur Dioxide (SO_2)	0.14 ppm*	24-hour	Unclassifiable/ Attainment		
	75 ppb	1-hour	Governor's Recommendation: Attainment	El Paso	

Units of measure:
ppm, parts per million by volume
ppb, parts per billion by volume
mg/m3, milligrams per cubic meter of air
µg/m3, micrograms per cubic meter of air
**Standard is scheduled to be revoked one year after the effective date of final designations for the 75 ppb standard.*

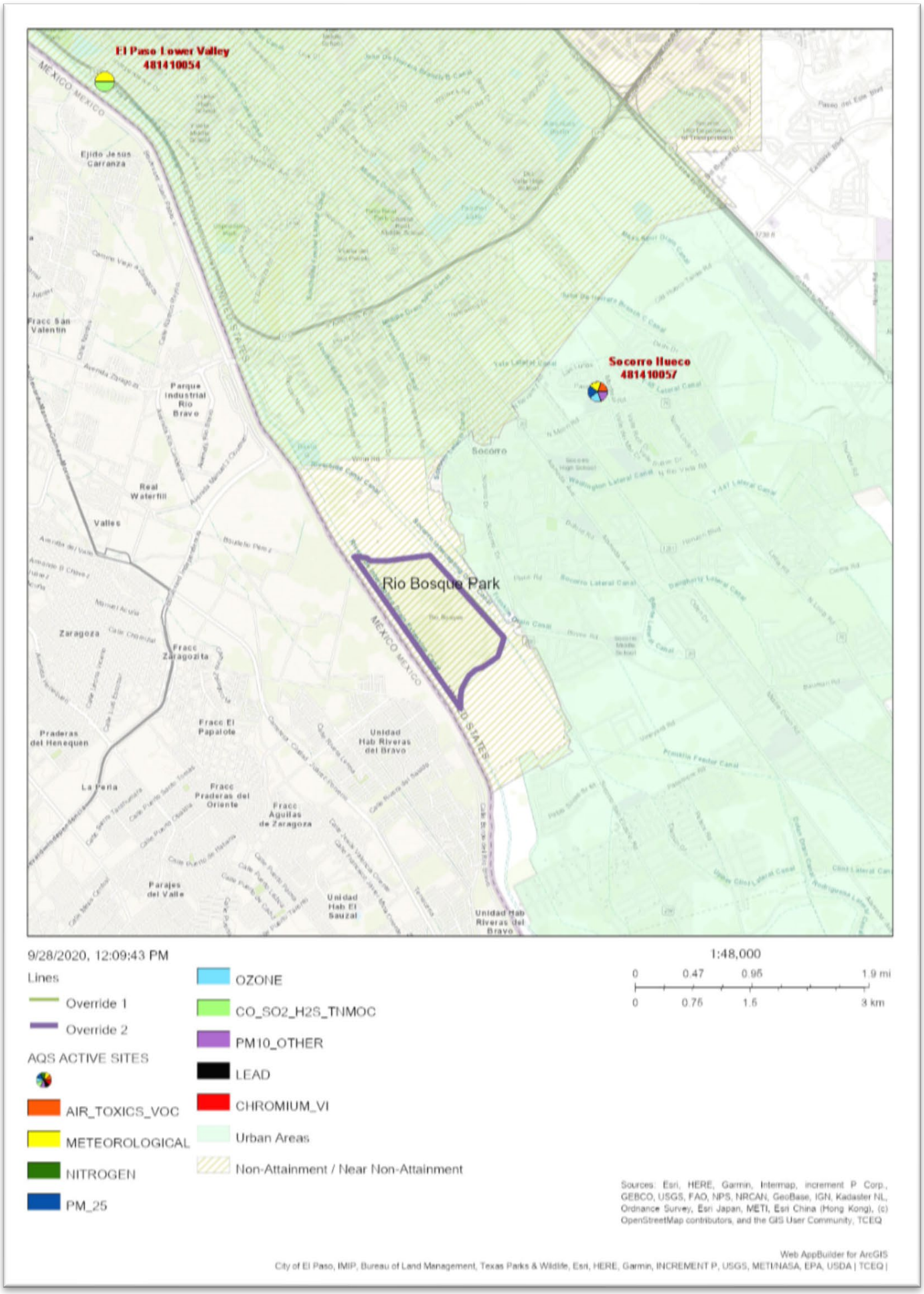

Figure 7. Map of air quality monitoring stations near Rio Bosque Park.

2.5.2 Sound and Noise

El Paso's noise control ordinance (Chapter 9.40) limits exterior noise levels to 50-70 decibels (dB(A)) depending on the Noise Zone. Noise Zone 1 includes residential structures with an allowable noise level of 55 dB(A) during normal working hours (between 7am-10pm) or 50 dB(A) at night. Noise Zone II is all commercial properties with an allowable noise level of 65 dB(A) during normal working hours. Noise Zone III is all manufacturing or industrial properties with an allowable noise level of 70 dB(A) during normal working hours. Noise sources associated with or vibration created by construction conducted during established construction hours is exempt from these provisions. The City of Socorro has similar noise standards (Socorro municipal ordinances Sec. 28, Article III). Property adjacent to the Park includes residential, or Noise Zone I, areas of Socorro, TX.

The noise level typical of an urban residential area is about 50 dB(A). Noise levels within the Park have not been measured but are likely much lower than 50 dB(A) due to the absence of motorized equipment within the Park. The Park provides a relatively quiet zone within this part of the City. This condition is expected to remain similar in the future. Under the No-Action alternative, there would be no construction and therefore no effect on noise.

2.5.3 Aesthetics

The study area, although altered from its original ecological condition, is undeveloped except for low-intensity recreational trails and water control features. The Park therefore provides a pleasant, natural aesthetic. This condition is expected to continue into the foreseeable future. The predominance of weedy and invasive species in some parts of the Park is less desirable. The disturbance associated with construction of the wetland cells and water delivery system in 1997 created favorable conditions for weedy and invasive species over large areas. Since then, through natural successional processes and active control efforts, these species have become less common in many areas but are still prominent in some. The corridor disturbed during construction of the new pipeline in 2014-2015 is one area where recent disturbance has led to extensive stands of tumbleweeds and other weedy species. In the future without a project, natural successional processes and active control efforts would continue to reduce the prominence of weedy species at the Park, but the transition would be gradual and incremental. Weedy species would continue to predominate over some parts of the Park, detracting somewhat from the Park's aesthetics.

2.6 Biological Resources

2.6.1 Vegetation Communities

Information on the vegetation communities of the Park was obtained primarily from the *Biological Management Plan for Rio Bosque Wetlands Park* (Watts et al. 2002; hereafter referred to as "the Management Plan"). Vegetation data from the Management Plan were verified and updated on site visits by the USACE Project Team in February 2014, June 2014, May 2015, and December 2016.

Vegetation patterns in the Park have been greatly influenced by past disturbance, including the channelization of the Rio Grande in the 1930s, past farming of lands now included in the Park, and the construction of the wetland cells and water-delivery system along with removal of extensive stands of saltcedar in 1997. In 2002, the vegetation in over approximately 65% of the Park was in early successional stages (Figure 8). These areas are dominated by species such as Russian thistle, seepweed (*Suaeda* sp.), alkali heliotrope (*Heliotropium curassavicum),* jackass clover (*Wislizenia refracta*), bitterweed (*Hymenoxys odorata*), tansy mustard (*Descurainia pinnata*), mountain pepperweed (*Lepidium montanum*), and Indian rushpea (*Hoffmannseggia glauca)*. Some areas remained largely barren (Management Plan, p.13).

In 2002, approximately 15% of the Park supported shrublands dominated by fourwing saltbush (*Atriplex canescens*), honey mesquite (*Prosopis glandulosa* var. *torreyana*), and jimmyweed (*Isocoma pluriflora*) (Figure 8). Another 15% of the Park supported woodlands, with tornillo (*Prosopis pubescens*) and saltcedar as the dominant species (Figure 9). Today, the shrublands have matured in many areas and have expanded into a number of areas that were previously largely barren. Two mature stands of saltcedar that were deliberately left in place in 1997 remain, but elsewhere saltcedar has been reduced in dominance in the Park. Tornillo, on the other hand, has colonized new areas throughout the Park, especially after a series of major storm events in the El Paso region in the summer of 2006.

Figure 8. Fourwing saltbush and honey mesquite with early successional vegetation (May 2015).

Figure 9. Saltcedar with tornillo and saltbush (December 2016); tornillo fruits (inset).

In 2002, only small areas of the Park supported riparian shrubs, such as wolfberry, arrowweed (*Pluchea sericea*), and coyote willow. These associations were found mainly near the Park perimeter in areas influenced by the Riverside Canal and the irrigation drains bordering the Park. Today, all are more abundant and widespread.

Efforts to establish riparian habitat along the historic river channel within the Park struggled during the years without water during the growing season. Pole plantings of Rio Grande cottonwood, Goodding's willow, and coyote willow persisted only with regular deliveries of water trucked from the WWTP. During drought years, when heavy groundwater pumping in the region caused steep declines in the water table, many trees died. More favorable conditions began to emerge in 2014: With both of the Park's wells operating together for the first time, a flow was maintained almost the full length of the historic river channel during the growing season. The pole plantings grew vigorously, and young cottonwood and willow seedlings appeared at scattered locations along the channel. Conditions continued to improve in 2015 when the new pipeline made possible growing-season water deliveries from the WWTP. In 2017, irrigation water, available for the first time from the Riverside Canal, further improved conditions for establishment of riparian habitat.

Today, a narrow band of wetland and riparian vegetation is developing along the historic river channel. Clusters of Rio Grande cottonwoods, scattered Goodding's willows, and thickets of coyote willow are present along much of the channel, with seepwillow, willow baccharis (*Baccharis salicina*), and Torrey wolfberry present in the understory. Two small stands of Goodding's willows have become established in the wetland cells. One is on the eastern edge of E1. It got started in 2001-2002 when the Park received water during the growing season. The other is on the west side of E2. It got started in 2015 on the margins of the area flooded during the growing season with water from the new pipeline (Figure 10).

A small area along the historic river channel in the southeast part of the Park has sand dune habitat and is the only area where broom psorothamnus (*Psorothamnus scoparius*), a shrub that favors deep, well-drained sands, grows in the Park. Another species that prefers deep sands is the rare cactus, sand pricklypear *(Opuntia arenaria)*, which has been transplanted from a development site into the Park, including the sand dune habitat along the historic river channel. This species is discussed further in section 2.6.4.

The Park has poorly developed herbaceous plant communities and understory vegetation. Open areas are currently occupied by early successional species, including invasive weeds like Russian thistle, rather than grasses and forbs. The history of disturbance and the Park's large population of black-tailed jackrabbits (*Lepus californicus*) may play an important role in the current scarcity of grasses.

If no project is implemented in the future, riparian and wetland vegetation communities are expected to slowly continue developing, as current restoration efforts continue, along the historic river channel and in the areas in the wetland cells that are now receiving water during the growing season. Increased water deliveries would facilitate the development or slow expansion of stands of riparian and wetland plants in areas. However, vegetation development would be gradual and efforts to control invasive species would need to continue.

Since water became available during the growing season, only small numbers of saltcedar seedlings have appeared along the historic river channel and in the wetland cells. Regular monitoring and removal of the seedlings has kept saltcedar from getting established in these areas. Gradual removal of mature saltcedars also continues today. Johnsongrass may present a more formidable problem, especially in the shallow water of the wetland cells. The presence of water during the growing season enabled rapid expansion of Johnsongrass along the margins of the historic river channel and in the wetland cells. Intensive removal efforts have helped keep this invasive perennial grass under control along the river channel, but its ability to produce abundant seeds and send up new shoots from rhizomes has allowed it to outpace more limited removal efforts to date in the wetland cells.

Another possible future without-project scenario is a minor long-term reduction in saltcedar cover and vigor because leaf beetles (*Diorhabda* sp.) have begun defoliating the saltcedar. However, under the No-Action alternative, it would take several years of defoliating for saltcedar presence to diminish. It is likely that the remaining stands of saltcedar would remain stable or continue to decrease in small increments due to limited removal efforts in years when the beetle is not prevalent.

Figure 10. Young Goodding's willows growing near outlet to existing wetland cell 2 (December 2016).

2.6.2 Wildlife

2.6.2.1 Birds

The Park's proximity to the Rio Grande, its undeveloped nature, and variety of habitats make the Park an important area for birds. The Management Plan recorded 191 species of birds; others have been added based on surveys conducted by UTEP, to bring the total to 244 species to date (Appendix C). The addition of water and the development of the wetland cells greatly increased the Park's avian diversity (Management Plan, p. 15). Thousands of ducks and other water birds now use the Park when the wetlands are flooded. However, overgrowth of emergent vegetation (cattails) as described in section 2.4 would reduce the wetlands' future suitability for waterfowl unless management action is taken.

Common nesting species in the Park include Harris's Hawk (*Parabuteo unicinctus*), Swainson's Hawk (*Buteo swanisoni*), Gambel's Quail (*Callipepla gambelii*), Mourning Dove (*Zenaida macroura*), Greater Roadrunner (*Geococcyx californianus*), Burrowing Owl (*Athene cunicularia*), Black-chinned Hummingbird (*Archilochus alexandri*), Western Kingbird (*Tyrannus verticalis*), Verdin (*Auriparus flaviceps*), Northern Mockingbird (*Mimus polyglottos*), Crissal Thrasher (*Toxostoma crissale*), Yellow-breasted Chat (*Icteria virens*), Cassin's Sparrow (*Peucaea cassinii*), Blue Grosbeak (*Passerina caerulea*), Painted Bunting (*Passerina ciris*), and House Finch (*Haemorhous mexicanus*).

A wide variety of raptors use the Park, particularly in winter. Raptors observed in the Park include the resident Harris's Hawks, wintering Northern Harriers (*Circus cyaneus*), Sharp-shinned Hawks (*Accipiter striatus*), Cooper's Hawks (*Accipiter cooperii*), Red-tailed Hawks (*Buteo jamaicensis*), Ferruginous Hawks (*Buteo regalis*), and Peregrine Falcons (*Falco peregrinus*). Bald Eagles (*Haliaeetus lecucocephalus*) have occasionally over-wintered at the Park (Management Plan, p. 15). White-tailed Kites (*Elanus leucurus*), a species first seen in the El Paso area in 2000 and near the Park in 2001, nested successfully at the Park in 2009, 2011, 2015, and 2017.

The Park is also important to nearctic-neotropical migrant birds that prefer riparian habitats, such as Yellow-breasted Chat, Blue Grosbeak, and Painted Bunting. The federally endangered Southwestern Willow Flycatcher (*Empidonax traillii extimus)* has been detected in the Park during migration, and the federally threatened Western Yellow-billed Cuckoo (*Coccyzus americanus*) formerly nested in saltcedar woodlands at the Park (Management Plan, p. 15). After the majority of the saltcedar was cleared in 1997, this species was not observed again until 2007. Migrating cuckoos have been detected infrequently since, including in 3 of the past 4 years. These species will be discussed further in Special Status Species (section 2.6.4).

In the future if no project were implemented, the Park would continue to provide important habitat for birds. The diversity of native habitats would increase gradually as current wetland and riparian habitats continue to develop and current restoration work continues; therefore, bird populations and species diversity would be expected to remain similar or increase minimally relative to present conditions.

2.6.2.2 Mammals

Mammals observed in the Park include abundant black-tailed jackrabbits (*Lepus californicus)*, desert cottontail (*Sylvilagus audubonii*); several small mammals, such as spotted ground squirrel (*Spermophilus spilosoma*), desert pocket gopher (*Geomys arenarius*); and several species of native mice, including the Chihuahuan Desert pocket mouse (*Chaetodipus eremicus*), a Species of Greatest Conservation Need. A complete list of mammals documented in the Park is provided in Appendix C. Large mammals are not found in the Park due to its urban surroundings, but mesocarnivores, including coyote (*Canis latrans*), gray fox (*Urocyon cinereoargenteus*), bobcat (*Lynx rufus*), raccoon (*Procyon lotor*), and striped skunk (*Mephitis mephitis*) are occasionally observed. When water is present, muskrat (*Ondatra zibethicus*) and beaver (*Castor canadensis*) use the water-delivery channels in the Park (Management Plan, p. 16). The muskrat found in this area is the Pecos River muskrat, a species of conservation concern that will be discussed further (section 2.6.4).

2.6.2.3 Amphibians & reptiles

The herpetofauna of the Park has been studied by UTEP using trap collections. The commonly observed lizards are the little striped whiptail (*Aspidoscelis inornatus*), prairie lizard (*Sceloporus undulatus*), Southwestern fence lizard (*Sceloporus cowlesi*), and side-blotched lizard (*Uta stansburiana*). Also present, but seen less often, is the Texas horned lizard (*Phrynosoma cornutum*), a state-listed threatened species. Snakes observed include glossy snake (*Arizona elegans*), Great Plains rat snake (*Elaphe emoryi*), night snake (*Hypsiglena torquata*), common kingsnake (*Lampropeltis getula*), coachwhip (*Masticophis flagellum*), gopher snake (*Pituophis catenifer*), longnose snake (*Rhinocheilus lecontei*), and checkered garter snake (*Thamnophis marcianus*) (Management Plan, p. 16 and UTEP data).

Aquatic species include the spiny softshell turtle (*Trionyx spiniferus*), observed regularly in the Riverside Canal and now being seen more frequently in the Park since water has become more consistently available during the growing season. Red-spotted toad (*Bufo punctatus*), Woodhouse's toad (*Bufo woodhousii*), and Couch's spadefoot (*Scaphiopus couchii*) all have been observed at the Park. In years when no spring-summer water is available, these species utilize ephemeral rain-fed pools and moist areas maintained by seepage from the Riverside Canal. Bullfrogs (*Rana catesbeiana*), which is considered non-native to the Rio Grande, first appeared in 2000, when water persisted all summer at several of the Park's water-control gates.

2.6.3 Noxious Weeds and Invasive Species

Executive Order 13112, Invasive Species (1999), directs federal agencies to prevent the introduction of invasive species and to control and minimize the economic, ecological, and human health impacts that invasive species cause.

The Federal Noxious Weed Act of 1974 established a federal program to control the spread of noxious weeds (defined as undesirable plant species). The Texas Administrative Code Title 4, §19.300 defines noxious and invasive plants as having "serious potential to cause economic or ecological harm to the state."

The predominant invasive species of concern in the Park is saltcedar or tamarisk. Prior to construction of the wetland cells, dense monotypic stands of saltcedar covered approximately 25% of the Park (Management Plan, p. 13). Much saltcedar was removed in 1997 during the construction of the wetland cells and water delivery system, but two large stands were deliberately left in place to provide continuing woodland habitat until enough native riparian vegetation was established to allow their eventual removal. In many of the cleared areas, saltcedar quickly resprouted from incompletely removed root systems, and extensive additional work was needed to remove the resprouting trees. Today, saltcedar has been eradicated from most of the Park and, other than a few scattered individual trees, persists only in the two remnant stands. Much of this remaining saltcedar is interspersed with tornillo. Nevertheless, the two dense stands of saltcedar remain. Although undesirable in general, the dense older stands of saltcedar provide shade and cover for wildlife, including Long-eared owls (*Asio otus*). Long-eared Owls are winter residents at the Park, usually roosting in the largest of the two remnant saltcedar stands (Figure 11). In 2007, after the heavy rains of summer 2006 led to a surge in small-mammal populations at the Park, a pair of wintering Long-eared Owls stayed and nested in this stand, the first known successful nesting pair for this species in the El Paso region since 1936.

Figure 11. Dense old saltcedar provides cover and roosting areas (December 2016).

Other nonnative and invasive species listed in the Management Plan include: annual sow thistle (*Sonchus oleraceus*), garden rocket (*Eruca vesicaria* ssp. *sativa*), summer cypress or kochia, Russian thistle, perennial pepperweed, London rocket (*Sisymbrium irio*) , Bermudagrass (*Cynodon dactylon*), barnyardgrass (*Echinochloa crusgallii*), hare barley (*Hordeum murinum* ssp. *glaucum*), rabbitfoot grass (*Polypogon monospeliensis*), Johnsongrass, tree tobacco (*Nicotiana glauca*), and Siberian elm (*Ulmus pumila*).

Controlling or eliminating non-native, invasive vegetation is an objective of the Rio Bosque Park Management Plan. The Plan recommends focusing these efforts on the most problematic species: saltcedar, perennial pepperweed, and Russian thistle (Management Plan, p. 37). In recent years, kochia and Johnsongrass have been added to this list. Once water became available to the Park during the growing season, these two species increased dramatically, especially in and around the wetland cells.

In the future without the proposed project, current efforts to control saltcedar and other invasive species would continue, and they would continue to require a large percentage of Park staff and volunteer time and effort. This would be an adverse long-term effect.

2.6.4 Special Status Species

Two agencies have primary responsibility for protecting and conserving plant and animal species within the study area. The United States Fish and Wildlife Service (USFWS), under authority of the Endangered Species Act of 1973 (16 U.S.C. 1531 *et seq.*), as amended, has the responsibility for federal listed species. The Texas Parks and Wildlife Department (TPWD) is responsible for state-listed species. Each agency maintains a continually updated list of species that are classified, or are candidates for classification, as protected based on their present status and potential threats to future survival and recruitment into viable breeding populations. Special status species that potentially occur in El Paso County and may occur near the study area are listed in Table 2 and discussed below.

Additional species, including state-listed rare species, Species of Greatest Conservation Need included in the Texas Wildlife Action Plan, and USFWS Birds of Conservation Concern with no legal status, are listed in Appendix C. These species are considered for planning purposes, and those that occur within the study area are also discussed briefly. For these species, the goal is to conserve populations and/or habitats to avoid the need for listing in the future.

2.6.4.1 Southwestern Willow Flycatcher

The Southwestern Willow Flycatcher (flycatcher), a Neotropical migrant songbird, is found in the U.S. from May until September. It winters in southern Mexico, Central America, and northern South America (Sogge et al. 2010). The flycatcher was listed as an endangered species by the U.S. Fish and Wildlife Service in 1995 (USFWS 1995). Critical habitat has been designated and was revised in 2013 (USFWS 2013) but does not exist in the study area. The Texas Management Unit does not have any goals identified in the Recovery Plan because of "either the lack of habitat, the inability for habitat to recover, or the determination that meaningful populations could not be established and persist"; therefore, no critical habitat was proposed.

The flycatcher is an obligate riparian species. Flycatchers occur in riparian habitats along rivers, streams, or other wetlands, where dense growth of willows (*Salix* spp.), *Baccharis*, arrowweed (*Pluchea* sp.), saltcedar (*Tamarix* sp.), or other plants are present, often with an overstory of cottonwood (Sogge et al. 2010). These riparian communities provide nesting and foraging habitat. Southwestern Willow Flycatchers nest in thickets of trees and shrubs approximately 6 to 23 feet in height or taller, with a densely vegetated understory approximately 12 feet or more in height. Nests are frequently associated with an overstory of scattered cottonwood. Surface water or saturated soil is usually present beneath or next to occupied thickets. Habitats not selected for nesting include narrow (less than 30 feet wide) riparian strips, small willow patches, and stands with low stem density. Areas not utilized for nesting may still be used during migration.

Throughout the range of flycatcher, suitable riparian habitats tend to be rare, widely separated, small and often linear locales, separated by vast expanses of arid lands. The flycatcher is endangered by extensive loss and modification of suitable riparian habitat and other factors, including brood parasitism by the Brown-Headed Cowbird (*Molothrus ater*).

The nearest known breeding and critical flycatcher habitat to the study area occurs approximately 160 miles upriver, along the Rio Grande upstream of Elephant Butte Reservoir, or a similar distance overland along the Gila River.

Surveys conducted by a USACE biologist detected a flycatcher that was identified as a migrant. The habitat within the Park includes small patches of willow and a narrow strip of mature saltcedar. These vegetation patches may provide foraging habitat during migration, but do not constitute suitable nesting habitat. While willow habitat is expected to increase incrementally in the future without the proposed project, there would be no major change in habitat or its use by migrating flycatchers.

Table 2: Listed and sensitive species in El Paso County.

NOTE: Data from Texas Parks and Wildlife Department (TPWD 2017) and USFWS (2017). Additional rare species that have no legal status, Birds of Conservation Concern, and Species of Greatest Conservation Need were reviewed but are not listed here; these species are listed in Appendix C.

Common Name	Scientific Name	Group	Status	Habitat, distribution	Potential in area?
Southwestern Willow Flycatcher	*Empidonax traillii extimus*	Bird	FE, SE	Riparian woodland	Y-migrants
Northern Aplomado Falcon	*Falco femoralis septentrionalis*	Bird	FE, SE	Savanna, open grassy plains with scattered mesquite, yucca, cactus	N
Least Tern (Interior Population)	*Sterna antillarum*	Bird	FE, SE	Sand and gravel bars within streams, rivers	N
Piping Plover	*Charadrius melodus*	Bird	FT	Sand and gravel bars within streams, rivers	N
American Peregrine Falcon	*Falco peregrinus anatum*	Bird	ST	Nests in tall cliff eyries; urban habitats	Y
Mexican Spotted Owl	*Strix occidentalis lucida*	Bird	FT, ST	Coniferous mountain woodland canyons	N
Yellow-billed Cuckoo	*Coccyzus americanus*	Bird	FT	Riparian woodland	Y-migrants, formerly nesting
Red Knot	*Calidris canutus rufa*	Bird	FT	(species only needs to be considered for wind energy projects)	N
Rio Grande silvery minnow	*Hybognathus amarus*	Fish	FE, SE	In the Rio Grande	N
Sneed pincushion cactus	*Escobaria sneedii var sneedii*	Plant	FE, SE	Limestone outcrops; Franklin Mts	N
Bluntnose shiner	*Notropis simus*	Fish	ST	In the Rio Grande	N
Mountain short-horned lizard	*Phrynosoma hernandesi*	Reptile	ST	Open, shrubby, areas with sparse vegetation at ground level	N
Texas horned lizard	*Phrynosoma cornutum*	Reptile	ST	Open, arid and semi-arid areas with sparse vegetation	Y-present
Chihuahuan Desert lyre snake	*Trimorphodon vilkinsonii*	Reptile	ST	Crevice-dwelling in limestone-surfaced desert	N
Gray wolf	*Canis lupus*	Mammal	FE, SE, ext	Formerly in forests, brushlands, or grasslands	N
Black-footed ferret	*Mustela nigripes*	Mammal	FE, SE, ext	Inhabited prairie dog towns	N
Black bear	*Ursus americanus*	Mammal	ST	Bottomland hardwoods and large tracts of inaccessible forest	N

Status Key: FE = Federally Endangered; SE = State Endangered; FT = Federally Threatened; ST= State Threatened; FC = Federal Candidate; blank = no legal status; ext = extirpated from county

2.6.4.2 Yellow-billed Cuckoo, Western population

The Western Distinct Population Segment of the Yellow-billed Cuckoo (*Coccyzus americanus*; cuckoo) was federally listed as threatened in 2014 (USFWS 2014b). Critical habitat was also proposed in 2014 (USFWS 2014a) and revised in 2020 (USFWS 2020). The cuckoo is also a riparian obligate species and is migratory, wintering in South America. Western Yellow-billed Cuckoos historically bred throughout riparian systems of western North America from southern British Columbia to northwestern Mexico (Hughes 1999). The decline of the cuckoo is primarily the result of riparian habitat loss and degradation. Within the three States with the highest historical number of cuckoo pairs, past riparian habitat losses are estimated to be about 90 to 95 percent in Arizona, 90 percent in New Mexico, and 90 to 99 percent in California (USFWS 2014b).

The cuckoo requires dense riparian vegetation for nesting. They nest almost exclusively in low to moderate elevation riparian woodlands with native broadleaf trees and shrubs, typically dominated by cottonwood and willow, within arid to semiarid landscapes. Cuckoos are most likely to be found in patches of willow–cottonwood riparian habitat greater than 200 acres in size and rarely use smaller patches of habitat (under 50 acres in size) (Halterman et al. 2015).

This species formerly nested in saltcedar woodlands at the Park, but cuckoos have not nested in the Park since much of the saltcedar was removed in the course of constructing the wetland cells (Management Plan, p. 15). Cuckoos have been observed occasionally during migration in mature tornillo habitat in the Park. The nearest known breeding and proposed critical habitat for cuckoos is located a similar distance from the study area as for the flycatcher; approximately 160 miles upriver, along the Rio Grande upstream of Elephant Butte Reservoir, or a similar distance overland along the Gila River.

Because increases in riparian and native habitat would be slow and incremental without the proposed project, there would be no major change in habitat or its use by migrating cuckoos.

2.6.4.3 Texas Horned Lizard

Texas horned lizard (*Phrynosoma cornutum*), a state listed threatened species, is known to occur within the Park, but although it has been observed occasionally, its population size has not been determined (Management Plan, p. 16). Habitat conditions for, and presence of the horned lizard is expected to be similar in the future without the proposed project.

2.6.4.4 Burrowing Owl

Burrowing owls (*Athene cunicularia*), a Species of Greatest Conservation Need, occur within the Park. Artificial nest burrows have been placed to increase habitat for the owls. The locations of the owl nest burrows are shown in Figure 12. In the future without the proposed project, there would be no change in burrowing owl habitat.

2.6.4.5 Peregrine Falcon

The American Peregrine Falcon may fly over or forage within the project area but does not nest within the Park. Due to its transient occurrence and ability to utilize urban habitats, this species' potential presence would not change in the future without the proposed project.

2.6.4.6 Sand Pricklypear

A rare plant species, sand pricklypear (*Opuntia arenaria*), was salvaged from a nearby development site and transplanted into suitable deep sandy soils within the Park. Sand pricklypear locations are shown in Figure 13, and the species is illustrated below (Figure 14). This species is expected to continue growing in suitable soils within the Park in the future without a project.

Figure 12. Burrowing owl on a perch at a nest location (May 2015).

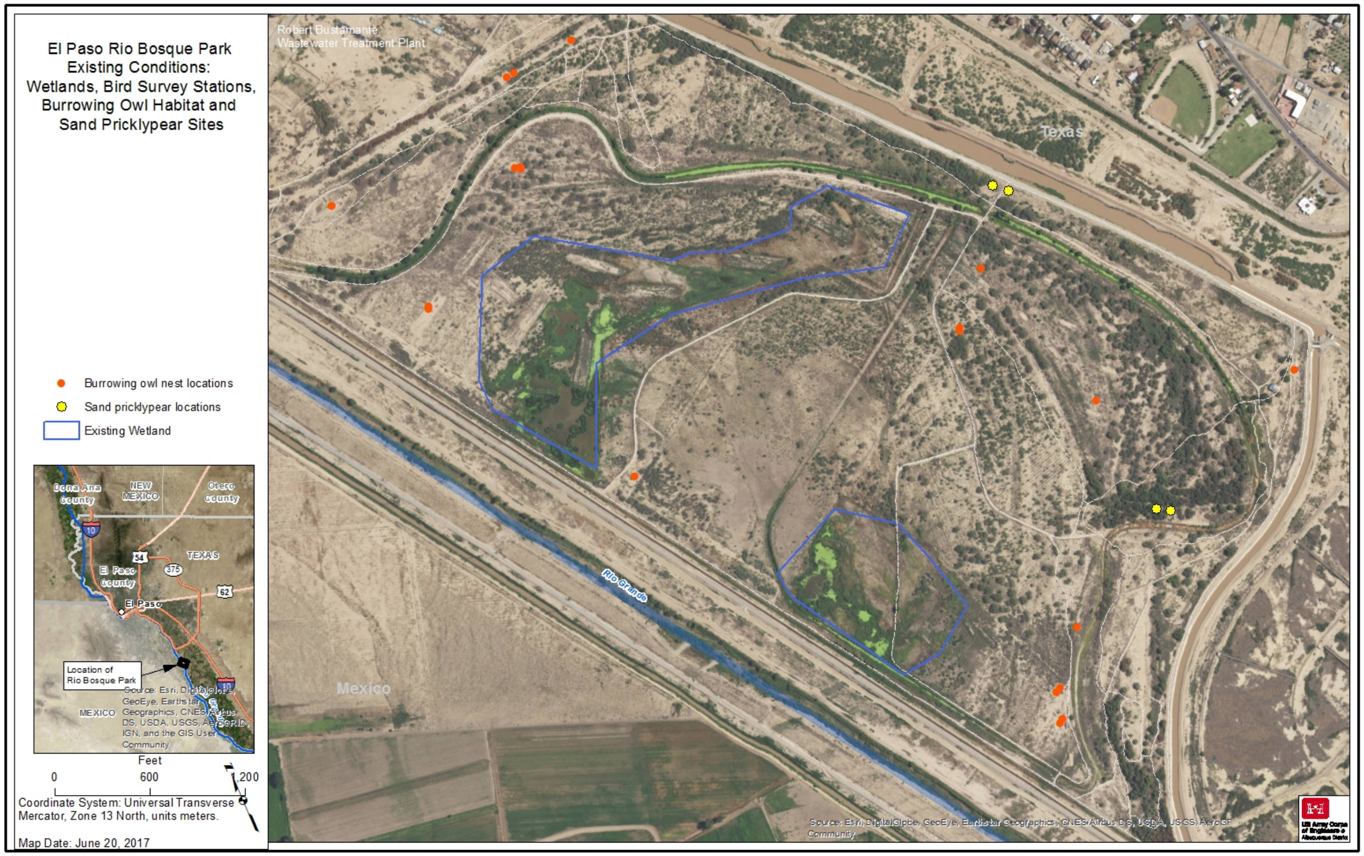

Figure 13. Map of Rio Bosque Park showing existing natural resources: Locations of existing wetlands, burrowing owl nesting habitats, and sand pricklypear sites.

Figure 14. Sand pricklypear at Rio Bosque Park (May 2017). (Photo credit: John Sproul)

2.7 Socioeconomic Considerations and Environmental Justice

The total population of the City in the 2010 Census was 649,121 (U.S. Census Bureau, 2020a) with El Paso County having a Census population of 800,647 (U.S. Census Bureau, 2020b). The City's most recent estimated population is 681,728 as of July 1, 2019 (U.S. Census Bureau, 2020a). The racial background for El Paso County is: 91.8 % white (including Hispanic origin), 4.0 % black or African American, 1.1% American Indian or Alaska Native, 1.4 % Asian, 0.2 % Native Hawaiian and other Pacific Islander, and 1.5 % are two or more races. Of the total El Paso County population, regardless of race, 82.9% is of Hispanic or Latino origin (U.S. Census Bureau, 2020b).

In 2018, El Paso had a per capita personal income (PCPI) of $35,856. This PCPI was 71% of the state average and 66% of the national average, $54,446. The 2018 PCPI reflected an increase of 4.7 percent from 2017. The 2017-2018 state change was 5.1 percent and the national change was 4.9 percent (U.S. Department of Commerce, Bureau of Economic Analysis, 2017).

The February 2020 unemployment rate in the El Paso metropolitan area was 3.8% (preliminary data), compared to 3.5% for Texas. Employment in El Paso suffered along with the rest of the United States due to the COVID-19 pandemic and rose to 14.8% in April 2020, the last month for which data are available. The national unemployment rate was 3.5% in February 2020 and 14.7% in April 2020 (U.S. Department of Labor, Bureau of Labor Statistics, 2020).

If no project is implemented, the conditions of neighborhoods adjacent to the Park are likely to remain comparable to the present situation. As such, the neighborhoods would not benefit from potential improvements in quality of life and possibilities for redevelopment stemming from project-related restoration and additional recreation opportunities. The Park would be less likely to play a key role in redevelopment of the area. Its value as a recreational and educational destination would continue to increase gradually as current restoration efforts continue. Some improvements may be made by local agencies if this project were not implemented.

2.8 Land Use and Recreation Resources

As a long-range project to establish meaningful examples of the native wetland and riparian habitats historically found along the Rio Grande in the El Paso region, the Park provides a unique opportunity to the El Paso area. Because past alterations to the Rio Grande resulted in the loss of native vegetation, the Park has the potential to become one of the few places in the region with a cottonwood-willow bosque, representative of the river's historic riparian vegetation.

In addition to providing a wildlife refuge, the Park was established to provide a venue for public recreation and education. The Park provides wetland and riparian habitat for animals, public open space for hiking and biking, and it offers educational opportunities for both school children and the general public. In addition, efforts to restore terrestrial and aquatic habitats provide research opportunities for students of all ages (Management Plan, p.1).

As stipulated in the agreement between CERM/UTEP and the city of El Paso, management of the Park focuses on restoring and enhancing valuable wetland and riparian habitat along the Rio Grande while providing public recreation and educational opportunities. Developing the Park to facilitate public access for appropriate recreation and educational purposes was addressed through the development of a master plan for the Park's development. Portions of this plan are currently being implemented (Management plan p. 21)

Visitation data for the Park from 2000-2017 shows from 450-2000 observed visitors/year, including school and volunteer groups. Since 2005, the Park has received over 800 observed visitors/year. Actual numbers of visitors are believed to be higher; many people visit the park independently of groups and events and at times when park staff are either not present or are working in parts of the park where they would not see visitors.

Without the proposed project, there would be no effect to recreation or educational use of the Park. Visitation is expected to fluctuate within the observed numbers in the foreseeable future (Figure 15) or may increase slightly. Increasing visitation would be consistent with the trend since 2011 as the vegetation in the Park continues to develop, especially in and adjacent to the areas now receiving water during the growing season. Recreational activities at the Park will not change appreciably but will fall short of the Park's potential without the proposed project.

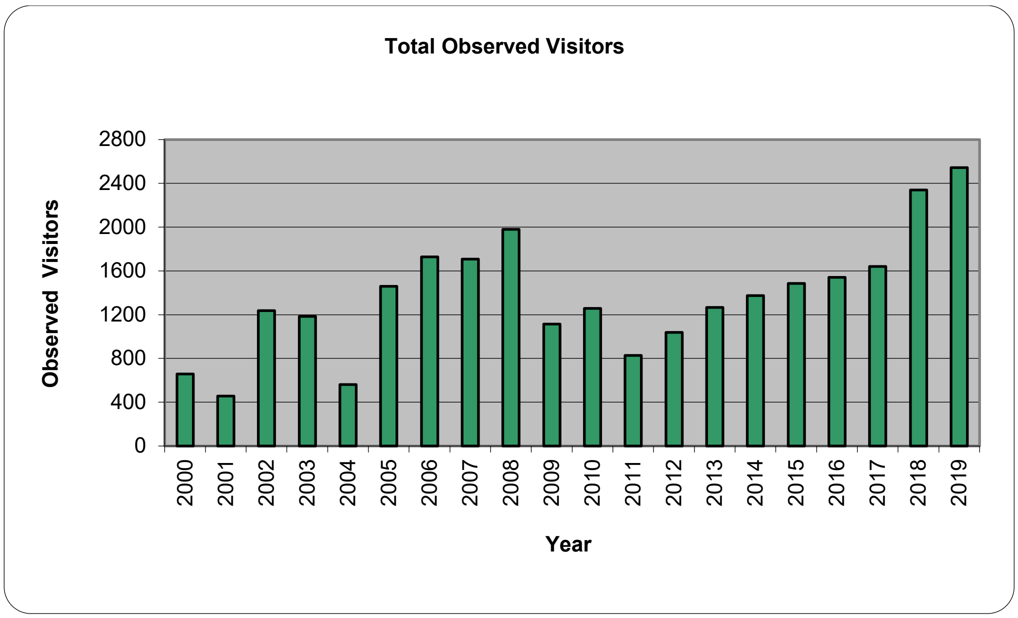

Figure 15. Visitation data for the Park, 2000-2019

2.9 Cultural Resources

Under Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended, all federal agencies are obligated to consider the impacts of their undertakings on historic properties. The Section 106 process includes the identification of historic properties that might be affected by a project, the evaluation of those properties, determinations of effect on those properties, consultation with various parties (including the Texas Historical Commission and Tribes) about those effects, and resolution of any adverse effect on historic properties. As such, the identification and evaluation of historic properties (including archaeological sites, historic buildings, and other features constructed or modified by humans in the past) is an important component of this project.

There is a long history of human occupation in the El Paso area, extending from more than 10,000 years ago to the present day. The prehistory and history of the El Paso area are divided by archaeologists into the following periods, with associated dates:

- Paleoindian: c. 10,000-6000 BC
- Archaic: 6000 BC – AD 200
- Formative: AD 200-1450
    - Mesilla Phase (AD 200-1100)

  - Dona Ana Phase (AD 1100-1200)
  - El Paso Phase (AD 1200-1450)
- Protohistoric: AD 1580-1659
- Historic: AD 1659-Present

Each of these periods is characterized by different lifeways, subsistence strategies, and technologies. These periods can be grouped into two major divisions: Prehistoric (dating before contact with Europeans), and Historic (dating after contact with Europeans).

2.9.1 Previously Documented Cultural Resources

Prior to this study, the Park and study area had not been surveyed for cultural resources, so USACE contracted with AmaTerra Environmental, Inc. (AmaTerra) to conduct an archaeological survey of the 388 acres within the Park study area.

Before contracting this survey, USACE conducted an initial examination of data gathered from the Texas Historical Commission's (THC) Texas Archaeological Sites Atlas database in July 2014, in order to develop a general characterization of the kinds of archaeological and historic resources that have been documented in the area around the study area. The results of this initial inquiry are presented here.

The available data are not comprehensive; they include information only from those areas that have (a) undergone systematic archaeological survey, and (b) have historic structures that have been documented and/or recorded by interested parties and have filed those records with the THC. Nonetheless, the information available from this database provides a general sense of the kinds of resources likely to be present in the unsurveyed areas within and near the study area.

Of the 710 documented sites within the overall area, the vast majority date to the Historic period (610 sites, or 80.1% of the total), with only 19.8% (total 151) being prehistoric in age (Table 3). Breaking down the time periods further, Table 4 shows that the majority of the prehistoric sites are of indeterminate age (127 out of 151, or 16.7% of all sites), with the remaining prehistoric sites (n=24) all falling within the Formative period (including the Mesilla and El Paso phases). There was insufficient information in the Atlas database to assign more precise ages to 306 of the 610 Historic sites. However, for the remaining 304 sites, the majority date to the recent Historic period, with 290 of those 304 sites dating to the 1800s or 1900s (Table 5).

Table 3: Archaeological sites by age (Prehistoric versus Historic).

Time Period	Count	Percent
Prehistoric	151	19.8%
Historic	610	80.1%
Unknown	1	0.1%
Total	762	100.0%

Table 4: Finer-grained time periods for documented archaeological sites.

Time Period	Count	Percent
Prehistoric (Indeterminate)	127	16.7%
Formative (Indeterminate)	11	1.4%
Mesilla - El Paso Phases	1	0.1%
Mesilla Phase	11	1.4%
El Paso Phase	1	0.1%
1700s	8	1.0%
1700s-1800s	5	0.7%
1700s-1900s	1	0.1%
Post-1700s	1	0.1%
1800s	71	9.3%
1800s-1900s	136	17.8%
1900s	82	10.8%
Historic (Indeterminate)	306	40.2%
Unknown	1	0.1%
Grand Total	762	100.0%

Table 5: Date ranges for Historic-age sites, where available.

Row Labels	Count	Percent of Dated Historic Sites
1700s	8	2.6%
1700s-1800s	5	1.6%
1700s-1900s	1	0.3%
Post-1700s	1	0.3%
1800s	71	23.4%
1800s-1900s	136	44.7%
1900s	82	27.0%
Grand Total		100.0%

These sites represent a variety of site types, including artifact scatters, prehistoric habitation sites, and historic structures. As shown in Table 6, the vast majority of Prehistoric sites are classified as “open campsites,” representing short-term or ephemeral use of an area and usually characterized by scatters of artifacts (including lithic artifacts and ceramic sherds) and often associated with features such as hearths. The Historic-period sites are overwhelmingly dominated by historic structures, mostly houses and residences.

Table 6: Site types by time period.

Site Type	**Prehistoric**	**Historic**	**Unknown**	***Total***
Artifact Scatter	26	2		*28*
Burial		1		*1*
Campsite/Habitation	2			*2*
Historic Misc		8		*8*
Historic Scatter		10		*10*
Historic Structures		575		*575*
Irrigation Canal		11		*11*
Isolated Feature	1			*1*
Open Campsite	121			*121*
Puebloan Structures		1		*1*
Residential		1		*1*
Unknown	1	1	1	*3*
Grand Total	151	610	1	*762*

2.9.2 National Register Districts

The study area is located within the El Paso County Water Improvement District (EPCWID) No. 1, listed on the National Register of Historic Places (NRHP; National Register # 97000885, listed in 1997). The NRHP listing recognizes the significance of the historic irrigation systems of the El Paso Valley, and currently includes 206 miles of canals and laterals and 195 miles of drains serving 56,000 acres of farmland, as well as hundreds of smaller engineering features. The EPCWID is limited to publicly owned properties. AmaTerra did not identify any resources within the Park associated with the EPCWID.

2.9.3 Archaeological Survey

AmaTerra Environmental, Inc., conducted an intensive archaeological survey of 388 acres encompassing the Park study area. The survey included pedestrian survey, shovel testing, and geoarchaeological assessment involving backhoe trenching. In total, crews excavated 69 shovel tests and 10 backhoe trenches. Results of the survey, including both field data and examination of historic imagery and maps, demonstrated that almost all of the study area has been strongly impacted by past fluvial processes, such as historic rechanneling of the Rio Grande, and by cultivation and later habitat-reclamation disturbances. As a result, prehistoric sediments (and the potential for prehistoric archaeological materials) are not present within the study area. The survey identified four newly-discovered archaeological sites, all of which of recent historic (twentieth-century) age: 41EP7146, 41EP7147, 41EP7148, and 41EP7149. Three of these sites are locations of former structures, and the fourth is an extensive recent trash dump. AmaTerra recommended that none of these sites be considered eligible for listing on the NRHP, and USACE has determined that none of these sites are eligible for NRHP listing. The THC concurred with these determinations on 22 February 2016 (Appendix D). An area adjacent to the Park to the south is currently being considered as a disposal location for sediment removed from the Park by the proposed project; this area is currently being evaluated pursuant to Section 106. Any disposal area selected for the proposed project will undergo full Section 106 consultation before construction would begin.

2.9.4 Future Without-Project Conditions

Cultural and historic resources identified within the study area include four twentieth-century archaeological sites identified during field investigations (41EP7146, 41EP7147, 41EP7148, and 41EP7149). All have been determined not eligible for inclusion on the National Register of Historic Places. None of these resources would be affected in any way in the absence of the proposed USACE project; in other words, the "future without project" condition of these resources would remain approximately constant and consistent with the current conditions.

2.10 Indian Trust Assets

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

Consistent with the Department of Defense's American Indian and Alaska Native Policy, signed by Secretary of Defense William S. Cohen on October 20, 1998, all Tribes that have indicated they have concerns within El Paso County have been contacted regarding the proposed project (Appendix D). To date, USACE has received no tribal concerns regarding the study. Ysleta del Sur has responded to scoping letters, indicating no concerns with the project. No specific concerns or ITAs have been brought to the attention of USACE.

2.11 Surface Water Quality

Constructed wetlands can be designed to reduce nutrients from incoming effluent discharges while providing suitable habitat for wildlife (Carey and Migliaccio 2009). However, the release of raw and treated wastewater can provide a source of fecal bacteria, pharmaceuticals and personal care products, endocrine-disrupting compounds, pharmaceuticals, hormones and other organic contaminants (Vitousek et al. 1997, Carey and Migliaccio 2009, Kim et al. 2009, Yoon et al. 2010). Effluent from point sources, such as WWTPs can overwhelm receiving waters, effectively dominating hydrological characteristics and regulating in-stream nutrient process (Vymazal 2007). In wetland systems, especially those that lack a surface water outflow, nutrients and carbon are retained and recycled through successive seasons of plant growth, death, and decay (Hammer 1989). The potential rate of nutrient uptake by plants is limited by the concentration of nutrients in the plant tissue and stage of growth (Vymazal 2007). Water that leaves a wetland through groundwater infiltration is filtered through the soils resulting in the accumulation of solutes and other pollutants (Hammer 1989).

The Park currently receives irrigation water, reclaimed wastewater, and groundwater (Section 2.12.4). Each of these sources have unique water quality characteristics (Arcadis 2012, Arcadis 2013, Street and Peery 2014, Pina & Lougheed Unpublished). To quantify the contributions of these sources on water quality within the Park, the annual average load was calculated using the estimated potential volume multiplied by the annual average mean concentration (Table 7). If an annual mean concentration was not readily available, discrete data were compiled and averaged. The potential volume of each source was obtained from the water budget (see section 2.3). To calculate the load from precipitation, concentrations were obtained from the National Atmospheric Deposition Program's (NADP) station in the nearby Guadalupe Mountains (TX22). Water quality data was obtained from a variety of sources (Arcadis 2012, Arcadis 2013, Street and Peery 2014, Pina and Lougheed Unpublished). Groundwater quality data was not available for wells RB-12 and RB-13, and data from test hole RB-5 was used as a surrogate (see Section 2.12.4). RB-5 is proximal to well RB-12 with similar screened intervals (see Figures 17 and 18 in Section 2.12.4).

The consistent water source within the Park has resulted in extensive areas of emergent vegetation within portions of the existing wetland cells (Section 2.1), with presumably positive effects on water quality (Rodriguez & Lougheed, 2010). However, the current configuration of the Park lacks a surface water outflow, with groundwater infiltration and evapotranspiration as the only losses.

Table 7: Annual average water quality loads for each of the water sources from the Park under existing conditions.

Source	Annual Volume (m^3 x10^6/year)	Chloride (mg L^{-1})	Chloride (kg year $^{-1}$)	Nitrate (mg L^{-1})	Nitrate (kg year $^{-1}$)	Total Phosphorus (mg L^{-1})	Total Phosphorus (kg yr^{-1})
Precipitation	0.05	0.10	5.08E+00	0.70	3.56E+01	ND	ND
Riverside Canal	0.43	393	1.69E+05	3.8	1.62E+03	1.8	7.63E+02
WWTP Effluent	5.52	322	1.78E+06	11.4	6.28E+04	2.7	1.46E+04
Wells RB 12 & 13	0.26	651	1.67E+05	ND	ND	ND	ND

ND: data not readily available.

2.11.1 Future Without-Project Conditions

The three water sources will continue to support wetland and riparian plant growth along the historic river channel within the Park and in portions of the existing wetland cells, with expected positive effects on water quality (Rodriguez and Lougheed 2010). However, the lack of surface outflow will likely result in accumulation of solutes over time. In addition, nutrient uptake rates in wetlands will likely decrease over time as phosphorus and other nutrients become saturated (Migliaccio 2009). Prolonged nutrient loading can have negative effects on the nutrient dynamics of the wetland, leading to shifts from one stable state to the next, often involving structural changes in the vegetation and losses of plant species diversity (Vymazal 2006).

2.12 Geology and Structural Setting

2.12.1 General Geology

El Paso is located within the Basin and Range physiographic province typified by north/south trending faults that created horst and graben structures (bolsons), north/south trending mountains, and broad intermountain basins. The City of El Paso and suburban developments surround the southern tip of the Franklin Mountains, form the terminus of the chain of mountains that extends southward from the San Andres-Organ Mountains of south-central New Mexico. The Franklin Mountains are about 20 miles in length, have a maximum width of about 8 miles, and rise to an elevation of 7,157 feet at the highest point. Structurally, the mountains are a fault block, which dips westward to the Rio Grande trough and exhibits a steep escarpment eastward toward the Hueco Bolson.

2.12.2 Stratigraphy

Rock exposed on the east side of the Franklin Mountains is primarily early Paleozoic limestone, dolomite, and sandstone overlying Precambrian granite, quartzite, and limestone. Tertiary igneous intrusive frequently are found cutting through the Precambrian and Paleozoic formations.

The lithologies in the Franklin Mountain furnished, via erosion, the majority of the sediments that fill the west side of the Hueco Bolson with broad coalescing alluvial fans. The deepest part of the Hueco Bolson lies just to the east of the Franklin Mountains. Gravity surveys have determined a north-south trending linear trough 20,000 to 30,000 feet deep filled with Pliocene through recent sediment.

Quaternary deposits are unconsolidated sand, silt, silty sand, and gravel and are divided into alluvial fans (bolson deposits) derived from the Franklin Mountains and Rio Grande terrace deposits of silty sand with intermittent lenses of gravel and fine-grained flood plain deposits. The Rio Grande terrace deposits are finer grained than the deposits of the alluvial fans.

2.12.3 Soils

The USDA-NRCS has produced a soil survey of El Paso County, TX, that includes the Park area. Soils are mapped to roughly 60 inches below ground surface. A list of the predominant soils in the study area can be found in Table 8. The locations of these soils can be seen on the map in Figure 16.

Table 8: Predominant soils present in study area.

Map Unit	Map Unit Name	Drainage Class	Saturated Hydraulic Conductivity (Ksat, in/hr)	Hydrologic Soil Group	Unified Soil Classification Code	USDA Texture
An	Anapra silty clay loam	Well Drained	0.20-0.57	C	CL, SM, SP-SM	Silty clay loam, silt loam, clay loam, fine sandy loam
Gc	Gila loam	Well Drained	0.57-1.98	B	CL, ML, SM	Loam, gravely sandy loam, silt loam
Ha	Harkey loam	Well Drained	0.57-1.98	C	CL-ML, ML	Loam, very fine sandy loam
Hk	Harkey silty clay loam	Well Drained	0.20-0.57	C	CL, ML	Silty clay loam, very fine sandy loam
Mg	Made land, Gila soil material	Well Drained	0.57-1.98	B	ML, SM	Fine sandy loam, loam, gravelly sandy loam, silt loam
Sa	Saneli silty clay loam	Well drained	0.00-0.06	D	CH, SM	Silty clay loam, fine sand
Sc	Saneli silty clay	Well drained	0.00-0.06	D	CH, SM	Silty clay, fine sand
Tg	Tigua silty clay	Well drained	0.00-0.06	D	CH, CL, CL-ML	Silty clay, clay, silt loam
Vn	Vinton fine sandy loam	Somewhat excessively drained	1.98-5.95	A	ML, SM	Fine sandy loam, loamy sand, fine sand

Figure 16. Map showing USDA-NRCS soil groups. USGS Soil Survey Geographic database, 2016.

2.12.3.1Hydrologic Soil Group Descriptions

Group A: Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B: Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C: Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D: Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Portions of the existing wetland areas lie over soils with high infiltration rates. Without the proposed project, infiltration will continue to impact the availability of water to support the wetlands and wetland plant growth. Any new or existing wetland features on permeable soils will require a liner to reduce water losses.

2.12.4 Groundwater

Based on historic data from the 14 groundwater-monitoring wells in the area (Figure 17), groundwater depths vary greatly depending on the time of year and location within the Park, with an average depth of 10 ft below ground surface (bgs). Winter groundwater depths, when extra water is available to flood the Park, range from 1 ft to 10 ft. However, during the summer when less water is available, the depth to groundwater ranged from 10 ft to 35 ft bgs prior to 2015. The greatest depths occurred in years when no water was available to the Park during the growing season and extensive groundwater pumping took place near the Park. During 2015-2017, with water available to the Park during the growing season, the drop in groundwater levels during summer has been less pronounced. In 2017, depth to groundwater between June and September ranged from 5.6 ft to 13.8 ft bgs. The shallowest depths were at monitoring wells near the historic river channel or the wetland cells; the greatest depths were at monitoring wells near producing wells that were pumping water, including the two within the Park. Total dissolved solids (TDS) and conductivity from each of the ground-water monitoring wells is assessed on a quarterly basis. The majority of the wells are screened between 10 ft and 20 ft deep, so during the years of greatest groundwater drawdown, the shallower wells often experience dry conditions where groundwater-depth or water quality data cannot be obtained.

However, six test holes (Figure 18) were drilled to approximately 180 feet and screened and developed at two discrete zones for water quality testing (Street and Peery 2014). The goal of this effort was to determine variation in pH, specific conductance, TDS, major anions and cations, total alkalinity, and dissolved arsenic laterally and with depth in the aquifer along with a comparison to USEPA maximum contaminant levels (MCL). The MCL is the maximum level allowed of a contaminant in water which is delivered to any user of a public water system. Groundwater depth and hydraulic properties of the aquifer were not investigated from these test holes beyond the pumping rate (i.e., 4-19 gpm). From the reported water quality data, a piper diagram (Figure 19) was developed to provide a visualization of common ions from each discrete zone (represented by symbol) and test hole (represented by color). The ternary diagram in the lower left of the piper diagram represents cations (magnesium, calcium, and sodium plus potassium), a ternary diagram in the lower right representing anions (chloride, sulfate, and carbonate plus bicarbonate), and a symbol in the middle, which is a matrix transformation of the two ternary diagrams. Each sample is normalized (sum of cations = 100 and sum of anions = 100), so the relative concentrations are on a percentage basis. The piper diagram suggests there is minimal variation in water chemistry laterally and with depth. TDS, chloride, and sulfate exceeded their respective MCLs from both zones from all test holes (Street and Peery 2014). While dissolved arsenic exceeded the MCL in at least one zone of each test holes, with the exception of RB04 (Street and Peery 2014). The samples collected did not exceed National Ambient Water Quality Criteria (USEPA 2019), with the exception of chloride (230 mg L^{-1}), which was exceeded in all test holes and zones. The pH ranged from 6-7.9 within the test holes, with one sample exceeding the USEPA criteria (6.5-9).

Under the No-Action Alternative, the groundwater table and associated quality beneath the Park will vary due to antecedent hydrologic conditions; water conveyance system operations and modifications; groundwater extraction for irrigation purposes when surface water does not meet demand; and infiltration. Anticipated declines due to lining of the adjacent Riverside Canal may be offset by the delivery of irrigation water. Groundwater quality (e.g., TDS and nitrate) beneath the Park may also degrade due to the lining of the adjacent Riverside Canal, which provides water of greater quality than the Bustamante WWTP effluent and shallow groundwater within the Park (Arcadis 2012). However, groundwater quality degradation may be offset by the delivery of additional irrigation water, which provides water of greater quality than the WWTP effluent and shallow groundwater within the Park (Arcadis 2012).

Figure 17. Locations of monitoring wells within the Park.

Figure 18. Aerial photograph of 2014 test hole locations.

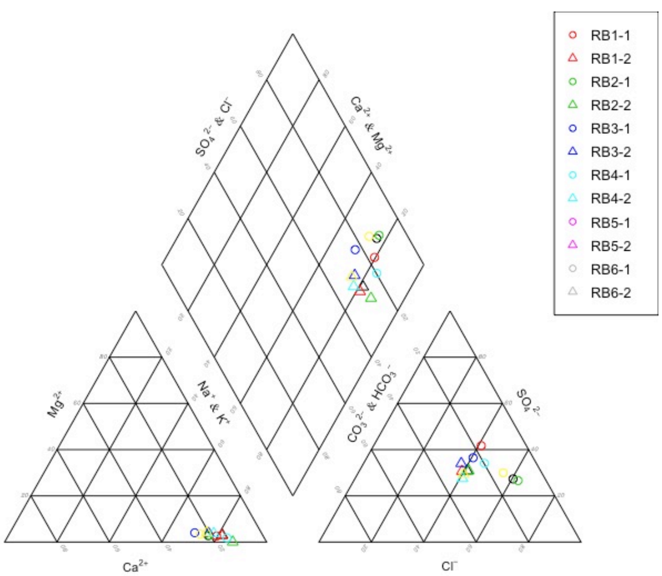

Figure 19. Piper diagram derived from groundwater quality data collected at two discrete-interval zones from six test holes in 2014.

2.12.5 Geotechnical

Currently, seepage and piping near Irrigation Gate #6 is leading to a sinkhole that threatens the structure (Figure 20). This is likely due to poor management of surface water near the gate structures combined with poorly compacted soils and a lack of filter materials. Lack of repairs and maintenance to the gate structures prohibits regulation of the wetland system and may lead to increased water loss from existing ponding areas. Erosion rills are also developing in many locations throughout the study area, specifically along the water supply ditches (Figure 21).

Figure 20. View of a sinkhole.


Figure 21. View of rill.

2.12.6 Future Without-Project Conditions

The general geology and soils will not change if the project is not implemented. Ground water will continue to fluctuate on a seasonal basis, depending on inputs from precipitation and water deliveries. With water now available during the growing season, groundwater conditions are more favorable for vegetation in the riparian areas of the Park. Should there be a reduction in water availability in the future, seasonal groundwater declines could again occur, and would lead to die off of beneficial species. Without repairs to the irrigation gate structures, erosion/piping will continue to the existing structures and possibly lead to the gates failing to function as originally designed. This will prevent the gates from being used effectively to supply the Park with water from the agricultural drain, and direct water where needed. Erosion rills in the ditches will develop deeper head cuts and eventually threaten the roadways within the Park.

2.13 Real Estate

All of the lands within the study area are owned in fee by the City of El Paso. It is anticipated that the future without-project would remain unchanged and have no effect on existing land ownership conditions at the site.

3 - Plan Formulation and Evaluation

3.1 Plan Formulation Rationale

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

This section presents the rationale used in the development of this plan. The USACE six-step planning process specified in ER 1105-2-100 (Planning Guidance Notebook) is used to develop, evaluate, and compare the array of candidate plans that are considered. The plan formulation process includes the following steps:

1. Identifying Problems and Opportunities: The specific problems and opportunities are identified, and the causes of the problems are discussed and documented. Planning goals are set, objectives are established, and constraints are identified.

2. Inventorying and Forecasting Resources: Existing and future without-project conditions are identified, analyzed, and forecasted. The existing condition resources, problems, and opportunities critical to plan formulation, impact assessment, and evaluation are characterized and documented.

3. Formulating Alternative Plans: Plan formulation is the process of building plans, consisting of structural or non-structural measures singly or in combination, which meet planning objectives and avoid planning constraints.

4. Evaluating Alternative Plans: Evaluation allows the PDT to determine whether each individual alternative plan meets the study's specified goals and objectives and whether it will therefore be compared against other plans. Specific criteria are used to evaluate qualified plans. The significant contributions or effects of an individual plan are assessed and appraised. Screening criteria include completeness, effectiveness, efficiency, and acceptability.

5. Comparing Alternative Plans: Alternative plans are compared against each other. Cost effectiveness and incremental cost analysis are used to prioritize and rank ecosystem restoration alternatives. A public involvement program obtains public input to the alternative identification and evaluation process.

6. Selecting Tentative Selected Plan: From the alternative plans, the plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the federal objective, is selected. This plan is identified as the National Ecosystem Restoration (NER) Plan. A locally preferred plan may be recommended and approved if the non-federal sponsors desire other acceptable project features than those in the NER Plan.

3.2 Development of Alternative Plans

Alternatives are formulated to address a comprehensive Federal project for aquatic ecosystem restoration in order to:

- Ensure that a wide variety of possible solutions were considered that incorporate public and stakeholder concerns, the highest cost benefit output feasible, and the least negative impact on the human environment;
- Provide decision-makers with information that can be utilized to help determine the balance between construction costs, real estate costs, and social issues and concerns;
- Comply with NEPA and other environmental laws and regulations;
- Restore a diversity of riparian and associated floodplain habitats to a more natural state;
- Produce NER benefits while positively contributing to the National Economic Development Account, Regional Economic Development (RED) account, and the Other Social Effects (OSE) account;
- Provide a framework for responding to future urban development in the floodplain consistent with Executive Order 11988; and
- Blend existing and proposed improvements where possible to take advantage of local improvements and to be consistent with future master planning of the local community.

The PDT identified a set of alternative restoration plans from various combinations of management measures, added together, eliminated, rescaled, and otherwise modified so that the resultant suite of formulated alternative plans addressed the planning goals and objectives of the study. Each alternative plan is made up of smaller components called measures. Restoration measures, the smallest components of the alternative plans, were developed to provide a specific element or restorative function. Measures were then combined based on position in the landscape, dependencies, and combinability to form restoration alternatives. Plan areas are a combination of several compatible measures at a specific location that achieves functional and sustainable restoration at that site. At any given location, more than one measure might be possible, but they must be mutually exclusive. For instance, a measure that includes creation of a wetland could not be implemented at the same place as a measure that includes planting a new stand of willows. Alternatives require analysis to determine whether they address the specified problems and opportunities, and planning objectives and constraints. As such, the alternatives as described in this feasibility report are not proposals for actual construction, nor are they of sufficient design detail to be constructed. Following the completion of the feasibility report, EA, public feedback, and project approval, if such action occurs, detailed design analysis and preparation of plans and specifications for construction would take place.

3.2.1 Preliminary Management Measures

The following measures have been identified to contribute to meeting the objectives identified in Section 1.10.3.1. Each measure will require limited periodic maintenance or modification to achieve the long-term objectives of the project. In developing measures, the PDT considered site history (Section 1.3) and challenges that previously had limited the success of past restoration efforts, such as limited water supplies and high infiltration losses.

The PDT's approach to meeting project objectives is to provide a mosaic of habitat types with wetland habitat being the dominant habitat type. Wetland habitat can be open water, deep wetlands, shallow wetlands, or marsh. Water regimes would vary from semi-permanent, deep areas to seasonal or intermittently flooded shallow wetlands or marsh. The deeper open water wetlands would provide a critical refugium for aquatic-obligate herpetofauna and invertebrates during drier periods as the shallower wetlands dry out. Size and connectivity would vary from small, relatively isolated wetlands to interconnected wetland-marsh complexes. Whereas larger, interconnected wetlands allow for movement of organisms into areas that remain wetted, smaller isolated wetlands provide habitat for unique, diverse assemblages of organisms (Singh 2015). The goal is to have wetland habitat comprise approximately 25% of the study area as water quantity allows.

The second most dominant habitat type would be riparian habitat at approximately 15% of the study area. Riparian habitat would provide a canopy of taller cottonwood or Goodding's willow trees with mixed density of willow/shrub lower canopy vegetation. This provides important avian habitat both during migration and for nesting by riparian obligate species.

The third habitat type is floodplain grassland, with a goal of approximately 5% of the study area comprising this habitat type. The floodplain grassland habitat type provides a transition zone or buffer between riparian or aquatic habitats and drier habitat, contributing to habitat and species diversity. Non-wetland areas adjacent to wetlands provide habitat functions critical for biodiversity, including nesting habitat for turtles, invertebrate production, shelter for small mammals, and habitat for herps and ground nesting birds (Beacon Environmental 2012, Bentrup 2008). This habitat type would be a mix of native grass and forb species and would replace early successional, mostly non-native vegetation, thereby providing a buffer against invasive species.

The PDT identified the following measures or actions for achieving the project objectives. The PDT was able to eliminate early on the need for some actions, and the rationale for eliminating is provided below.

1. Deepen Existing Wetlands

   The two existing wetland areas, which historically received water only during the winter non-irrigation season, now receive water during the irrigation season as well. These areas would be deepened to provide improved wetland habitat with varying depth and a larger area of relatively permanent wetlands. Edge habitat would be approximately 0.5 – 1.5 feet deep sloping down into wetland with open water approximately 3-6 feet deep. The deeper open water portion of the wetland would provide refuge habitat for aquatic species during drier periods. Finally, emergent wetland vegetation would be planted to 'jump start' development of high quality wetland habitat. These wetlands would be lined with Geosynthetic Clay Liners (GCL) or bentonite clay as needed to reduce loss of water through infiltration (USDA-NRCS, 2009). These areas are connected to the Bustamante WWTP water line, but also require water delivery system improvements, such as lining the distribution channels and replacing worn gates to take advantage of the newly available irrigation water.

2. New Wetlands

   These areas would be either adjacent to existing wetland areas or other suitable areas, and would be excavated as new wetlands. Some of the areas originally proposed for new wetlands were also considered for development as shallow marsh (measure 4). Similar to the existing wetlands, new wetlands would have edge habitat approximately 0.5 – 1.5 feet deep sloping down into wetland with open water approximately 3-6 feet deep, and emergent wetland vegetation would be planted. Depending on the soil infiltration rates in the locations of the new wetland areas, GCL or bentonite clay may be necessary to reduce water losses. Water delivery system improvements connecting these areas to a permanent water source would be required.

3. New Riparian Area

   New cottonwood-willow riparian areas would be created in suitable locations, such as adjacent to existing riparian or wetland habitat, adjacent to the old river channel, or other areas with adequate depth to groundwater.

4. New Marsh

   Marsh is a shallow wetland habitat type that would be constructed adjacent to deeper wetland habitat, providing an expanded area of wetlands when sufficient water is available. The marsh habitat would be seasonally or intermittently flooded, enhancing invertebrate production and providing important shorebird and waterfowl foraging habitat. Expected water depth would be approximately two inches to two feet.

5. New Floodplain Grasslands

   Floodplain grasslands provide connectivity among habitat types and serve as transition zones between riparian or wetland and drier habitats. They also act as a buffer and provide for open viewing areas for visitors. Floodplain grasslands would consist of a mix of native grass and forb vegetation.

6. Saltcedar Thinning

   The majority of saltcedar would be removed within these areas in coordination with the Park. Dense mature saltcedar used by long-eared owls would be left undisturbed. Saltcedar would be cut and treated with herbicide. These areas would be seeded with native grass. We anticipate that tornillo will colonize these areas, so other plantings won't be necessary. Maintenance control of saltcedar resprouts will be needed.

7. Elevate and Line Channel

   The main channel may be elevated in order to provide a suitable gradient for water to flow by gravity to all wet habitat that it is connected to; lining of the channel with GCL or bentonite clay will reduce seepage losses. Raising the elevation of the channel was eventually deemed unnecessary after the Sponsor explained other means already exist for stimulating an increase in flow, when needed.

8. Water System Improvements

   Proposed connections (either open flow or via pipe or other structure) and additional gates are required to move water from the various water sources (WWTP, Riverside Drain, Riverside Canal, or existing channel) at various times of year to proposed measures. These improvements are not included in the subsequent cost-effectiveness and incremental cost analysis (CE/ICA) , since they are considered needed improvements regardless of which set of measures are selected.

9. Burrowing Owl Habitat

   There is potential to use excavated material from implementation of wetland deepening to enhance existing, or create new, berms with artificial burrows for Burrowing Owls. This would increase available suitable habitat and reduce the cost of disposal of excavated material. Early on, the PDT determined sufficient burrowing owl habitat already exists, and this measure was eliminated from further consideration.

3.2.2 Formulation of Alternative Plans

Locations within the study area were considered for implementation of each measure. The conceptual locations for all measures considered are shown on Figure 22.

- **Deepen Existing Wetlands**: There are two areas of existing wetlands that are suitable for this measure (E1 and E2)
- **New Wetlands**: Five sites have potential for implementation of this measure (W1-W5)
- **Riparian Area**: There are seven sites with potential for creation of riparian areas in proximity to water conveyance channels (R1-R7).
- **New Marsh**: Two sites were initially identified as having potential for implementation of this measure (M1 and M2).
- **Grass Meadow**: There are four sites with potential for enhancement of native grass vegetation within the study area (G1-G4).
- **Saltcedar Thinning**: Two areas have been identified for saltcedar thinning (SC1 and SC2).
  .

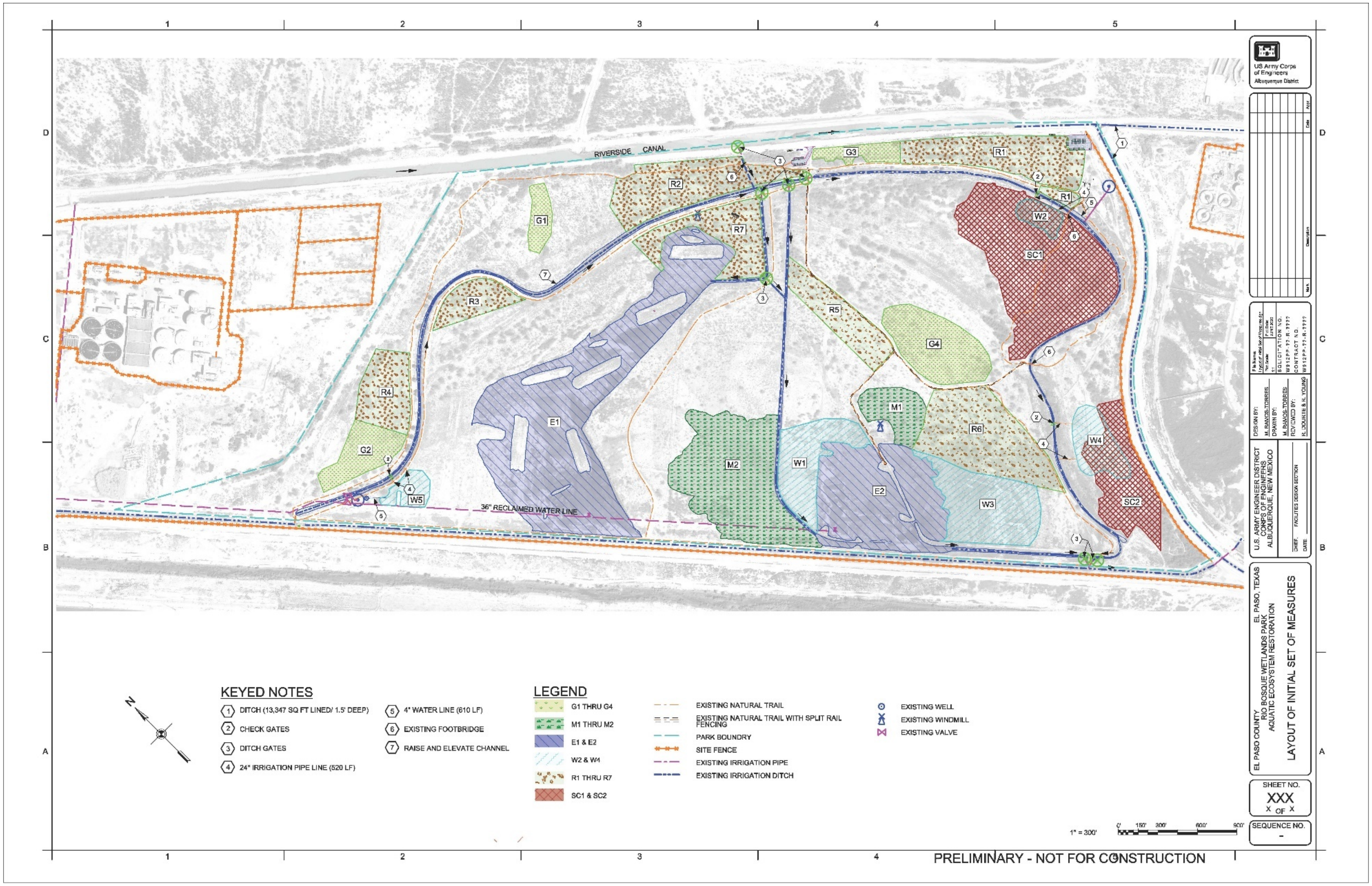

Figure 22. Conceptual plan showing draft preliminary measure locations.

3.3 Evaluation of Preliminary Alternatives

3.3.1 Incremental Cost Analysis and NER Plan Selection

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 NER Plan. CE/ICA is the technique used by USACE to develop 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" that meets the restoration objective is usually chosen as the tentatively selected 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 objective.

3.3.2 CE/ICA Analysis

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. A management measure is a feature or an activity that can be implemented at a specific geographic site to address one or more planning objectives. Management measures are the building blocks of alternative plans. See Appendix E for a more detailed discussion of the iterative CE/ICA process.

Restoration measures to enact the proposed improvements for this project include: a) new wetlands, b) existing wetlands, c) new marsh, d) riparian habitat, e) floodplain grassland habitat, and f) saltcedar removal. Water system improvements (elevating and/or lining the channel and establishing new channel or pipeline connections) are considered prerequisites for any restoration measures that would increase wetland or riparian habitat. These measures were not evaluated in CE/ICA because they are required in order to do any of the restoration measures that contribute towards the project purpose. In addition, CE/ICA evaluation does not include incidental recreation measures.

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. Table 9 summarizes each of the restoration measures used in this study. Locations of those measures are displayed in Figure 22. Each of the restoration measures were entered into USACE Institute for Water Resources (IWR) Planning Suite (IWR-Plan). Each measure included the No-Action option. 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.

Table 9: Measures analyzed in IWR-Plan and their description.

W1 – W5	New Wetlands	Construct new wetlands.
E1-E2	Existing Wetlands	Existing wetlands would be deepened and lined to provide improved habitat and a larger permanent wetland area.
M1-M2	New Marsh	New shallow marsh wetland habitat would be constructed adjacent to deeper wetland habitat.
R1-R7	Riparian Habitat	New cottonwood-willow riparian habitat would be created adjacent to existing riparian habitat, channels or wetlands.
G1-G4	Floodplain Grassland Habitat	Floodplain grasslands would be planted as a transition zone or buffer between riparian or aquatic habitats and drier habitat. .
SC1-SC2	Saltcedar Removal	Activities to remove exotic saltcedar from specific areas within the study area.

Most federal agencies use annualized output values 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. Habitat units (HU) are annualized by estimating the HUs at designated target years throughout the period of analysis (50 years total) to estimate changes in habitat value with-project (WP) and without-project (WOP). HUs are annualized by discounting any future variability in those benefits to present values using the administratively published discount rate (2.75% in FY 2020). The results of this calculation are referred to as average annual habitat units (AAHU) and can be expressed mathematically. Using AAHU as a metric, the WP and WOP conditions 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 evaluate whether that change is cost effective.

3.3.2.1 Plan Generation

Using the software, IWR-Plan, once a planning study comprised of variables, outputs, and attributes has been defined with the plan editor, the plan generation module is used to populate a new planning set with plan alternatives.

There are 24 different measures available, which would generate approximately 6.2x10^23 alternatives if run in one model. The study was divided into four components in order to reduce the number of possible alternatives to a level that the software could process. In each run, each measure was assessed relative to the benefits to a single species chosen as an indicator (for example, wetland measures were assessed using only the American coot as an output measure).

This analysis considers the Average Annual Habitat Unit (AAHU) output as a desirable output of the ecosystem restoration efforts. The benefit stream for all the measures was calculated over a 50 year project life, summed and discounted using the FY 2020 rate of 2.75%. The composite output calculation takes into account other species' output computations (using the America coot for wetlands, the Northern pintail for marsh, the Yellow warbler for riparian and saltcedar removal, and the Black-tailed prairie dog for grassland), weighting them all equally at 25% of the total score. This assumption served as a starting point of the analysis. Finally, where the existing condition is assigned a value for a given measure, that measure's (output score in the existing condition) x (number of acres) is removed from the (output score with project) x (number of acres) to compute only the marginal benefits of performing a specific measure in the cost effectiveness analysis.

To disaggregate the options to something the software can handle, four cost effectiveness models were created. Each model contained only measures benefiting a single indicator species (e.g. the American coot, Yellow warbler, etc.) The intent of these four models is to identify only the best buys to be carried forward into a final composite run. To simplify terminology, each of these models can be categorized by habitat type: grassland, riparian, wetland, and marsh.

Each of the four runs yielded a list of best buy plans, which then became measures in a second cost-effectiveness run. In this second run, 550 plans were evaluated, and 24 were identified as best buys. Figure 23 is a graphical representation of the plans. To summarize these results, it makes sense to install all the grassland measures first, followed by the riparian measures, and then the marsh measures, and finally the wetland measures. There was no real mixing of habitat types in generating output.

Each best buy includes the efforts in prior best buys. Each best buy represents an incremental addition to the previous best buy's slate of activities. No best buys that substituted activities from previous best buys were identified.

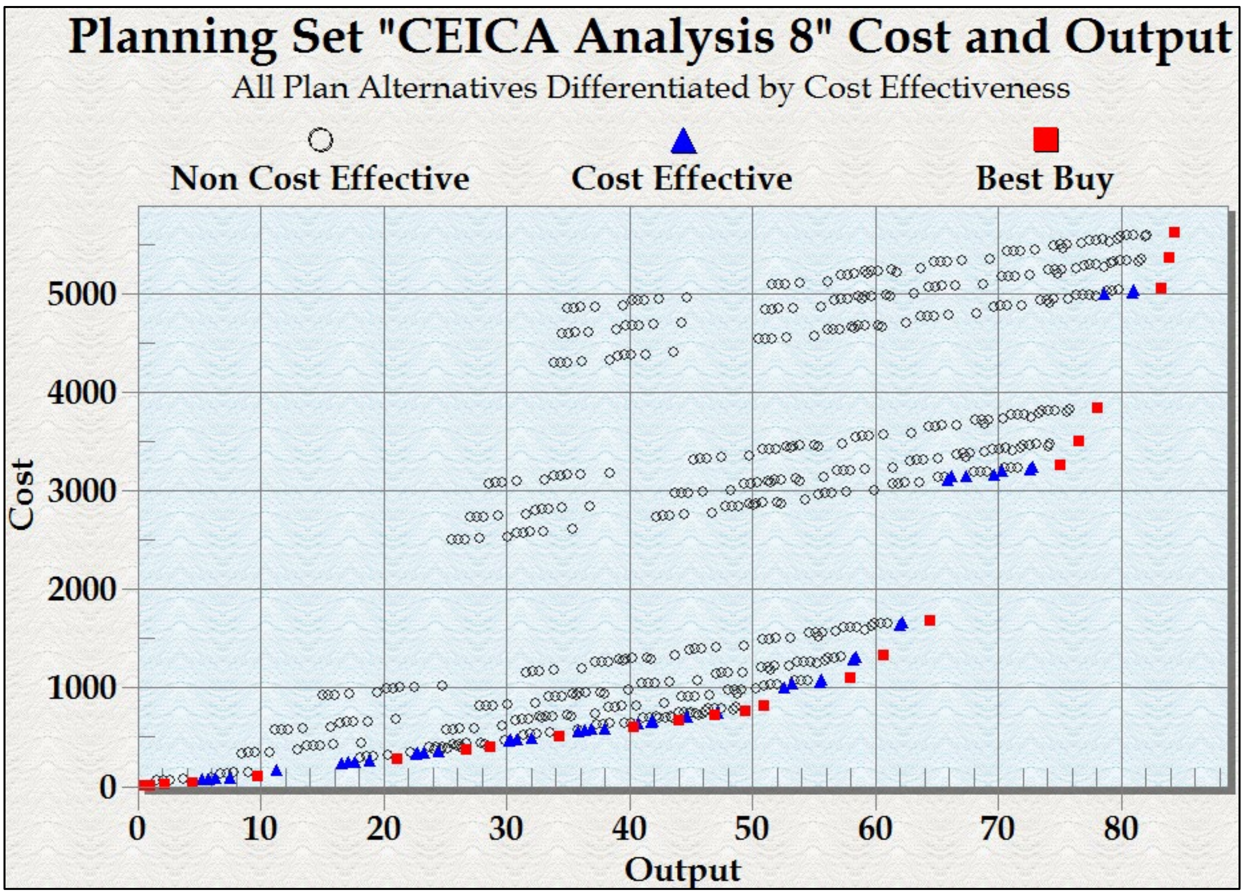

Figure 23. Representative graph showing best buy plans.

3.3.2.2 Sensitivity Analysis

A few sensitivity analyses were done to evaluate the impact of key variables on the final decision, evaluating the degree to which changing variable and yardsticks impacted cost effectiveness or plan order in the incremental analysis. The PDT was concerned there was no real mixing of habitat types along the final supply curve, which would make the "habitat heterogeneity" objective of the study impossible to meet without implementing each proposed measure in the study area. The first sensitivity run explored using acreage, rather than habitat units as outputs, and showed very similar results to the initial habitat run. Another run involved weighting species against each other in accordance with the Habitat Evaluation Procedures manual (USFWS 1980) and the PDT Biologist's expert opinion on beneficial outcomes for the study area. This method prioritizes habitats, such as wetlands, that are scarce and difficult to replace while assigning lower priority to habitats that are common. While this run did not substantially alter the final array of best buys, the PDT elected to use the weighted output sensitivity run as the basis for the incremental cost analysis.

Another finding of the first several runs was that deepening the existing wetlands would result in high construction costs forcing an exclusion of other measures that contribute to the diversity of habitat objective. For the final run, the PDT in turn reduced the existing wetlands area to be modified by 30%, which included lining this reduced area. Of this reduced area, 50% would be deepened. In addition, given the high cost associated with the excavation and lining of new wetlands, the PDT eliminated W5 and converted W1 and W3 into two new marshes, M3 and M4. OMRR&R costs were generated and added to the measures' installation cost for inclusion in the cost-effectiveness analysis. The decisions made for this second iteration culminated in the results of the CE/ICA presented below.

Figure 24 represents the output/cost graphs for the best buys. Figure 25 displays all the plans screened for cost effectiveness, per the final run in the IWR Planning Suite.

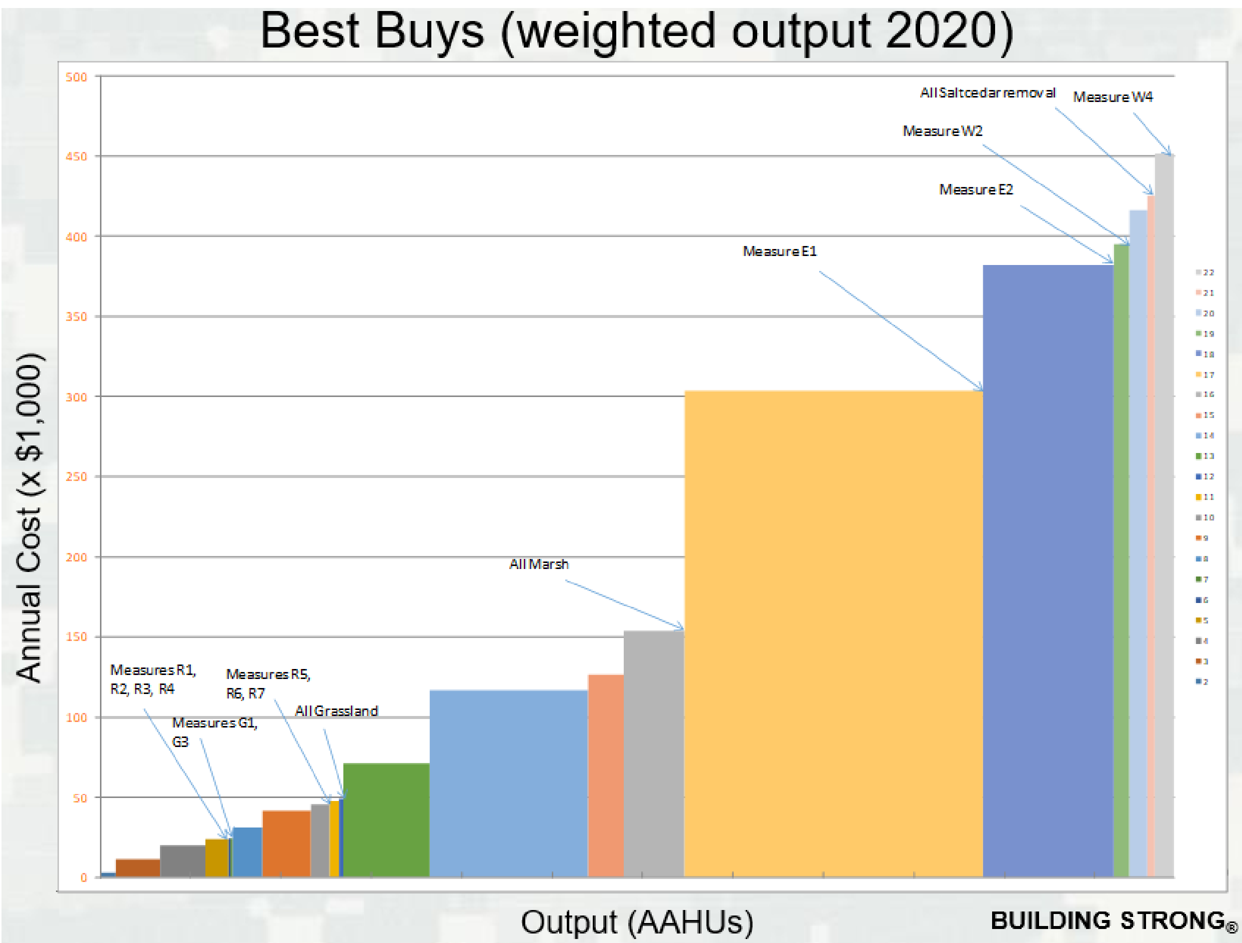

Figure 24. Best buy mapping and key plans identified, weighted output.

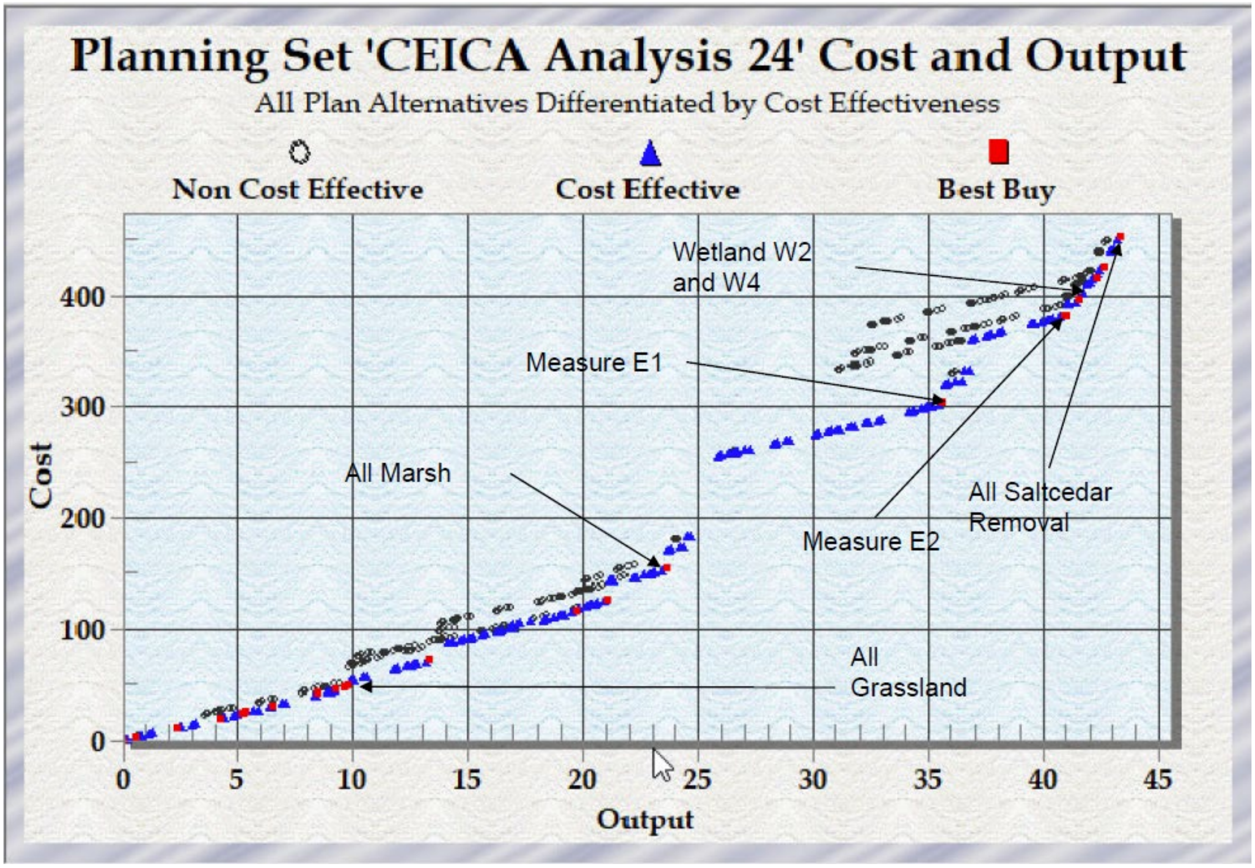

Figure 25. Best buy mapping and key plans identified (Cost in thousands of dollars, output in AAHUs)

3.3.2.3 Incremental Analysis

Weighted Output

As a result of the cost-effectiveness analysis, there were 21 best buy plans (plus the No-Action alternative) carried forward for incremental analysis (Table 10). The earliest plans involve a mix of riparian and grassland habitat creation. Next on the supply curve are marsh measures. Only after all riparian, marsh, and grasslands options are exercised does the cost-effective solutions begin to include wetland options, starting with existing wetland E1. New constructed wetlands and salt cedar removal then show up.

Table 10: Best Buy Plans. (Actual $, 2020 Price Level, 50-year period of analysis @ 2.75% interest rate)

BB #	Plan	Total Cost	Avg Ann Cost	AAHU's
0	No Action Plan	$0	$0	0
1	G0R1WM0	$61,805	$2,889	0.63
2	G0R2WM0	$239,245	$11,184	2.43
3	G0R3WM0	$418,678	$19,572	4.25
4	G0R4WM0	$510,389	$23,859	5.18
5	G1R4WM0	$518,148	$24,304	5.27
6	G2R4WM0	$525,475	$24,724	5.35
7	G2R5WM0	$668,632	$31,188	6.57
8	G2R6WM0	$895,296	$41,422	8.5
9	G2R7WM0	$988,348	$45,623	9.29
10	G3R7WM0	$1,021,969	$47, 550	9.65
11	G4R7WM0	$1,039,211	$48,538	9.83
12	G4R7WM1	$1,638,562	$71,404	13.33
13	G4R7WM2	$2,828,034	$116,422	19.72
14	G4R7WM3	$3,089,216	$126,407	21.13
15	G4R7WM4	$3,806,431	$153,513	23.62
16	G4R7WM5	$7,824,719	$303,487	35.68
17	G4R7WM6	$9,923,832	$381,965	40.95
18	G4R7WM7	$10,269,290	$395,227	41.56
19	G4R8WM7	$10,477,083	$416,073	42.29
20	G4R9WM7	$10,570,543	$425,584	42.62
21	G4R9WM8	$11,256,738	$451,586	43.38

As defined in Section 1.10.3, objectives of the study include the following:

- Within 5 years of construction, re-create the mosaic of habitats characteristic of the historic Rio Grande floodplain with an emphasis on wetlands of varying sizes, water regimes, and connectivity, and designed to endure.
- To increase the quantity and diversity of native wetland, riparian, and floodplain grassland habitats along with their associated native wildlife in the study area within 5 years of construction. Upon completion of the project, the study area should be comprised of approximately 25% wetlands, 15% cottonwood-willow riparian habitat, and 5% floodplain grassland.

Comparing the Best Buy Plans to the study objectives, the PDT focused on Best Buy Plans 16 thru 21 for further analysis. The following table summarizes the final array plans.

Table 11: Final Array of Alternatives from CE/ICA.

Alternative	Plan Measures	Approx. First Cost	Average Annual Cost	AAHU's	Approx. Area (acres) (Approx. Wetland Acres)
16	R3, R1, R2, R4, G3, G1, R7, R6, R5, G4, G2, M4, M2, M1, M3, E1	$7,824,720	$303,490	35.68	142.1 (81.8)
17	R3, R1, R2, R4, G3, G1, R7, R6, R5, G4, G2, M4, M2, M1, M3, E1, E2	$9,923,830	$381,970	40.95	158.7 (98.4)
18	R3, R1, R2, R4, G3, G1, R7, R6, R5, G4, G2, M4, M2, M1, M3, E1, E2, W2	$10,269,290	$395,230	41.56	160.1 (99.8)
19	R3, R1, R2, R4, G3, G1, R7, R6, R5, G4, G2, M4, M2, M1, M3, E1, E2, W2, SC1	$10,477,080	$416,070	42.29	181.4 (99.8)
20	R3, R1, R2, R4, G3, G1, R7, R6, R5, G4, G2, M4, M2, M1, M3, E1, E2, W2, SC1, SC2	$10,570,540	$425,580	42.62	191.2 (99.8)
21	R3, R1, R2, R4, G3, G1, R7, R6, R5, G4, G2, M4, M2, M1, M3, E1, E2, W2, SC1, SC2, W4	$11,256,740	$451,590	43.38	194.7 (103.3)

The makeup of the final array of alternatives consists of the combination of measures included in Alternative 16 and then for each larger plan includes one additional measure. Table 12 demonstrates the number and type of measures that are incrementally added to each larger alternative.

Table 12: Final Array of Alternatives Showing Measures.

Alternative	Plan Areas		Measures
16	R3, R1, R2, R4, G3, G1, R7, R6, R5, G4, G2, M4, M2, M1, M3, E1		Creation of 7 new riparian areas and 4 new marsh areas. Enhancement of four areas with native grass. Deepen one existing wetland.
17	R3, R1, R2, R4, G3, G1, R7, R6, R5, G4, G2, M4, M2, M1, M3, E1, E2	Alt 16 plus E2	Deepen another existing wetland.
18	R3, R1, R2, R4, G3, G1, R7, R6, R5, G4, G2, M4, M2, M1, M3, E1, E2, W2	Alt 17 plus W2	Creation of a new wetland.
19	R3, R1, R2, R4, G3, G1, R7, R6, R5, G4, G2, M4, M2, M1, M3, E1, E2, W2, SC1	Alt 18 plus SC1	Removal of salt cedar in one area.
20	R3, R1, R2, R4, G3, G1, R7, R6, R5, G4, G2, M4, M2, M1, M3, E1, E2, W2, SC1, SC2	Alt 19 plus SC2	Removal of salt cedar in another area.
21	R3, R1, R2, R4, G3, G1, R7, R6, R5, G4, G2, M4, M2, M1, M3, E1, E2, W2, SC1, SC2, W4	Alt 20 plus W4	Creation of another new wetland.

The Best Buy Plans, including the final array of alternatives, were also compared to the study objectives to identify the National Ecosystem Restoration Plan. Table 13 shows a Best Buy Plan's ability to address the objective and metric for meeting the objective.

The final array of alternatives includes the No-Action alternative. The No-Action alternative has no federal action or investment. In accordance with current policy, it is necessary to evaluate the No-Action alternative for purposes of comparison to other alternatives and the future with-project conditions. Evaluation of the No-Action alternative is synonymous with the "future without-project condition" described above. It is expected that the future without-project assumptions would be maintained in the study area. The No-Action alternative does not address the established objectives for the study area.

Table 13: Best Buy Plans Compared to Study Objectives and Criteria.

	Best Buy Plans																					
OBJECTIVES	**No Action**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
Within 5 years of construction, re-create the mosaic of habitats characteristic of the historic Rio Grande floodplain with an emphasis on wetlands of varying sizes, water regimes, and connectivity, and designed to endure.	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	2	2	2	2
To increase the quantity and diversity of native wetland, riparian, and floodplain grassland habitats along with their associated native wildlife in the study area within 5 years of construction. Upon completion of the project, the study area should be comprised of approximately 25% wetlands, 15% cottonwood-willow riparian habitat, and 5% floodplain grassland.	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	2	2	2	2

Notes: 0 (Red) - plans do not meet objectives. 1 (Yellow) - plans partially meet the objectives. 2 (Green) - plans fully meet the objectives.

The first project objective is to re-create the mosaic of habitats characteristic of the Rio Grande prior to the Twentieth Century, with an emphasis on wetlands of varying sizes, water regimes, and connectivity. This objective is partially achieved with the addition of shallow marsh wetland habitat in Best Buy Plans 12 through 15. However, the existing wetlands are also relatively shallow and lack deep water habitats. The "varying sizes and water regimes" part of this objective is only fully met with the creation of deeper wetlands or deepening existing wetlands. Plan 16 is the first plan to include deeper, open-water wetlands and was therefore the first plan that the PDT considered in the final array. The "varying connectivity" part of this objective is met by including both interconnected and relatively isolated wetlands. Plan 18, which includes creation of a new, deep wetland that is not directly connected to the other wetlands, is the first plan that fully meets this objective. Although W2 adds only a small increment to the project wetland acreage, it adds a different type of wetland- relatively small, deep, and semi-permanent. As described in Section 3.2.1, smaller isolated wetlands provide habitat for unique, diverse assemblages of organisms. Therefore, the PDT feels that Plan 18 is the first plan that fully meets this project objective. Additionally, W2 contributes to the OSE account (see Section 3.3.2.4 (b)) by providing a more accessible wetland feature that visitors can readily observe.

The second objective, to increase the quantity and diversity of native wetland, riparian, and grassland habitats along with their associated native wildlife in the study area, includes a quantitative metric: upon completion of the project, the study area should be comprised of approximately 25% wetlands, 15% riparian habitat, and 5% grass meadow. Plans 12 through 15 add areas of shallow wetland, and plan 16 adds a deeper existing wetland area, partially meeting the qualitative part of this objective. Nevertheless, only with the inclusion of new wetland W2, plan 18, is the full diversity of wetland types achieved, and the metric of having the project area be comprised of 25% wetlands met.

Principles and Guidelines (P&G) criteria are applied to plans as part of plan formulation. The criteria are as follow:

- Completeness: The extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects. This may require relating the plan to other types of public or private plans if the other plans are crucial to realization of the contributions to the objective.
- Effectiveness: The extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities.
- Efficiency: The extent to which an alternative plan is the most cost-effective means of alleviating the specified problems and realizing the specified opportunities, consistent with protecting the Nation's environment.
- Acceptability: The workability and viability of the alternative plan with respect to acceptance by State and local entities and the public and compatibility with existing laws, regulations, and public policies.

The Best Buy Plans were scored as low, medium, or high related to their ability to meet the Completeness and Effectiveness criteria. For the Efficiency and Acceptability criteria, the plans were rated Yes or No. Because of the CE/ICA process, all the Best Buy Plans meet the Efficiency criterion. Table 14 summarizes the comparison of the Best Buy Plans to the P&G criteria.

Table 14: P&G Criteria Compared to Best Buy Plans.

	P&G Planning Criteria			
Best Buy Plans	**Completeness**	**Effectiveness**	**Efficiency***	**Acceptability**
No Action	LOW	LOW	NO	NO
1	LOW	LOW	YES	YES
2	LOW	LOW	YES	YES
3	LOW	LOW	YES	YES
4	LOW	LOW	YES	YES
5	LOW	LOW	YES	YES
6	LOW	LOW	YES	YES
7	LOW	LOW	YES	YES
8	LOW	LOW	YES	YES
9	LOW	LOW	YES	YES
10	LOW	LOW	YES	YES
11	LOW	LOW	YES	YES
12	MEDIUM	MEDIUM	YES	YES
13	MEDIUM	MEDIUM	YES	YES
14	MEDIUM	MEDIUM	YES	YES
15	MEDIUM	MEDIUM	YES	YES
16	MEDIUM	MEDIUM	YES	YES
17	MEDIUM	MEDIUM	YES	YES
18	HIGH	HIGH	YES	YES
19	HIGH	HIGH	YES	YES
20	HIGH	HIGH	YES	YES
21	HIGH	HIGH	YES	YES

**By definition, all Best Buy Plans are Efficient. The PDT assumes all plans will be designed and built in a way that is acceptable to local entities and compatible with existing laws, regulations and policies. The Best Buy Plans were scored as low (red), medium (yellow), or high (green) related to their ability to meet the Completeness and Effectiveness criteria.*

3.3.2.4 System of Accounts

The *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (March 10, 1983) establishes four accounts to facilitate the evaluation and display of effects of alternative plans. They are described in ER 1105-2-100, Planning Guidance Notebook, paragraph 2-3.

The comparison and evaluation of alternatives involves the consideration of the effects of the plans on planning objectives and constraints. The following discussions address the differences and similarities between the future without project conditions and the alternatives. The four national accounts are considered in the comparison and evaluation of alternative plans, as are the associated evaluation criteria. In the 1970 Flood Control Act, Congress identified four equal national accounts for use in water resources development planning. The accounts are National Economic Development (NED), Regional Economic Development (RED), Environmental Quality (EQ), and Other Social Effects (OSE). Policy in the 1970s regarded making contributions to only two of these, NED and EQ, as national objectives.

Because the primary outputs for the El Paso Rio Bosque project would be ecosystem restoration, benefits are realized for the EQ as well as OSE accounts. Benefits of recreation are accounted for within the NED Account. Benefits to the RED are realized from both the restoration and recreation components.

(a) Environmental Quality (EQ)

The EQ account displays non-monetary effects on ecological, cultural, and aesthetic resources, including the positive and adverse effects of ecosystem restoration plans. The arrays of plans described in Appendix E have ecosystem restoration as their stated goals. EQ benefits or impacts are identified and evaluated relative to the cost of restoration alternatives.

All of the best buy plans would contribute to the EQ account by increasing the amount and quality of high value habitat in the study area by their respective quantity of outputs. All best buy plans provide an increase in habitat and therefore benefits to the EQ account as quantified by AAHU's in Table 10. Benefits to the EQ account increase with plan outputs as does the costs for the project and incremental costs for each AAHU. As described earlier, only plans 17 and above will meet the improvement objective of the study. Benefits would increase in the following criteria as the amount and quality of habitat increases.

Air Quality – An increase in the number and acres of plants would contribute to absorption of carbon dioxide and release of oxygen in this urbanized area. The riparian vegetation also acts as a heat sink during warmer months providing a corridor of shady, relatively moist environment that contrasts the urban asphalt and concrete.

Wildlife – The increase in habitat diversity would provide for an increase in diversity and density of migratory birds and other wildlife species.

Endangered Species: There may be a long-term benefit to the Southwestern willow flycatcher and Yellow-billed cuckoo due to improved habitat function and increased area of habitat for resting and foraging during migration.

Noise: A temporary increase in noise would occur during construction and would potentially increase in duration with an increased project size. The bosque itself acts as a noise sink.

Essentially, the larger the project is the more benefits to this account would be gained. This is quantified in total AAHU in Table 10. The cost effectiveness analysis has provided a measure of efficiency to assure there are no alternatives that provide more output for a given cost, or the same outputs at cheaper costs.

(b) Other Social Effects (OSE)

The Other Social Effects (OSE) account displays plan effects on social aspects, such as community impacts, health and safety, displacement, energy conservation, and others. In most cases, impacts of proposed projects not covered in other accounts are described and evaluated here. Primary affects to OSE from the proposed restoration would benefit health, standard of living, and education by providing a public area of improved aesthetics and air quality and providing passive recreational and educational opportunities.

The proposed project would improve existing trails and create additional access, as well as provide amenities, such as benches or picnic tables for an improved recreational experience. Habitat improvements would also enhance the recreational experience through those criteria listed under the EQ account and the aesthetic quality of the area. The newly constructed view over a wetland is generally more pleasing than a view obstructed by thick brush 10-20 feet high. Habitat improvements would also provide the opportunity to view wildlife considered rare in the study area. The opportunity for this area to become a destination for recreational and educational activities, as well as the improved experience, would increase the overall standard of living for the entire community in the El Paso southeast area.

(c) Regional Economic Development (RED)

The Regional Economic Development (RED) account displays changes in the distribution of regional economic activity (e.g., income and employment). This account is typically used to capture the regional impacts of a large capital infusion of project implementation dollars on income and employment throughout the study area through the use of income and employment multipliers. Employment impacts of small businesses invested in by the New Mexico Small Business Investment Corporation had a multiplier of 1.4-1.5 (Baca, Bhandari and Mitchell, 2017). Multipliers used to calculate the economic impact of construction at UTEP are 1.59 and 1.44 for incremental output and labor income, respectively (Schauer, Olmedo and Soden 2008). A recent study for the Nuclear Watch of New Mexico suggests that public sector multipliers tend to be below 1.5, while the Department of Energy claimed multipliers of 2.4 to 3.5 in fiscal year 1998. Regardless of the specific multiplier for this project, a large infrastructure project in the El Paso area will have a positive impact on local income and employment.

3.3.2.5 Final Findings

The study team is convinced that project success is met upon the inclusion of at least one new wetland area, W2, as well as inclusion of riparian, marsh, and grassland habitats and the enhancement of existing wetlands, E1 and E2. As a result of the CE/ICA weighted output analysis, wetland area W2 was the most cost-effective additional wetland (the first new wetland to be included in the supply curve). As a small, isolated wetland, W2 is expected to provide biodiversity benefits different from the larger existing wetlands. “Small wetlands are extremely valuable for maintaining biodiversity in a number of plant, invertebrate and vertebrate taxa (e.g., amphibians)” (Semlitsch and Bodie 1998). For example, small wetlands are important to maintaining wetland plant diversity (Deane et al. 2017), producing large numbers of metamorphosing juvenile amphibians (Semlitsch and Bodie 1998), and contributing to invertebrate species diversity (Chaparro et al. 2018). Additionally, W2 is immediately adjacent to visitor parking and provides a highly visible and easily accessible example of a wetland habitat to visitors and represents an opportunity to enhance the educational value of the entire project. Wetland W2 represents the final increment and was deemed necessary for project success. Wetland W4 was a relatively more expensive means to increase habitat totals, with high total and unit costs, as the supply curve approaches “Do Everything.” In addition, the study team believed salt cedar removal was an activity that could be accomplished by volunteers recruited by the non-federal Sponsor. The study team felt that it was not necessary to spend an extra 10% in construction funds to chase an extra 1% in habitat output.

The recommended best buy is plan 18 (referred to as Best Buy 19 in Appendix E, due to the fact that the software labeled the No-Action alternative as Plan 1). The results show that the federal portion of the total cost for construction of the ecosystem restoration project is expected to be $6.7 million and the non-federal portion $3.6 million, for a total cost of $10.3 million. This plan was the first plan that fully meets the study objectives and sponsor goals (see Appendix E).

3.4 *Description of the Tentatively Selected Plan

The tentatively selected plan (TSP) is Plan 18, the best buy plan that meets planning objectives most completely by providing a mosaic of diverse habitat types, including different types of wetland habitat (Figure 26). The TSP is comprised of the following measures: riparian habitat creation, grassland planting, wet marsh creation, existing wetland deepening and lining, and wetland creation. Other features, such as gate replacement and new piping for water distribution, are integral to the plan. Wetland and marsh areas would be connected to water sources as needed – the WWTP water line, Riverside Drain, and the existing channel, or new channel or pipe. Riparian areas would be flood irrigated during plant establishment, estimated to last three years, through the use of temporary gas-powered pumps and the installation of new gates to allow for gravity flow from existing channels and into the riparian areas. The overall plan will result in activities over approximately 150 acres of the study area. The TSP components are further described below.

Riparian habitat creation: Currently existing riparian areas would be enhanced, and new riparian areas would be created adjacent to existing riparian habitat or in other suitable areas. Cottonwood and Goodding's willow poles and riparian shrubs would be interplanted among existing sparse native vegetation using small equipment to auger holes. These areas would be connected to water sources as needed to help the riparian plants get established. Plantings would include cottonwood, willows, and seepwillows. The understory would be seeded with native riparian grasses using no-till equipment.

The riparian areas are designated as R1 through R7 on Figure 26. Table 15 below lists the areas and approximate acreage either enhanced or created for each riparian area.

Table 15: Riparian habitat creation areas.

Area	Estimated Area (acres)
R1	8.9
R2	9
R3	3.1
R4	4.6
R5	3.9
R6	9.5
R7	6
Total:	**45**

Floodplain Grassland planting: Floodplain grassland habitat provides a buffer between other habitats. This upland habitat type will be suitable for wildlife, such as small mammals and grassland birds, including burrowing owls. Non-native shrubs would be removed from these areas prior to seeding with native grasses and forbs. The grassland areas are designated as G1 through G4 on Figure 26. Table 16 below lists the grassland areas and approximate acreage either enhanced or created for each.

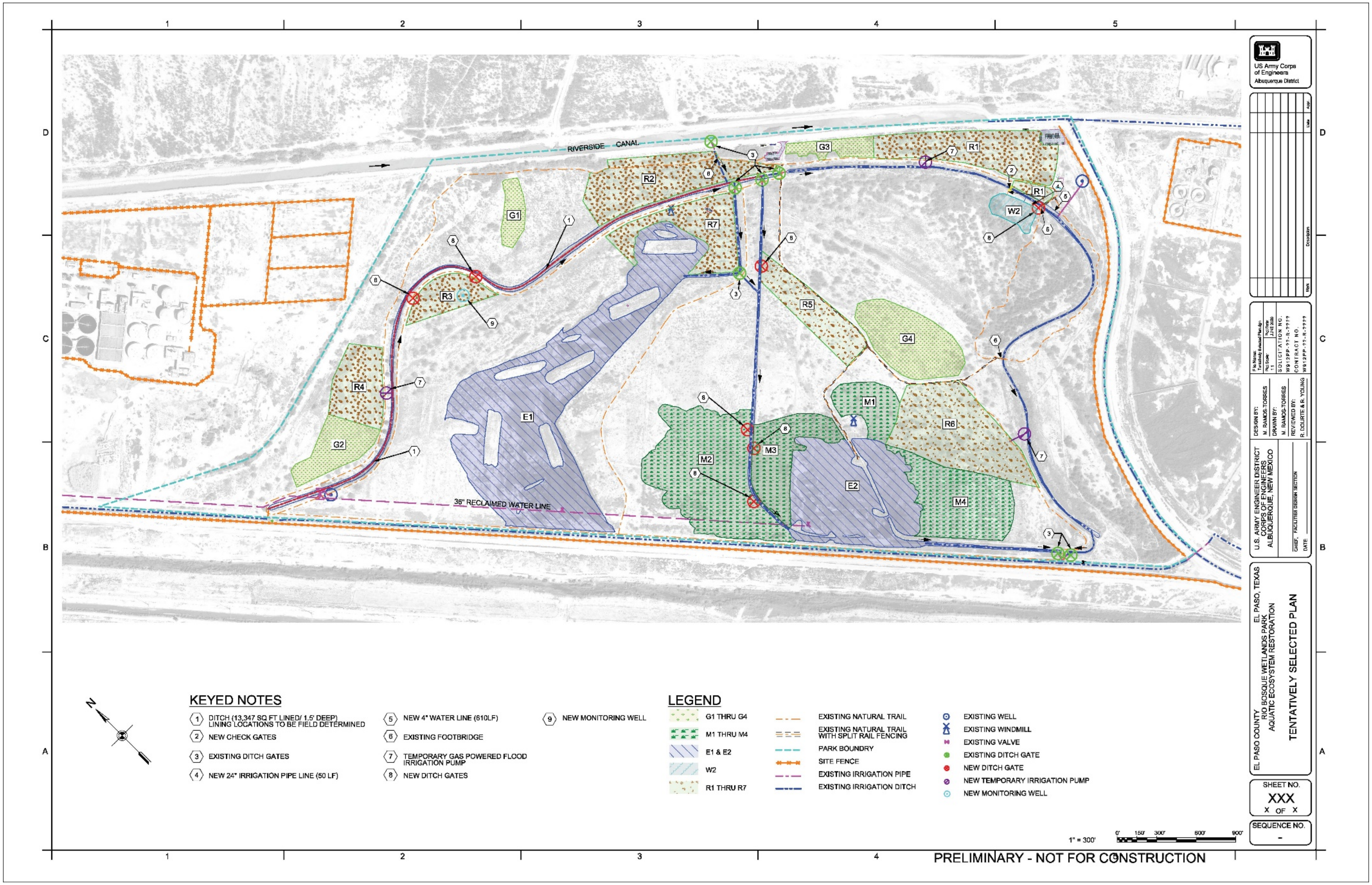

Figure 26. Map showing the tentatively selected plan components.

Table 16: Grassland creation areas.

Area	Estimated Area (acres)
G1	1.7
G2	4
G3	1.8
G4	7.8
Total:	15.3

Marsh creation: Marsh is a shallow wetland habitat up to two feet deep. Marshes would be constructed adjacent or close to existing wetland habitat and near water sources. Shallow marshes would be planted with wetland plugs and seeding, and the marshes are expected to become completely vegetated over time. The wet marsh areas are designated as M1 through M4 on Figure 26. Table 17 below lists the marsh areas and approximate acreage either enhanced or created for each area. Wetland features on permeable soils will require a liner to reduce water losses. Area M4 would be lined as an extension of the lining for wetland area E2 described below.

Table 17: Marsh wetland creation areas.

Area	Estimated Area (acres)
M1	3.5
M2	15.9
M3	6.2
M4	8.7
Total:	34.3

Existing wetland deepening and lining: Existing wetlands would be deepened to create zones of open water (5 ft. deep) surrounded by shallower edge habitat. Portions of existing wetland habitat with sandy, permeable soils would be lined using GCL or bentonite clay. Areas with less permeable soils may be treated with soil amending materials, such as ESS-13 vegetable oil/water emulsion. Additional topography could be created (as beneficial for waterfowl). These areas would be connected to water sources as needed. After earthwork is complete, the shallower edge habitat areas would be planted with emergent wetland plants, such as bulrushes and other plants that provide food for waterfowl. The wetland areas are designated as E1 and E2 on Figure 26. Table 18 below lists the areas and approximate acreage for each wetland.

Material slated to be dredged or excavated from the existing ponds shall be characterized in accordance with EM 1110-2-5025 (USACE 2015), since the primary contributing water source is currently treated WWTP effluent, which may result in the accumulation of contamination within the sediments. The investigation will determine the existence and extent of HTRW within the dredged material in accordance with ER 1165-2-132 (USACE 1992). All dredged or excavated material will be disposed of at an approved offsite location or placed in unlined lagoons adjacent to the Park, within the decommissioned Socorro WWTP, southeast of the Park.

Table 18: Existing wetland deepening and lining.

Area	Estimated Area (acres)
E1	38.5
E2	16.6
Total:	55.1

Saltcedar removal (Not in TSP): The majority of saltcedar would be removed selectively within these areas in coordination with the Park. Dense mature saltcedar used by long-eared owls would be left undisturbed. Saltcedar would be cut and treated with herbicide. These areas would be seeded with native grass. We anticipate that tornillo will colonize these areas, so other plantings won't be necessary. Maintenance control of saltcedar resprouts will be needed. Given the relatively low habitat unit output and extra cost of this measure, it was not included in the TSP. Nevertheless, controlling saltcedar and other invasive plants is important to the overall success of the ecosystem restoration project. We anticipate that the Sponsor's efforts to manage invasive species will be continued.

Wetland creation: One new wetland area, W2, would be created and is shown on Figure 26. W4 would not be created given the lower habitat unit output and extra cost of this measure. W2 would be excavated to a similar depth as the existing wetlands, with shallow edge habitat 0.5 – 1.5 feet deep sloping down into the 5-foot deep open water area of the wetland. Planting would occur similar to the existing wetlands. Wetland features on permeable soils will require a liner to reduce water losses. Table 19 below lists the approximate acreage for new wetland creation.

Table 19: Wetland creation areas.

Area	Estimated Area (acres)
W2	1.4
Total:	1.4

Potential Water Delivery Improvements: Currently, there are three sources of water available to the Rio Bosque Wetlands Park: irrigation water from the north, reclaimed wastewater from the Bustamante WWTP, and pumped groundwater.

The internal channel provides the means for the water supplied from the treatment plant and the irrigation water from the Riverside Canal to be distributed throughout this area. Improvements to this existing channel may include three additional ditch gates.

Areas that require water but may not be able to receive it via a gravity system will need to obtain it by another means, such as temporary water pumps that utilize the water from the existing channel. Two of these pumps may be required.

The channel that runs through the center portion of the site and separates E1 from E2 may require three additional ditch gates to provide the necessary water for the adjacent selected areas.

The new wetland W2 at the eastern portion of the site will need to obtain water from both the nearby existing well and from the adjacent channel. Anticipated improvements include an additional 4-inch water line from this well, a check gate, and 24-inch irrigation pipe.

3.5 Recreation Plan

A third objective of the El Paso Rio Bosque Wetlands Aquatic Habitat Restoration study is to increase the availability of passive recreational and educational opportunities at Rio Bosque Park. The El Paso Rio Bosque Wetlands Aquatic Habitat Restoration study includes a recreation component. Improvements or additions would be made to the existing recreational infrastructure and trail system, interpretive signs, and wildlife viewing amenities as allowable per the results of an economic justification analysis.

USACE performed a cost effectiveness analysis and alternative evaluation to identify the selected recreation plan. A description of the recreation measures and alternatives is presented below.

3.5.1 Existing Recreation Infrastructure and Proposed Improvements

The Rio Bosque Wetlands Park offers an extraordinary resource to residents and visitors by providing a very unique recreational opportunity to observe the flora and fauna native to this extremely limited southwest wetland environment. The 372-acre Park has a small visitor center, parking area, and trail system. A map of the Park can be seen in Figure 27 below. There is a total of 4.5 miles of improved trails at the park and 0.6 miles consists of a hard surfaced, fully accessible trail suitable for wheelchairs. The park allows for hiking, biking, and horseback riding. Although the existing trails are functional, the proposed new recreational features would enhance existing infrastructure and expand visitor opportunities and public use by improving access and providing amenities for a more diverse group of visitors.

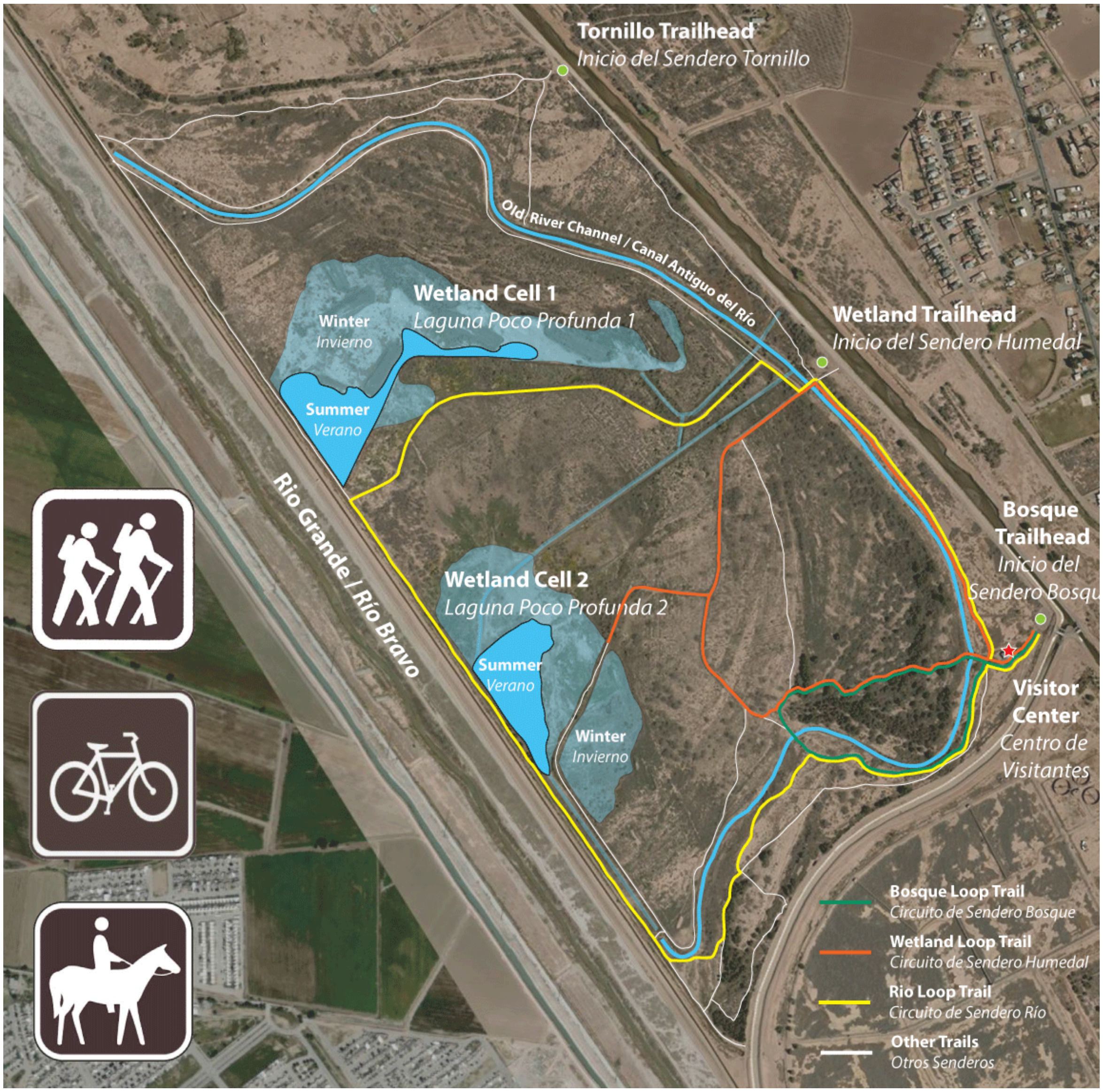

Figure 27. Rio Bosque Park and Existing Recreation Infrastructure

3.5.2 Recreation Infrastructure Improvements

Proposed recreation improvements would expand on and enhance the existing recreational experience.

In coordination with the non-federal Sponsor, the PDT identified several measures for improving upon the existing recreation infrastructure. They are as follows:

- New Bridge/Platform
- New wildlife viewing areas and trail shelters
- Existing trail reclamation
- New ADA accessible feature
- New bicycle rack
- New information kiosk
- New binocular/viewing scope
- New trash receptacles
- New visitor center roof rain gutter
- New picnic tables
- Trail concrete curb replacement
- New walking trails
- New raised boardwalk to traverse the wetlands
- New split rail fencing
- Footbridge deck replacement
- New park benches

The budget for recreation improvements is limited by the amount economically justified, and this amount is determined through a Unit Day Value analysis described in Section 3.5.3. The economically justifiable amount for recreation determined in this analysis is approximately $80,000. With this being the case, many of the above listed measures were screened due to the limited budget. The non-federal Sponsor aided the PDT in determining the preferred recreation improvements to be retained.

A site plan containing the proposed recreation improvements can be seen in Figure 28, and a description of the improvements follows.

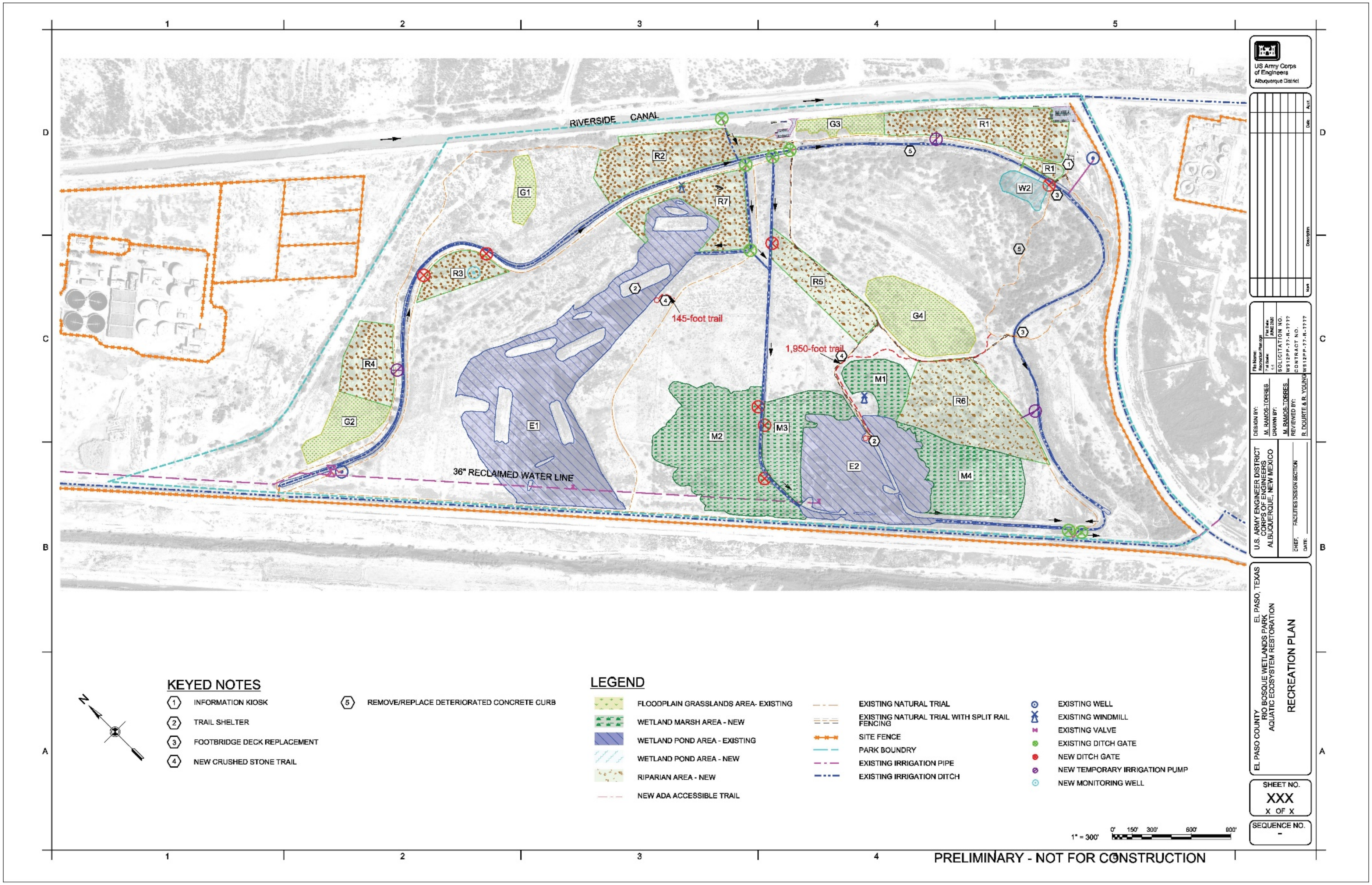

Figure 28. Map of proposed recreation features

Trail Improvements, Signage, and Environmental Interpretive Opportunities

New trails would be added to complement the existing trails at the park. New ADA accessible trails will be added to allow the physically disadvantaged segment of the population access to areas previously inaccessible. Approximately 1,950 linear feet would consist of compacted crusher fines and base (Figure 29) and would spur off the existing ADA trail and lead to the existing wetland (E2) on the southwest side of the site. Approximately 145 linear feet of new trail consisting of compacted crusher fines and base will spur off an existing trail to provide access to a new shelter adjacent to existing wetland E1. Approximately 200 linear feet of existing and deteriorating concrete curb borders would be replaced with new ones. Figure 30 provides an example of a gravel trail with concrete curb borders. The decking on three existing footbridges will be replaced.

With environmental educational opportunities for grade school groups being a priority for the non-federal Sponsor, park enhancements would build upon the existing educational facilities. Two shelters placed near the existing wetland areas would be equipped with benches and viewing scopes (Figure 31), to allow visitors observe the flora and wildlife with minimal disturbance. A park orientation kiosk (Figure 32) is planned near the visitor center and entrance to the focal trail.

Quick response (QR) codes connecting visitors to websites with information about the flora and fauna found in the park will be considered.

Miscellaneous Site Furnishings

Additional site furnishings include a trash can at the visitor center.

Table 20 contains recreation measures with associated quantities and costs.

Table 20: Recreation Measures Cost Estimate

Item	Unit	Quantity	Total Cost ($)
Information Kiosk	Each	1	$17,391
Trail Shelter	Each	2	$30,265
Trash Receptacle	Each	1	$979
New Walking trail – crushed stone;	LF	2095	$21,537
Concrete curb – remove existing deteriorated curb and replace with new	LF	200	$1,416
Footbridge deck replacement	SF	608	$4,725
TOTAL			$79,891

Figure 29. Compacted gravel trail

Figure 30. Crusher fine trail with curb

Figure 31. Trail Shelter with viewing scopes

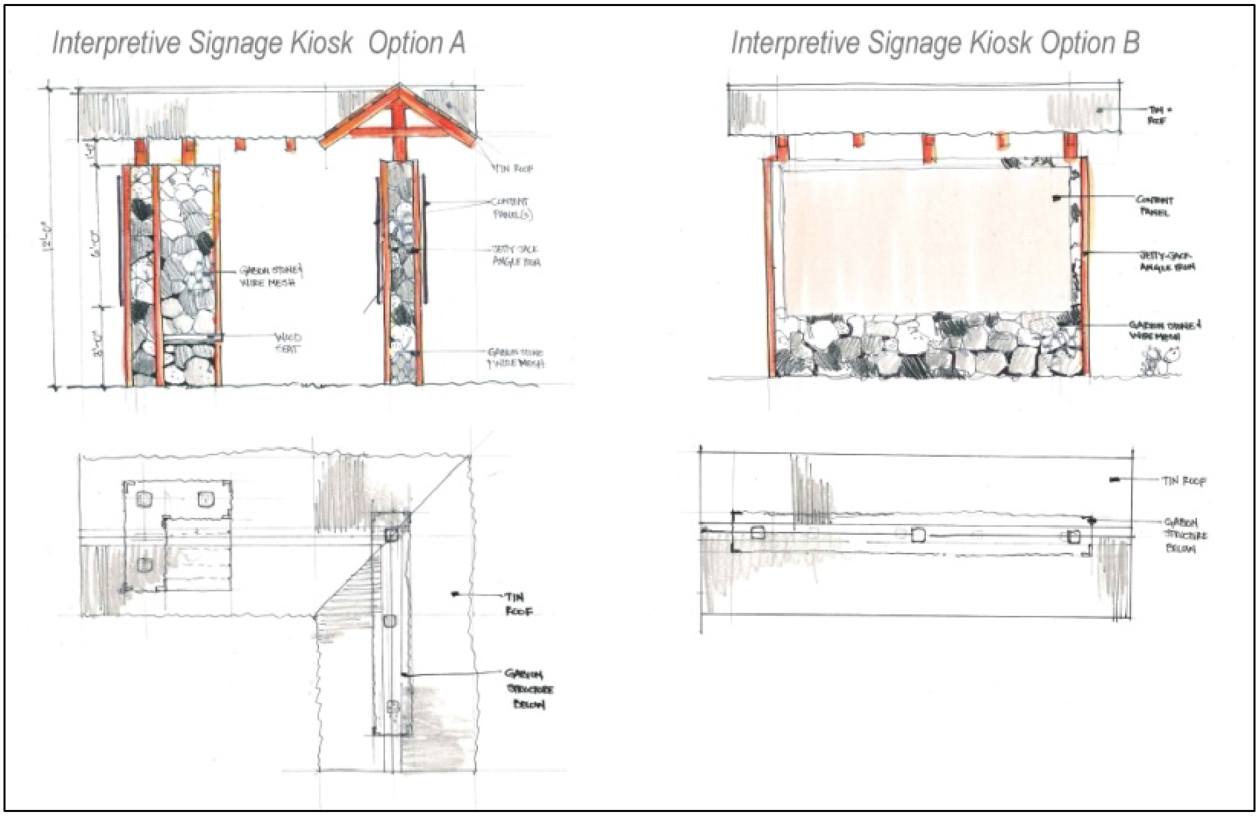

Figure 32. Example design for Kiosk

3.5.3 Recreation Economic Justification

3.5.3.1 Overview

This recreation analysis follows the NED benefit evaluation procedures contained in ER 1105-2-100, Appendix E, Section VII. Because the recreation features identified in the proposed project are of a small scale and incidental to the project purpose, USACE selected the unit day value (UDV) method of benefit evaluation for this analysis. The Rio Bosque Park was established to provide a venue for public recreation and education. The Park provides wetland and riparian habitat for animals, public open space for hiking and biking, and it offers educational opportunities for both school children and the general public. In addition, efforts to restore terrestrial and aquatic habitats provide research opportunities for students of all ages.

The UDV calculations require a scoring of 5 criteria when evaluating the without and with-project recreation experience. A discussion of each of those five criteria follows:

- Recreation experience – This criterion tries to explore what recreation opportunities exist at the site. In the case of Rio Bosque Park, there are some general activities common to the region, such as hiking (walking, running) and wildlife viewing. The sheer size of the undeveloped area makes the recreation experience uncommon to the region. Proposed features within the recreation plan are additional improved trails, which would add to the unique experiences found within the southeast El Paso metropolitan area.

- Availability of opportunity – This criterion evaluates the uniqueness of the recreation experience by identifying the number and proximity of available substitutes. The Rio Bosque Park represents a unique environmental feature within the urbanized El Paso metropolitan area, as the park represents a large, unimproved, and natural stretch of wildlife habitat in the El Paso area. The proposed habitat improvements would represent an even more unique recreation opportunity for residents in the region.

- Carrying capacity – This criterion evaluates the ability of the recreation facilities to handle the existing and projected demand. The thinking behind this criterion is that excessively crowded facilities diminish the recreation experience for users. Similarly, facilities that cannot handle the increased visitation also experience a diminished recreation experience. The proposed plan includes an information kiosk, new and improved trails through the park, and a pair of trail shelters. These features both guide users through the natural environment and provide extra facilities for recreation visitors. This increase in net carrying capacity is expected to be more than adequate for any increased visitation.

- Accessibility – This criterion examines the relative ease by which users can get to and through the recreation site.

- Environmental – This criterion measures the aesthetic value of the recreation experience. The habitat, as mentioned throughout this report, represents a unique and highly prized habitat that exists within the El Paso metropolitan area. Efforts to improve the bosque habitat are naturally expected to increase that aesthetic value.

Table 21, which follows, describes the qualitative assessment of the without-project condition. Table 22 describes the qualitative assessment of the with-project condition. The highlighted fields are the qualitative judgment of the without-project condition and the effect of implementing the restoration and recreation plans.

Table 21: Recreation values without project

General Recreation Values		Without project conditions			
Criteria			Judgment factors		
Recreation experience[1] Total Points: 30 Point Value:	Two general activities[2] 0-4	Several general activities 5-10	Several general activities: one high quality value activity[3] 11-16	Several general activities; more than one high quality high activity 17-23	Numerous high quality value activities; some general activities 24-30
Availability of opportunity[4] Total Points: 18 Point Value:	Several within 1 hr. travel time; a few within 30 min. travel time 0-3	Several within 1 hr. travel time; none within 30 min. travel time 4-6	One or two within 1 hr. travel time; none within 45 min. travel time 7-10	None within 1 hr. travel time 11-14	None within 2 hr. travel time 15-18
Carrying capacity[5] Total Points: 14 Point Value:	Minimum facility for development for public health and safety 0-2	Basic facility to conduct activity(ies) 3-5	Adequate facilities to conduct without deterioration of the resource or activity experience 6-8	Optimum facilities to conduct activity at site potential 9-11	Ultimate facilities to achieve intent of selected alternative 12-14
Accessibility Total Points: 18 Point Value:	Limited access by any means to site or within site 0-3	Fair access, poor quality roads to site; limited access within site 4-6	Fair access, fair road to site; fair access, good roads within site 7-10	Good access, good roads to site; fair access, good roads within site 11-14	Good access, high standard road to site; good access within site 15-18
Environmental quality Total Points: 20 Point Value:	Low aesthetic factors[6] that significantly lower quality[7] 0-2	Average aesthetic quality; factors exist that lower quality to minor degree 3-6	Above average aesthetic quality; any limiting factors can be reasonably rectified 7-10	High aesthetic quality; no factors exist that lower quality 11-15	Outstanding aesthetic quality; no factors exist that lower quality 16-20

Table 22: Recreation values with the proposed project

General Recreation Values		With project conditions			
Criteria			Judgment factors		
Recreation experience[1] Total Points: 30 Point Value:	Two general activities[2] 0-4	Several general activities 5-10	Several general activities: one high quality value activity[3] 11-16	Several general activities; more than one high quality high activity 17-23	Numerous high quality value activities; some general activities 24-30
Availability of opportunity[4] Total Points: 18 Point Value:	Several within 1 hr. travel time; a few within 30 min. travel time 0-3	Several within 1 hr. travel time; none within 30 min. travel time 4-6	One or two within 1 hr. travel time; none within 45 min. travel time 7-10	None within 1 hr. travel time 11-14	None within 2 hr. travel time 15-18
Carrying capacity[5] Total Points: 14 Point Value:	Minimum facility for development for public health and safety 0-2	Basic facility to conduct activity(ies) 3-5	Adequate facilities to conduct without deterioration of the resource or activity experience 6-8	Optimum facilities to conduct activity at site potential 9-11	Ultimate facilities to achieve intent of selected alternative 12-14
Accessibility Total Points: 18 Point Value:	Limited access by any means to site or within site 0-3	Fair access, poor quality roads to site; limited access within site 4-6	Fair access, fair road to site; fair access, good roads within site 7-10	Good access, good roads to site; fair access, good roads within site 11-14	Good access, high standard road to site; good access within site 15-18
Environmental quality Total Points: 20 Point Value:	Low aesthetic factors[6] that significantly lower quality[7] 0-2	Average aesthetic quality; factors exist that lower quality to minor degree 3-6	Above average aesthetic quality; any limiting factors can be reasonably rectified 7-10	High aesthetic quality; no factors exist that lower quality 11-15	Outstanding aesthetic quality; no factors exist that lower quality 16-20

*There was some discussion among the PDT whether the restored Rio Bosque Park had available substitutes, thus the green highlighted box here.

3.5.3.2 UDV evaluation of the existing and proposed project condition

From the previous discussion of the five criteria used for establishing a score of the recreation experience afforded by the El Paso Rio Bosque Wetlands Park, it is clear that the proposed project would touch each of these criteria in a beneficial direction. Table 23 presents an estimate of the Unit Day Valuation of the without and with-project condition.

Table 23: Estimate of the UDV of the without and with-project condition.

UDV calculations		WOP	WP	assumptions/reasoning
Receation experience	Several general activities; more than one high quality (kayak) activity	4	10	Bike, walk, run, picnic, wildlife watching. One parking lot.
Availability of Opportunity	Several within 1 hr. travel time; a few within 30 min. travel time	3	6	Urban resource for some activities. Increase due to extra trails and trail upgrades.
Carrying capacity	Minimum facility for development for public health and safety	2	8	Increase due to adding trail shelters and upgrade of trails
Accessability	Limited access by any means to site or within site	3	6	Increase due to improved trails.
Environmental	Low aesthetic factors that significantly lower quality	2	10	Factors to be rectified include non-native species (low visibility), occasional fire, increased diversity of wildlife
		14	40	

Converting these point values into dollars per Economic Guidance Memorandum (EGM) 19-3, the without project condition is worth $5.13 per visit, and the with-project condition is worth $7.77 per visit. The benefits attributable to planned recreation features are therefore worth $2.64 per visit.

3.5.3.3 Recreation usage in the existing and proposed project condition.

The Rio Bosque Park represents the most significant natural ecosystem feature in the study area. Park visitation data recorded since 2000 indicates visitation has been trending upward since 2000, but stabilized around 1400 visitors from 2013-2017, as depicted in Figure 33.

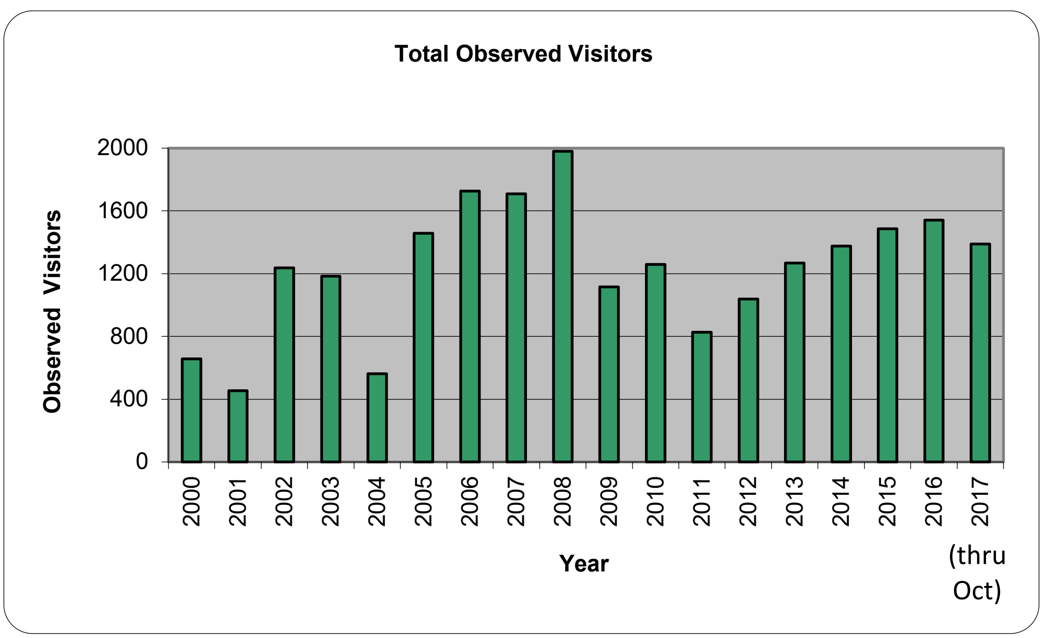

Figure 33. Park visitation from 2000 until 2017

The Sponsor has indicated that even more recent visitation data has been trending upward significantly in 2018 (Figure 34). Early 2019 data suggests the trend may continue, but the data does not yet support extrapolation.

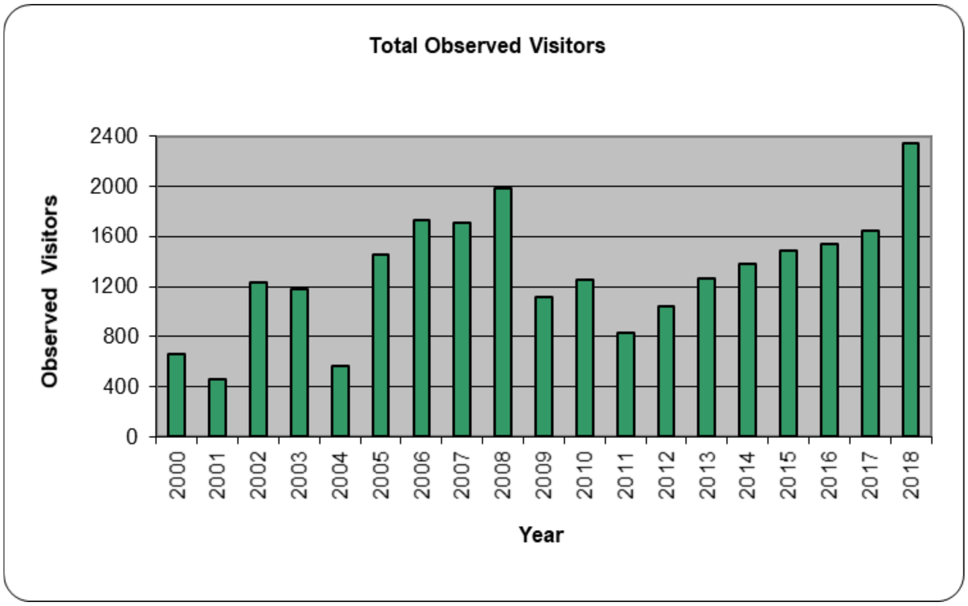

Figure 34. Park visitation from 2000 until 2018

3.5.3.4 Benefit determination of the proposed recreation features.

This evaluation started with an evaluation of the value of the existing, without-project, recreation experience in the study area. Table 23 developed an estimate of the without and with-project UDV values. Multiplying the benefits identified in Table 23 by the estimated annual visitation provides the annual benefit of the proposed recreation features (Table 24).

Table 24: Annual benefit calculation for the proposed features.

Without-Project UDV Value (points)	Without-Project Value (dollars)	With-Project UDV Value (points)	With-Project Value (dollars)	Benefits/visit (dollars)**	Annual Benefits**
14	$5.13	40	$7.77	$2.64	$3,698.80

**Errors due to rounding.

The estimated cost of the proposed recreation project is $79,891 as follows:

Table 25: Recreation Measures Cost Estimate

Item	Unit	Quantity	Total Cost ($)
Information Kiosks	Each	1	$17,391
Trail Shelters	Each	2	$30,265
Trash Receptacles	Each	1	$979
Walking trail – crushed stone; no concrete curb border	LF	2095	$21,537
Concrete curb – remove existing deteriorated curb and replace with new	LF	200	$1,416
Footbridge deck replacement	SF	608	$4,725
TOTAL			$79,891

3.5.3.5 Sensitivity Analysis of recreation benefits

From the previous discussion of the 5 criteria used for establishing a value of the recreation experience afforded by the Rio Bosque Park, it's clear that the proposed project would touch each of these criteria in a beneficial direction. What is unclear is the qualitative improvement's translation to the UDV point values. Therefore, multiple scenarios were developed to evaluate the impact of the proposed project on the existing recreation facilities. One scenario assumes the existing facilities have relatively low point values (the "minimum points" scenario), and the proposed recreation features provide a significant boost to the quality of the recreation experience. Another scenario assumes the recreation experience has a relatively high starting value (the "most likely" scenario) and the proposed recreation features are somewhat less beneficial than described in the "minimum points" scenario. This analysis will run a matrix of starting conditions and beneficial "point boosts" to establish a range of values and consider the possibility that the recreation plan isn't justified per the NED benefit evaluation procedures. This analysis will explore the impact of the "UDV point boost" expected through implementing the proposed project. The following Table 26 presents an evaluation of the without- and with-project condition for both scenarios:

Table 26: UDV point evaluation comparison under the "minimum" and "most likely" point scenarios.

UDV point valuation in the without-project condition					
		Minimum points in w/o project condition		Most Likely points in w/o project condition	
Criteria	Without Project Condition	Without Project	With project	Without Project	With Project
Recreation experience	Several general activities	0	5	4	10
Availability of Opportunity	Several within 1 hr. travel time; a few within 30 min. travel time	0	4	3	6
Carrying capacity	Minimum facility for development for public health and safety	0	6	2	8
Accessability	Limited access by any means to site or within site	0	4	3	6
Environmental	Low aesthetic factors that significantly lower quality	0	7	2	10
	Total	0	26	14	40

It is expected that the restoration efforts in the El Paso Rio Bosque Wetlands Park will improve the environmental aesthetic. The features of the recreation plan (trail shelters, informational kiosk, additional trails, improved trails) are expected to touch each of the other criteria in the UDV assessment in a positive fashion. The following Table 27 presents a minimum and most likely point assessment of the marginal benefits attributed to the proposed recreation features:

Table 27: UDV marginal effects (point increase) in the with-project condition.

UDV marginal effects in the with-project condition			
Criteria	With Project Condition	Min.	Likely
Recreation experience	Bike, walk, run, picnic, wildlife watching. One parking lot.	5	6
Availability of Opportunity	Urban resource for some activities. Increase due to extra trails and trail upgrades.	4	3
Carrying capacity	Increase due to adding trail shelters and upgrade of trails	6	6
Accessability	Increase due to improved trails.	4	3
Environmental	Factors to be rectified include non-native species (low visibility), occasional fire, increased diversity of wildlife	7	8
	Total	**26**	**26**

Economic Guidance Memorandum (EGM) 19-3 outlines the general and specialized recreation valuation for UDV point values for FY 2019. The guidance outlines the value of the recreation experience per visit based upon the point values assessed. The following Table 27 is a reprint of the guidance converting points to dollar values (FY 2019 price level):

Table 28: Recreation point values and valuation

Point Values	General Recreation Values (1)	General Fishing and Hunting Values (1)	Specialized Fishing and Hunting Values (2)	Specialized Recreation Values other than Fishing and Hunting (2)
0	$4.14	$5.95	$29.00	$16.83
10	$4.92	$6.73	$29.77	$17.86
20	$5.44	$7.25	$30.29	$19.16
30	$6.21	$8.03	$31.07	$20.71
40	$7.77	$8.80	$31.85	$22.01
50	$8.80	$9.58	$34.95	$24.86
60	$9.58	$10.62	$38.06	$27.44
70	$10.10	$11.13	$40.39	$33.14
80	$11.13	$11.91	$43.50	$38.58
90	$11.91	$12.17	$46.60	$44.02
100	$12.43	$12.43	$49.19	$49.19

It's unlikely that any recreation opportunities would line up perfectly with any 10-point increment, so a linear interpolation of point values is necessary to measure the value afforded by the recreation experience. The following Table 28 presents the marginal point values for the General Recreation Values identified in EGM 19-3:

Table 29: Recreation point values, marginal dollars/point

Point Values	General Recreation Values (1)	Marginal $/point
0	4.14	
10	4.92	0.078
20	5.44	0.052
30	6.21	0.077
40	7.77	0.156
50	8.8	0.103
60	9.58	0.078
70	10.1	0.052
80	11.13	0.103
90	11.91	0.078
100	12.43	0.052

As the foregoing illustrates, a single point in the Unit Day Value computation can have a value of between 5 and 16 cents per visit. Applying those values to the minimum and most likely values imparted by the proposed project gives a range of values of the proposed recreation plan. A 26-point increase crosses two point-value thresholds and would be worth between $0.77 and $1.76 per recreation visit.

The without-project condition was evaluated in the UDV framework using the five criteria and was assessed a value of 0 or 14 points having a value of $4.14 or $5.13 per visit, respectively. The proposed project is anticipated to increase that value between 26 and 40 points, which would provide a benefit of between $0.77 and $3.63 per recreation visit. Those values fall to the lower bounds of the possible values described above and will represent a reasonable estimate of the benefits of implementing the recreation plan.

Table 30: Without-project and with-project dollar values

Without-Project UDV Value (points)	Without-Project Value (dollars)	With-Project UDV Value (points)	With-Project Value (dollars)	Benefits/visit (dollars)**
		+26 pts.		
0	$4.14	26	$5.90	$1.76
0	$4.14	40	$7.77	$3.63
		+26 pts.		
14	$5.13	26	$5.90	$0.77
14	$5.13	40	$7.77	$2.64

3.5.3.6 Sensitivity analysis of benefits of the proposed recreation features.

This evaluation started with scenarios to evaluate the value of the existing, without-project, recreation experience in the study area. The "minimum points" scenario was a fairly conservative estimate of the relative worth of the Rio Bosque Park habitat and recreation facilities. The "most likely" scenario was a bit more generous in assessing the value of the without-project recreation experience. Table 29 developed two estimates of the with-project UDV values. Multiplying the benefits/visitor identified in Table 24 above by the estimated annual visitation established in Figure 33 (1400 visitors) provides the annual benefit of the proposed recreation features. The "Justifies" column in Table 30 defines how much of a recreational investment could be supported by the visitation and recreational experience valuation described by "annual benefits." The annual benefits could be considered an annual payment over 50 years with a discount rate of 2.75%, which would fulfill a loan of the specified amount. However, to acknowledge the uncertainties in assessing UDV point values in the without- and with-project condition, this analysis developed a matrix of possible without- and with-project UDV point values and computed the benefits against the estimate of visitation developed above. The range of UDV point values in the without- and with-project condition, as well as potential minimum and maximum scores associated with 26 and 40 point UDV value boosts, is provided in the following Table 30:

Table 31: Recreation benefits and project amounts justified using different UDV point assumptions

Without-Project UDV Value (points)	Without-Project Value (dollars)	With-Project UDV Value (points)	With-Project Value (dollars)	Benefits/visit (dollars)**	Annual Benefits**	Justifies
		+26 pts.				
0	$4.14	26	$5.90	$1.76	$2,467	66,596.62
0	$4.14	40	$7.77	$3.63	$5,082	137,199.62
		+26 pts.				
14	$5.13	26	$5.90	$0.77	$1,084	29,254.13
14	$5.13	40	$7.77	$2.64	$3,699	99,857.13

The cost of the proposed recreation project is in Table 20 above and remains unchanged in this sensitivity analysis.

The purpose of the sensitivity analysis is to determine some boundary conditions for this recreation analysis. Table 30, above, presents a range of values of the benefits of the recreation plan. The plan costs approximately $80,000. There are some assumptions in Table 30 where the benefits do not cover this cost. It is important, therefore, to evaluate those assumptions to determine their reasonableness in the benefit calculations.

In the first row of Table 30, it is assumed the without project condition has zero points per UDV evaluation in Table 25, and the qualitative benefits (highlighted fields in Table 21) are the absolute minimum possible in terms of point valuation. That was deemed unreasonable by the PDT because the Rio Bosque Park exists, and does provide some services (trails, restrooms, parking, and information kiosks) in a natural, though degraded environment. The Sponsor and the PDT believe the proposed improvements will improve the Rio Bosque Park's ability to attract and serve different users. Specifically, the Sponsor is targeting school groups and hopes to bring more groups in the with-project condition. That trend explains part of the visitation increase in 2018 and 2019. The proposed restoration project will bring riparian habitat to El Paso County, Texas, which is exceedingly rare in the urbanized area. The proposed improvements will increase the carrying capacity of the park and provide ADA compliant accessibility through the park.

The third row of Table 30 assumes a high value to the without project condition (using maximum points for the values ascribed in Table 25). That condition was also deemed unreasonable by the Sponsor and the PDT. The assumptions here would lead to the effects of the project being even less beneficial than is described in the first row of the table (explored in the previous paragraph). The Sponsor and PDT reject this notion as the purpose of the ecosystem restoration project is to restore riparian and wetland habitat that is in critically short supply in El Paso. The restored project will be unique to the area, and the proposed trails and trail improvements will provide residents opportunity to see, appreciate, and enjoy a rare habitat just a short drive from their home.

How unique is the Rio Bosque Park in the with-project condition? This recreation analysis assumes the available substitutes within a 1-hour drive are the Franklin Mountains State Park and the Mesilla Valley Bosque State Park in Mesilla, New Mexico. The Franklin Mountains State Park provides trails, picnic tables, and benches, and would provide the infrastructure necessary to support equivalent activities, and has the carrying capacity to support the significantly higher visitation. However, the Park has no riparian habitat and minimal wetland habitat, being within the Franklin Mountains. The Mesilla Valley Bosque State Park is 1-2 hours away (varies by where in El Paso the user begins the journey) for a recreational experience within a riparian habitat. Because of the limited substitutes available for a recreation experience within a riparian habitat, the Sponsor and PDT are more comfortable with the assumptions and benefits described in Table 30, but acknowledges those benefits could be higher. Those benefits assume maximum points in the without and with-project condition, but also keeps to the minimum and likely "point boosts" as described in Table 27.

3.5.3.7 Reasonableness of results.

Based upon the project cost and the range of benefits that can be attributed to the recreation features, it's reasonable to assume, absent agreement of the value of the existing and proposed project features, that the proposed recreation plan provides benefits to the existing Rio Bosque Park users in excess of costs, and represents a feature with positive net benefits within the ecosystem restoration plan. It's important to note that this evaluation makes no effort to quantify any increased visitation due to the attractiveness of the proposed project, which would only increase claimable benefits. For instance, a mere 100 visitors per year added to the estimated annual visitation used to calculate benefits (Table 24) would justify an additional $7,100 in construction costs. The Sponsor is confident the visitation will increase, in large part due to active recruitment and hosting of school group outings.

4 - * Foreseeable Effects of the Alternatives

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

4.1 Climate and Climate Change

4.1.1 Climate Risks to the Tentatively Selected Plan

As discussed in Sections 2.1 and Appendix A (Current Climate, Climate Trends and Future Climate Conditions: Southern New Mexico and West Texas), the wetlands will be faced with two long-term challenges under a changing climate:

- Decreases in surface water availability regionally may stress municipal, industrial, agricultural, and other water supplies, which may lead to competing demands for waters currently allocated to support the wetlands.
- Rising temperatures are likely to increase surface water evaporation rates and plant transpiration rates, increasing water demand for wetlands and stressing floodplain and grassland vegetation.

Table 32: Climate Risks to the Tentatively Selected Plan

Feature	Trigger	Hazard	Harm	Qualitative Likelihood
Water Supply	Reduced precipitation (locally, regionally)	Reduced water supply and increased competition for available water	Reduction in water available to support the wetlands	Likely
Floodplain and grassland plantings	Increased temperatures	Increased evapotranspiration and reduced soil moisture	Plants may become stressed or die, resulting in decreased habitat quality in riparian and other areas	Likely

4.2 Hydrology, Hydraulics and Sedimentation.

The “Future with Project” condition acknowledges provision of a continuous year-round water source to serve the Park. Improvements to water delivery and reduction of infiltration from wetland areas will enhance effectiveness of available water for restoration.

Under the “Future with Project” condition, reclaimed water discharged from the Bustamante WWTP is the primary seasonal water source for the Park during the non-irrigation season of mid-October to mid-February. Water from the WWTP and irrigation water deliveries are the major sources during the growing season. Groundwater discharged from irrigation wells located within the Park boundary is a secondary seasonal water source for the Park. Two of the existing irrigation wells (i.e., RB-12B and RB-13) within the Park boundary are equipped with submersible pumps. Each of these wells produce about 400 gallons per minute (gpm). The "Future with Project" condition may require additional or replacement irrigation wells. Existing windmills at the Park, which may provide less than 5 gpm (with sufficient wind), were not considered a significant water source and were excluded. An MOU exists for the annual delivery of 2,000 acre-feet of water between May and September from the WWTP. An agreement for another 3,500 acre-feet will be provided by the non-federal Sponsor. Varying seasonal irrigable flows during the non-growing season will also be provided through an agreement.

In 2014-15, a new system for delivery of reclaimed water from the WWTP to the Park was constructed. The new pipeline is located on the west side of the Park. This pipeline provides a more direct and efficient means of delivering reclaimed water from the WWTP to the Park. The new pipeline system includes associated control valves and three alfalfa valves. One of the alfalfa valves discharges reclaimed water into the upstream end of the old meander stream bed. The other alfalfa valves discharge reclaimed water into two of the three Park wetland cells.

With the addition of permanent wetlands and water delivery features, it is likely that the population of beavers within the Park will increase after the project is implemented. Undesirable beaver activity, such as plugging culverts would be addressed using non-lethal methods, including "beaver deceivers" and exclusion devices placed around culverts and water intakes. The project Operations and Maintenance Manual will include descriptions of these devices.

A feasibility-level water budget is included in Appendix I. This budget balances the primary seasonal inflows (irrigation water, reclaimed water discharged from the WWTP, and groundwater) against consumptive uses and primary losses (infiltration and evaporation), and tracks inflows, outflows, and storage on a monthly basis. Irrigable water inflows may vary annually and may be expected to be lower in years of drought and higher in wetter years. To account for possible drought conditions, the water budget assumed that only 25-percent of irrigable water would be available in a typical year. The water budget incorporated infiltration rates applicable to ESS-13 (a liquid polymer emulsion) or similar soil amendment, in conjunction with synthetic or bentonite clay liners. Use of ESS-13 may reduce or eliminate the need for temporary dewatering of existing wetlands. ESS-13 may either be poured into the water or mixed with the soil and compacted to reduce seepage losses from the Park wetland cells. ESS-13 is less expensive than synthetic liners or bentonite clays; however, use of ESS-13 will require an experienced applicator to ensure quality seals for the wetland cells.

A limited sensitivity analysis is included in Appendix I that considers both achievable reductions to infiltration rates and the availability of irrigation water at 50% and 75% of total availability. The water budget determined that sufficient water supply was available for the Park under the Tentatively Selected Plan. However, implementation would likely require both the application of ESS-13 and the use of bentonite or a synthetic lining to significantly reduce infiltration in the Park area. In addition, it was determined that the project must include sufficient on-site storage in the wetland and marsh areas to keep the Park from drying when inflow from the WWTP is most limited. This minimum storage requirement was determined to be approximately 90 acre-feet, as discussed below and in Appendix I. Subsequent to this analysis, the Tentatively Selected Plan was revised to eliminate ESS-13 treatment and to incorporate geosynthetic clay liners. These revisions should result in lower infiltration rates than assumed in the water budget and increase confidence in the analysis.

Results from the water budget are shown in Figure 35, which shows the wetland, marsh, and riparian areas of the Park to be completely filled to an estimated volume of 300 acre-feet at the beginning of the calendar year due to the availability of large amounts of effluent between November and January. This estimated volume involved a deepening of the entire area of the existing wetlands; however, the PDT reduced this area significantly in order to reduce construction costs. Though the available storage volume is no longer estimated to be 300 acre-feet, the net storage requirement determined in the water budget is still valid. During the months of February through April, the volume of stored water is expected to decrease due to decreased inflows from the WWTP. During March and April, the water budget shows a combined deficit (where use exceeds inflow) of approximately 90 acre-feet. Water storage in the Park is expected to be at a minimum in April, then increase as effluent inflows resume during the peak irrigation season, resulting in restoration of full storage capacity by May. Water supply will only slightly exceed project needs in October due to decreased supply of effluent, but the project will have surplus inflow for the last two months of the year when effluent supply is restored. Given the higher water surplus in the months of November through January, annual flushing of the wetlands could potentially occur during these months.

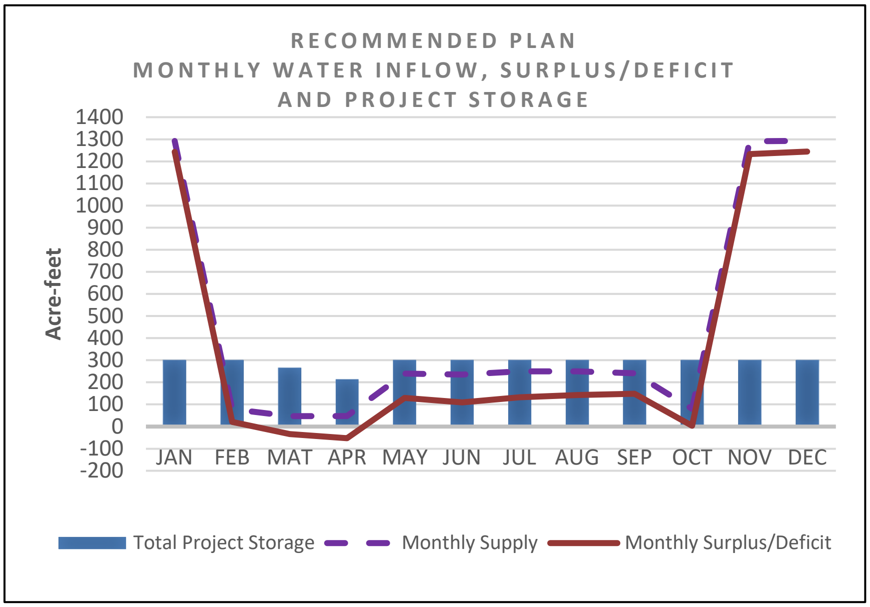

Figure 35. Monthly Water Surplus/Deficit for Tentatively Selected Plan

Refinement of this water budget will be necessary for the development of an operation and maintenance manual to optimize the delivery of a combination of reclaimed water from the WWTP and groundwater discharged from the irrigation wells within the Park.

4.3 Site Geology/Geotechnical

Implementation of this project will not affect the geology at the Park. The increase in water to the Park may change the composition of some of the soils depending on the characteristics of the discharge water. It will also allow for maintenance of areas between the gates, prolonging the life of the project. Filling, grading, and armoring of rills on the irrigation channel banks will improve bank stability and prevent further damage to the access roads.

4.4 Environmental Resources

4.4.1 *Affected Environment

A summary comparing effects between the No Action alternative and the TSP is presented in Table 33. With-project conditions are discussed in more detail in the following section.

Table 33: Alternative comparison table.

Item Assessed \ Alternative	No Action		TSP	
	Short-term	Long-term	Short-term	Long-term
Surface Water	No effect	No effect	No effect	Beneficial effect
Groundwater	No effect	No effect	No effect	Beneficial effect
Wetlands	No effect	No effect	Minor, temporary adverse effect	Beneficial effect
Air Quality	No effect	No effect	Minor, temporary adverse effect	No effect
Noise	No effect	No effect	Minor, temporary adverse effect	No effect
Aesthetics	No effect	No effect	Minor, temporary adverse effect	Beneficial effect
Cultural resources	No effect	No effect	No historic properties affected	No historic properties affected
Socioeconomics and Demographics	No effect	No effect	No effect	No effect
Land Use, Recreation and Education	No effect	No effect	No effect	Beneficial effect
Vegetation	No effect	No effect	Minor, temporary adverse effect	Beneficial effect
Noxious weeds and invasive species	No effect	Minor beneficial effect	Beneficial effect	Beneficial effect
Wildlife and migratory birds	No effect	No effect	Minor, temporary adverse effect	Beneficial effect
Special Status Species	No effect	No effect	No effect	No effect

4.4.1.1 Water Resources

(a) Surface Water

The area and volume of surface water would increase under the proposed project as the new wetlands are constructed and filled with water. This is considered a beneficial long-term effect because surface water is valuable for wildlife, particularly migratory waterfowl. Constructing the new wetlands would allow the Park to take full advantage of the newly acquired irrigation water rights.

(b) Groundwater elevation

The proposed project would not change the amount of groundwater being pumped by the Park's two windmills. During the non-irrigation season, when higher water flows are available from the WWTP, infiltration of water from the new wetlands and riparian areas into the groundwater is expected to increase, due to the larger areas that will be available for flooding and the greater water-storage capacity of the deepened wetland areas. During the irrigation season, infiltration will be comparable to that seen today with the water currently being delivered during the irrigation season to the existing wetlands and the historic river channel. This would be a long-term beneficial effect because it may aid in maintaining groundwater at a level that is accessible to vegetation. However, the infiltration within lined portions of the wetland cells would be reduced throughout the year. Continued monitoring of the Park's groundwater wells would enable USACE and the Sponsor to evaluate any changes in groundwater. One additional groundwater monitoring well should be installed in or near riparian area 3 (R3) to measure the depth to groundwater in this area. Depth to groundwater data should be collected either manually on a weekly basis, or with an automated datalogger, downloading water level readings on a quarterly or semi-annual frequency. This should be coordinated with monitoring of the existing wells.

(c) <u>Groundwater quality</u>

Groundwater quality (e.g., TDS and nitrate) beneath the Park may be improved, due to the lining of the wetlands. The lining will reduce infiltration of treated effluent from the WWTP, which contains high levels of dissolved solutes, into the groundwater (Arcadis 2012).

4.4.2 <u>Floodplains and Wetlands</u>

4.4.2.1 Floodplains

Executive Order 11988, Floodplain Management, stipulates that federal agencies shall take action to preserve the natural and beneficial values served by floodplains and to avoid direct or indirect support of floodplain development. Because the study area is no longer part of the floodplain of the Rio Grande, the proposed project would have no effect on the floodplain. The proposed project also would not induce floodplain development. Therefore, the proposed project is in compliance with EO 11988.

4.4.2.2 Wetlands

The proposed project would enhance 55.1 acres of existing wetlands by deepening, lining as needed, and planting native vegetation. Approximately 4.9 acres of new deep wetlands and 34.3 acres of new shallow marsh would be created. The proposed project would therefore have a direct, long-term beneficial effect on wetlands. The project would also contribute towards conservation efforts by the State of Texas because wetlands are considered high priority habitats.

Short-term adverse effects may occur to the existing wetlands because the areas that are planned to be lined may need to be dewatered temporarily. This impact would be minimized by dewatering only the part of the wetland that requires lining and by timing the construction to occur in the late summer or early fall, before migratory waterfowl arrive. Additionally, flagging and fencing would be used to keep equipment out of parts of the wetlands that are not being deepened and away from cottonwood and willow root zones.

Discharge of fill into wetlands is regulated under Section 404 of the Clean Water Act (33 U.S.C 1251 *et seq.*). Additionally, all wetlands within USACE projects are subject to EO 11990 'Protection of Wetlands', including non-jurisdictional wetlands, and are subject to avoidance, minimization, and mitigation to compensate for remaining unavoidable losses. Under the proposed project, construction of water lines to supply new wetlands may necessitate placement of a small quantity of fill into existing wetland E2. This fill would cause a short-term adverse impact to less than ½ acre of the wetland. A formal wetland delineation has not been conducted for this wetland. For the purposes of this project, a Provisional Jurisdictional Determination will be used, and we assume the wetland is jurisdictional. The discharge of dredged or fill material associated with the TSP has been found to meet the requirements of Nationwide Permit (NWP) 27 (Aquatic Habitat Restoration, Enhancement, and Establishment Activities), NWP 33 (Temporary Construction, Access, and Dewatering), or NWP 18 (Minor Discharges) under Section 404 of the Clean Water Act. All requirements of these NWPs and associated Regional Conditions would be adhered to during construction (Appendix G). As required by Section 401 of the CWA and pursuant to Title 30, Texas Administrative Code, Chapter 279, the Texas Commission on Environmental Quality has issued conditional Water Quality Certification under CWA Section 401 for these NWPs. All regional conditions for the State of Texas would be followed. Additionally, wetland acreage would increase with the proposed project. Therefore, the proposed project is in compliance with the Clean Water Act and with Executive Order 11990.

4.5 Air Quality, Sound, and Aesthetics

4.5.1 Air Quality

During construction of the proposed project, temporary, minor adverse effects to air quality may occur due to emissions from construction vehicles and dust from operations. These impacts would be controlled using the following BMPs:

- The contractor would be required to have emission control devices on all equipment.
- To control dust and wind erosion, soils within the construction zone would be kept wet. Stockpiles of debris, soil, or other materials that could produce dust would be watered or covered. Materials transported on- or off-site by truck would be covered. The contractor would be required to comply with local sedimentation and erosion-control regulations.

After construction is complete, there would be no further impacts to air quality from the proposed project. Plant cover would increase in the study area, possibly contributing to a minor long-term improvement in air quality by trapping dust and filtering pollutants. Under the No-Action alternative, air quality would remain unchanged.

4.5.2 Sound and Noise

The OSHA (Occupational Safety and Health Administration) noise standard limits noise levels to 90 dB(A) averaged over an eight-hour day (US Department of Labor OSHA 2017; 29 CFR 1910.95). No worker may be exposed to noise in excess of 115 decibels [dB(A)] without protection, which would reduce the exposure below 115 dBA. However, experts agree that continued exposure to noise above 85 dB(A) over time will cause hearing loss (Center for Hearing and Communication 2017). The National Institute for Occupational Safety and Health (NIOSH) has recommended that all worker exposures to noise should be controlled below a level equivalent to 85 dB(A) for eight hours to minimize occupational noise induced hearing loss. These conditions are not expected to be exceeded during construction by use of appropriate equipment.

During construction of the proposed project, there would be a temporary, minor increase in noise in the immediate area from the operation of construction equipment. Noise impacts to residential areas outside the Park would be minor and would be kept within the limits specified by the Cities of El Paso and Socorro's noise control ordinances. The construction contractor's work hours would be during daytime established construction hours so that evening and nighttime quiet hours would remain undisturbed.

Over the long term, the proposed project would have no effect on noise. The Park would continue to provide a relatively quiet zone within this part of the City.

4.5.3 Aesthetics

Under proposed project, areas that are currently sparsely vegetated with annual and disturbance species would be replaced by wetland, riparian, and native grassland plant communities. Vegetation changes are discussed in more detail below; in summary, the quantity and diversity of native vegetation would increase within the Park. This would be considered aesthetically beneficial. Short-term impacts to aesthetics due to the presence of construction equipment and temporarily bare soil would be minor.

4.6 Biological Resources

4.6.1 Vegetation Communities

The proposed project would create new wetland and riparian plant communities and enhance those that already exist; replace some areas that are in early successional stages or largely barren with native grasslands and shrubs; and increase the area of native riparian vegetation. Areas within the Park that support tornillo woodlands would be left as-is and would not be affected by construction. Cottonwoods, willows, and riparian shrubs would be interplanted among existing sparse native vegetation using small equipment to auger holes, causing minimal disturbance to existing vegetation. These would all be long-term beneficial effects to vegetation by increasing diversity and the proportion of vegetation that is native.

4.6.2 Wildlife

The proposed project would produce long-term improvements to wildlife habitat by increasing the diversity of habitats, the acreage of riparian and wetland habitats, and the availability of water. In particular, the increase in wetland habitat would benefit waterfowl and shorebirds, while the increase in riparian habitat would benefit nearctic-neotropical migrant birds. Aquatic herpetofauna would benefit from the proposed project as wetlands would increase.

Temporary construction-related adverse impacts would be minimized through timing and phasing of construction; particularly, conducting construction activities outside the migratory bird nesting season. As described in the "Wetlands" Section 4.4.2.2 above, measures would be taken to minimize impacts to wetland habitat during construction. This would also minimize impacts to wildlife, especially waterfowl, using the wetlands. For terrestrial and upland species, sensitive areas, such as the Burrowing Owl habitat areas, would be buffered by at least 165 ft. from construction activity. To minimize adverse effects to small mammals and herpetofauna, all trenches (such as those dug for water supply lines) would be covered the same day or escape ramps would be provided for small animals.

4.6.3 Noxious Weeds and Invasive Species

Controlling or eliminating non-native, invasive vegetation is an objective of the Management Plan. The proposed project would advance this objective by planting native species. The proposed grassland and riparian habitat planting would reduce the acreage dominated by invasive annuals, such as kochia/summer cypress and Russian thistle. This benefit would be both short- and long-term.

4.6.4 Special Status Species

4.6.4.1 Southwestern Willow Flycatcher

The proposed project would not affect the flycatcher. Although riparian habitat would increase in the long term, potentially benefitting the flycatcher during migration, the Park is far removed from critical habitat and known nesting sites and is probably not a large enough area to support viable flycatcher nesting. Short-term effects would be avoided by conducting construction activities outside the migration and nesting season and by avoiding impacts to the mature tornillo habitat where flycatchers have been detected. Flycatchers are expected to continue using the Park as migration habitat if the proposed project is implemented.

4.6.4.2 Yellow-billed Cuckoo, Western population

The proposed project would not affect the cuckoo. Although riparian habitat would increase in the long term, potentially benefitting the cuckoo during migration, the Park is far removed from proposed critical habitat and known nesting sites. The Park is not a large enough area to support viable cuckoo nesting. Short-term effects would be avoided by conducting construction activities outside the migration and nesting season and by avoiding impacts to the mature tornillo habitat where cuckoos have been detected. Cuckoos are expected to continue using the Park as migration habitat if the proposed project is implemented.

4.6.4.3 Texas Horned Lizard

The Texas horned lizard population within the Park is not likely to be affected by the proposed project because the project would have minimal activity in upland areas. By increasing the native grassland habitat in the area, the project may have a minor beneficial effect on this species. Its status in the study area is not expected to change in the future if the proposed project were implemented.

4.6.4.4 Burrowing Owl

The proposed project would avoid construction within 165 feet of the established Burrowing Owl nesting habitats in the Park. Grassland habitat preferred by the owl would increase. Therefore, there would be no effect or may be a minor beneficial effect to the burrowing owl.

4.6.4.5 Peregrine Falcon

The American Peregrine Falcon may fly over or forage within the study area but does not nest within the Park. Due to its transient occurrence and ability to utilize urban habitats, this species would not be affected by the proposed project.

4.6.4.6 Sand Pricklypear

During construction of the proposed project, sand pricklypear locations would be flagged and/or fenced for avoidance. The proposed project would not affect this species.

4.6.4.7 Pecos River Muskrat

With the proposed project, as the water supply to the Park wetlands becomes more constant, wetland vegetation is expected to increase, and the muskrats may become more regular inhabitants of the Park.

4.6.4.8 Additional Species of Concern or Greatest Conservation Need

The proposed project may have long-term beneficial effects to other bird species listed as rare, Species of Greatest Conservation Need, or USFWS Birds of Conservation Concern. By increasing riparian and wetland habitat, the Park area is expected to become even more attractive to migratory birds.

4.6.4.9 Summary of Effects

Due to the season of Project construction, the limited extent of impacts to vegetation, avoidance of high-quality habitat, such as mature tornillo stands, and the implementation of Best Management Practices, the Project would have no effect on federal or state-listed species, and no effect or a long-term beneficial effect on state Species of Greatest Conservation Need and other species of concern.

4.7 Socioeconomic Considerations and Environmental Justice

4.7.1 Demographics

No change in demographics or socioeconomics are expected to result from the proposed project.

4.8 Land Use and Recreation Resources

The proposed project would have a minor recreation and educational component. By improving trails, and providing viewing blinds and improved access, the project is expected to result in increased public interest and visitation. Additionally, the improvements in habitat and resultant increases in bird and wildlife diversity are expected to increase educational opportunities and visitor enjoyment.

4.9 Cultural Resources

Cultural and historic resources identified within the study area include four twentieth-century archaeological sites identified during field investigations (41EP7146, 41EP7147, 41EP7148, and 41EP7149). All have been determined not eligible for inclusion on the National Register of Historic Places (NRHP).

The proposed project would involve potential impacts to three of these sites, which fall within the footprints of proposed measures. Measure R1 (a riparian area) intersects the boundaries of site 41EP7147, measures SC1 (saltcedar thinning) and W2 (a new wetland) intersect the boundaries of site 41EP7148, and measures W4 (a new wetland) and SC2 (saltcedar thinning) intersect 41EP7149. No measures are currently planned for the location of site 41EP7146.

While the proposed project would likely result in modification of each of these three sites, USACE determined that none of the resources within the boundaries of the Park are eligible for listing on the NRHP. The THC concurred with these determinations (Appendix D). USACE consulted with Tribes regarding potential impacts to resources from the current project, and to date has not received indication of Tribal concerns (Appendix D, see Chapter 6 for list of consulted Tribes). Given the above, the USACE determines that the proposed project would result in no historic properties affected.

USACE also plans to use land immediately adjacent to the Park to the southeast to receive excess sediment removed from the Park during construction. The USACE determined that recent ground disturbance throughout the proposed disposal area makes it highly unlikely that any intact archaeological or other cultural resources would be present, and as such determined that disposing of sediment in these areas would also result in no historic properties affected. THC concurred with this determination as well (Appendix D).

4.10 Surface Water Quality

Short-term soil disturbance would result from the proposed actions (e.g., grading, clearing and grubbing, plantings, expanding of wetlands, non-native plant removal). Denuded soils would be susceptible to erosion by wind and water. To minimize the discharge of pollutants, including sediment in stormwater, the selected contractor and local Sponsor will apply for coverage under the National Pollutant Discharge Elimination System (NPDES) Construction General Permit (CGP). A Stormwater Pollution Prevention Plan (SWPPP) will be completed prior to earth disturbing activities and followed until coverage under the CGP is terminated. Short-term sediment disturbance would also result from the proposed actions (e.g., deepening existing wetlands). To minimize the transport of soil and sediment from the project areas to adjacent water bodies, down-gradient sediment controls (e.g., buffers, perimeter controls, exit controls, dewatering, and turbidity curtains) that control discharges from the initial activities that disturb soil or sediment will be designed, installed, and maintained until coverage under the CGP is terminated. Per the

CGP, disturbed areas will be stabilized, with the exception of features that were designed to remain unvegetated (e.g., open-water wetland). All stormwater controls at locations designed to remain unvegetated will be removed immediately following construction. Potential short-term contributions of sediment to adjacent water bodies are possible during the removal of the physical buffers and following construction of water or near-water features.

Mechanical equipment, such as excavators or backhoes, could potentially leak oil, fuel, or hydraulic fluid, which could reach adjacent water bodies and affect surface water quality. Spills of such materials could similarly contaminate surface water. The SWPPP will identify locations where potential spills and leaks could occur that could contribute pollutants to stormwater discharges. Pollution prevention requirements (Section 2.3 of the CGP), including spill prevention and response procedures, will be documented in the SWPPP and implemented until coverage under the CGP is terminated.

To estimate the long-term effects to water quality, the annual loads were estimated using the potential volume from each source to the Park (Table 34). Annual average water quality loads were estimated for each of the water sources from the Park under the future with-project scenario. The potential volume of each source was obtained from the water budget (see Section 2.3). However, due to the use of potential volumes rather than actual volumes in the water budget, the only load that changes is precipitation due to an increase in surface area. It is recommended that loading calculations be updated after construction is completed and the diverted volumes are better quantified.

Post-construction activities (e.g., periodic flushing with low salinity and low nutrient waters; mechanical removal of macrophytes and detritus; aeration to minimize anoxic conditions; addition of barley straw to control algae, etc.) to improve water quality will be detailed in the operation and maintenance manual. These activities will be implemented by the non-federal Sponsor if water quality conditions are found to be degraded.

Table 34: Annual average water quality loads for each of the water sources from the Park under the future with-project scenario.

Source	Annual Volume (m^3 x10^6/year)	Chloride (mg L^{-1})	Chloride (kg year $^{-1}$)	Nitrate (mg L^{-1})	Nitrate (kg year $^{-1}$)	Total Phosphorus (mg L^{-1})	Total Phosphorus (kg yr^{-1})
Precipitation	0.05	1.00E-01	1.28E+01	7.00E-01	8.98E+01	ND	ND
Riverside Canal	0.43	3.93E+02	1.69E+05	3.75E+00	1.62E+03	1.77E+00	7.63E+02
WWTP Effluent	5.52	3.22E+02	1.78E+06	1.14E+01	6.28E+04	2.65E+00	1.46E+04
Wells RB 12 &13	0.26	6.51E+02	1.67E+05	5.00E-01	1.28E+02	4.00E-01	1.03E+02

ND: data not readily available.

4.11 Cumulative effects

Cumulative effects are the impacts on the environment that result from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or entity (federal or non-federal) or person undertakes such other actions (40 CFR 1508.7)

The Region of Influence for this cumulative effects analysis is the historic floodplain of the Rio Grande through the El Paso metro area. Activities that contribute to cumulative effects in the area surrounding the Park include: past farming; past, present and future residential development and associated infrastructure; the Rio Grande Rectification Project; the ongoing lining of the Riverside Canal; flood risk management measures, including USACE's El Paso Flood Control Project; proposed implementation of a conservation storage reservoir immediately to the south of Rio Bosque Park; and potential changes to border infrastructure, including transportation and border wall improvements.

The following resources are analyzed for cumulative effects: vegetation communities, wildlife, migratory birds, special status species, air quality, noise, and water quality. Cumulative effects were not analyzed for other resources because there would be no adverse effect to these resources from the proposed action.

The cumulative effects of the above-mentioned activities over the past several decades [to century] have resulted in a disruption of the original hydrologic and hydraulic regime and the degradation of the Rio Grande riparian ecosystem. The proposed project would have a countervailing effect by restoring part of this ecosystem. Therefore, the cumulative effects of the proposed project on the ecosystem, including the vegetation communities, wildlife, migratory birds, and special status species that occur within it, would not be significant.

Minor cumulative effects to air quality and noise levels would occur during the project construction period. However, the additive effects on air quality and noise would not extend beyond the period of equipment operation. During the period of project construction, effects on air quality or noise would not exceed any critical environmental thresholds due to implementation of BMPs.

Action under the proposed project would have no additive or long-term adverse impact on the existing water quality conditions. Minor, localized, long-term beneficial effects to water quality could occur as a result of the removal of nutrients by vegetation growing in the created wetlands and the enhancement of wetland and riparian areas. Therefore, there would be no cumulative adverse effects on water quality as a result of the proposed project.

For these reasons, the proposed project action when combined with past, present, and future activities within the City of El Paso would not significantly add to or raise local cumulative environmental impacts to a level of significance.

4.12 Real Estate

The sponsor must acquire and/or provide fee interest for the project footprint. A land survey of the project to ascertain ownership interests and create legal descriptions is recommended. Any conveyance estates used for this project shall be the "Minimum Estate Required" as stated in the Real Estate Handbook, ER 405-1-12, for Civil Works Real Estate acquisitions.

There are no private landowners within the study area. All land required for this project, including staging, stockpiling, and disposal areas, is owned by the Sponsor. The study area consists of approximately 388 acres and is owned in Fee by the City of El Paso. Project activities would take place on approximately 186 acres within the study area. The Sponsor has indicated that staging and stockpiling excavated materials may be either on-site at the Park or at the adjacent WWTP. The access roads required for ingress/egress are either owned in fee by the Sponsor or public access.

Table 35: Breakdown of land ownership.

Feature	Ownership	Interest Acquired	Acres
Riparian habitat creation areas	City of El Paso	Fee Simple Title (Standard Estate #1)	45
Grassland creation areas	City of El Paso	Fee Simple Title (Standard Estate #1)	15.3
Wet marsh creation areas.	City of El Paso	Fee Simple Title (Standard Estate #1)	34.3
Existing wetland deepening and lining	City of El Paso	Fee Simple Title (Standard Estate #1)	15.1
Saltcedar thinning areas	City of El Paso	Fee Simple Title (Standard Estate #1)	31.1
Wetland creation areas	City of El Paso	Fee Simple Title (Standard Estate #1)	4.9
Staging & Disposal areas	City of El Paso	Temporary Work Area Easement (Standard Estate #15)	Unknown

5 - Recommendation

It is recommended that the array of ecosystem restoration measures referred to herein as "Best Buy 18" be constructed under USACE authority under Section 206 of WRDA 1996, as amended. This integrated feasibility report and environmental assessment took into consideration significant aspects, including environmental, social, and economic effects, as well as engineering feasibility.

The TSP consists of the construction of new wetlands, modification of existing wetlands, construction of new shallow marsh wetlands, enhancement of riparian habitat, and construction of new floodplain grassland habitat. The TSP is the NER Plan, which maximizes net ecosystem restoration benefits compared to costs and is consistent with the federal objective. This feasibility report and environmental assessment fulfills the requirements of USACE planning and policy as well as requirements under NEPA for evaluation of alternatives and selection of a TSP.

The proposed project would result in only minor, temporary, adverse impacts to water quality, air quality, aesthetics, noise levels, soils, vegetation, land use, recreation, wildlife, and waters of the United States during construction. The project would have no impacts to threatened and endangered species, historic properties and other cultural resources, Tribal trust resources, floodplains, hydrology, socio-economics and environmental justice. There would be long-term benefits to habitat quality and diversity, vegetation, and wildlife diversity and density, which would outweigh these short-term adverse impacts. There would be no adverse cumulative effects to the environment from the proposed project.

5.1 Views of the Non-Federal Sponsor

The El Paso Water Utilities has affirmed their intent to participate in the project. The Sponsor's commitment to the success of the proposed project is evidenced by their investment of resources in acquiring water rights for the Park. The results attained in the additional analyses conducted and presented in this feasibility report have not changed the Sponsor's favorable support of this project. USACE has received statements of financial support from the El Paso Water Utilities, which continue to show interest and support for this project.

5.2 Study Schedule

Table 36 indicates the schedule for the remaining milestones for the study.

Table 36: Schedule of Project Milestones.

Milestones	Date
South Pacific Division Review	August 2020
MSC Decision Milestone	14 September 2020
Concurrent Reviews and Revisions	October 2020 thru January 2021
Transmit Final Draft FONSI to SPD	January 2021
Decision Document Approved by SPD (MFR)	May 2021
Execute Design Agreement	September 2021
Receive D&I Funds	October 2021
Construction Begin	April 2023
Construction End	April 2025
Monitoring and Adaptive Management End	April 2030

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

5.3 Cost Sharing Requirements

The non-federal Sponsor is responsible for the cost share amount equal to 35% of total project costs as well as Land, Easements, Rights-Of-Way, Relocation, and Disposal Areas (LERRDs) and Operation and Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R). All costs for construction in excess of that amount would be accomplished by the local Sponsor as a betterment.

Operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) becomes the Sponsor's responsibility after construction of the project. OMRR&R costs are estimated at $50,000 annually (FY18 price level). These estimates will be refined during final design.

Table 37: Costs share apportionment for the estimated project costs.

Oct. 2020 Price Level, ($1,000's)	TOTAL FEDERAL	TOTAL NON-FEDERAL	Total
LERRDs	$10	$814	$824
Construction (Ecosystem Restoration)	$6,230	$3,355	$9,585
Construction Recreation (50/50 Cost Share)	$40	$40	$80
Construction Management	$496	$267	$763
Monitoring & Adaptive Management	$209	$113	$322
Adjustment	$529	($529)	$0
Total First Cost (Ecosystem Restoration and Recreation)	**$7,514**	**$4,060**	**$11,574**

Federal implementation of the recommended project would be subject to the non-federal Sponsor agreeing to comply with applicable federal laws and policies, including, but not limited to, the items listed below:

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

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

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

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

Upon completion of the project construction, the Government would turn the project over to the local Sponsor who would be responsible for operating, maintaining, repairing, rehabilitating, and replacing the project features for the life of the project, in accordance with USACE guidelines and regulations.

6 - *Coordination and USACE Review Process

6.1 Agency Coordination and Collaboration

Scoping letters were mailed on February 20, 2015; March 15, 2015; and April 13, 2015 to appropriate federal, state, and local government agencies, as well as other entities who may have a potential interest in or who have expressed an interest in the proposed project.

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

- Friends of the Rio Bosque
- Audubon Society of New Mexico
- US Fish and Wildlife Service
- University of Texas – El Paso
- US Bureau of Reclamation
- US International Boundary Water Commission
- Texas Parks and Wildlife Division
- El Paso City Parks and Recreation
- University of Texas El Paso CERM
- US Environmental Protection Agency
- Texas Commission on Environmental Quality
- City of El Paso Public Works Department
- Texas State Soil and Water Conservation Board
- USDA Natural Resource Conservation Service
- Apache Tribe of Oklahoma
- Comanche Nation of Oklahoma
- Fort Sill Apache Tribe
- Kiowa Tribe of Oklahoma
- Mescalero Apache Tribe
- Wichita and Affiliated Tribes
- Ysleta del Sur Pueblo
- Tonkawa Tribe of Indians of Oklahoma
- White Mountain Apache Tribe

Information on the proposed project, including project background, purpose and need, project description, proposed alternatives, and study area map, were mailed to all entities contacted in the above list.

6.2 Comments and Responses to Scoping Letter

Comments received from scoping letter inquiries concerning the proposed construction project include the following. No concerns were expressed, as follows:

- The US International Boundary Water Commission (USIBWC) responded, stating its agreement to be a Cooperating Agency and its willingness to provide technical information on the survey and design of a previous (2012) diversion channel turnout project.
- Rio Bosque Wetlands Park Manager John Sproul responded, providing a detailed discussion of the history of the wetland project, as well as goals, opportunities, and priorities envisioned for the proposed project.
- Ysleta del Sur Pueblo responded indicating that they had no comment and did not believe the project would result in any adverse effects to traditional, religious, or culturally significant sites, but requested further consultation in the event that any human remains or artifacts falling under NAGPRA (Native American Graves Protection and Repatriation Act) guidelines were identified during project implementation.

6.3 *Preparers and Quality Control

6.3.1 Preparation

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

Brian Sanchez – Project Manager

Leeanna Torres – Project Manager

Lynette Giesen – Project Manager

Alicia Austin-Johnson – Project Manager

Lance Faerber – Structural Engineer

Ondrea Hummel – Biologist

Dana Price – Biologist

Jonathan Van Hoose – Archaeologist

Christina Sinkovec - Archaeologist

Robert Browning – Economist

Vince Vigil – Hydraulic Engineer

James Hewitt – Hydraulic Engineer

Jame Eisenberg – Hydraulic Engineer

Huff Horton – Civil Engineer

Richard Dourte – Civil Engineer

Maribel Ramos-Torres – Civil Engineer

Henry Martinez – Cost Engineer

Sonia Murdock – Cost Engineer

Stacy Samuelson – Planner

Mark Doles – Planner

Dale Cottrell – Architectural Designer

Carlos Aragon – Geotechnical Engineer

Steven Wagner – Environmental Engineer

Justin Reale – Environmental Engineer

Ariane Pinson – Climate Science Specialist

6.3.2 Technical Review

6.3.2.1 District Quality Control

The Albuquerque District's Quality Control Reviewers included:

– Hydrologic Engineer

– Real Estate

– Economist

– Biologist

– Plan Formulation

- Archaeologist

- Geologist

- HTRW

– Civil Engineer

– Geotechnical Engineering

– Cost Engineer

7 - *References

Arcadis U.S., Inc. (Arcadis). 2012. Rio Bosque area potable reuse feasibility assessment. Prepared for El Paso Water Utilities.

Arcadis. 2013. A potable reuse and wetlands improvement concept for drought-challenged El Paso, TX. Prepared for El Paso Water Utilities.

Baca, J., D. Bhandari and J. Mitchell. 2017. Economic Impacts of the New Mexico Small Business Investment Corporation. University of New Mexico Bureau of Business and Economic Research. https://bber.unm.edu/media/publications/SBIC_Impact_Study_FINAL.pdf

Beacon Environmental. 2012. Ecological Buffer Guideline Review. Prepared for Credit Valley Conservation by Beacon Environmental, Ltd. Ottowa, Ontario. Available: https://cvc.ca/wp-content/uploads/2013/08/Ecological-Buffer-Guideline-Review.pdf, accessed June 29, 2020

Bentrup, G. 2008. Conservation buffers: design guidelines for buffers, corridors, and greenways. Gen. Tech. Rep. SRS-109. Asheville, NC: Department of Agriculture, Forest Service, Southern Research Station. 110 p. Available: https://www.fs.usda.gov/nac/buffers/docs/conservation_buffers.pdf, accessed June 29. 2020.

Carey, R. O., and Migliaccio, K. W. 2009. Contribution of wastewater treatment plant effluents to nutrient dynamics in aquatic systems: a review. Environmental management 44:205-217.

Center for Hearing and Communication. 2017. Common Environmental Noise Levels. Online at http://www.chchearing.org/noise-center-home/facts-noise/common-environmental-noise-levels, accessed May 24, 2017.

Chaparro, G., Z. Horvath, I. O'Farrel, R. Ptacnik, T. Hein. 2018. Plankton metacommunities in floodplain wetlands under contrasting hydrological conditions. Freshwater Biology 63: 380-391. DOI: 10.1111/fwb.13076

City of El Paso. Noise ordinance. El Paso, Texas Code of Ordinances, Chapter 9.40. Online at https://www.municode.com/library/tx/el_paso/codes/code_of_ordinances?nodeId=TIT9HESA_CH9.40NO_9.40.070NOSEZO, accessed May 24, 2017.

Crawford, C. S., A. C. Cully, R. Leutheuser, M. S. Sifuentes, L. H. White, and J. P. Wilber. 1993. Middle Rio Grande Ecosystem: Bosque Biological Management Plan. Bosque Biological Interagency Team, U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

Deane, D.C., D.A. Fordham, F. He, and C.J.A. Bradshaw. 2017. Future extinction risk of wetland plants is higher from individual patch loss than total area reduction. Biological Conservation 209 (2017): 27-33.

Dinerstein, E., D. Olson, J. Atchley, C. Loucks, S. Contreras-Balderas, R. Abell, E. Iñigo, E. Enkerlin, C. Williams, and G. Castilleja, eds. 2000. Ecoregion-based conservation in the Chihuahuan Desert: A biological assessment. World Wildlife Fund. Available: awsassets.panda.org/downloads/wwfbinaryitem2757.pdf, accessed 29 Aug. 2017.

Dumas, L.J. 2003. Economic Multipliers and the Economic Impact of DOE Spending in New Mexico.

Easterling, D.R., K.E. Kunkel, J.R. Arnold, T. Knutson, A.N. LeGrande, L.R. Leung, R.S. Vose, D.E. Waliser, and M.F. Wehner, 2017: Precipitation change in the United States. In: Climate Science Special Report: Fourth National Climate Assessment, Volume I [Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, D.J. Dokken, B.C. Stewart, and T.K. Maycock (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 207-230, doi: 10.7930/J0H993CC.

El Paso Water Utilities. 2005. Borehole Geophysical Log TH-RB. Prepared by Stewart Brothers Drilling Company for the El Paso Water Utilities.

EPWU Public Service Board Meeting, March 8, 2017. Contract to classify land within El Paso County Water Improvement District No. 1 as irrigable land and to establish covenants running with such land.

Fullerton, W., and Batts, D. 2003. Hope for a Living River: *A Framework for a Restoration Vision for the Rio Grande.* Santa Fe, N.M.: The Alliance for the Rio Grande Heritage. Available: smiley.nmsu.edu/pdnwc/docs/VisionReport.pdf, accessed 29 Aug. 2017.

Halterman, M.D., M.J. Johnson, J.A. Holmes and S.A. Laymon. 2015 (Draft dated May 2016). A Natural History Summary and Survey Protocol for the Western Distinct Population Segment of the Yellow-billed Cuckoo: U.S. Fish and Wildlife Techniques and Methods, 45 p.

Hammer, D. A. 1989. Constructed wetlands for wastewater treatment: municipal, industrial and agricultural. CRC Press.

Henrickson, J. and M.C. Johnston. 1986. Vegetation and community types of the Chihuahuan Desert, p. 20–39. In: Invited papers from the second symposium on resources of the Chihuahuan Desert region, United States and Mexico. Chihuahuan Desert Research Institute, Sul Ross State University, Alpine, Texas.

Hink, V.C., and R.D. Ohmart. 1984. Middle Rio Grande Biological survey. U.S. Army Corps of Engineers, Albuquerque District, New Mexico. Contract No. DACW47-81-C-0015, Arizona State University.

Hughes, J.M. 1999. Yellow-billed Cuckoo (*Coccyzus americanus*). *In* The Birds of North America, No. 148 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA. 28 pp.

Kim, J.-W., Jang, H.-S., Kim, J.-G., Ishibashi, H., Hirano, M., Nasu, K., Ichikawa, N., Takao, Y., Shinohara, R., and Arizono, K. 2009. Occurrence of pharmaceutical and personal care products (PPCPs) in surface water from Mankyung River, South Korea. Journal of Health Science 55:249-258.

Nielsen-Gammon J. 2011. The Changing Climate of Texas. in Schmandt J, Clarkson J, North GR (eds.) The Impact of Global Warming on Texas, 2nd edition. University of Texas Press, Austin, TX, pp. 14-38.

Olson, David M. and Eric Dinerstein. 2002. The Global 200: Priority Ecoregions for Global Conservation. Annals of the Missouri Botanical Garden, Vol. 89, No. 2 (Spring, 2002), pp. 199-224.

Pina, A. E., and Lougheed, V.L. Unpublished. Rio Bosque Park water chemsitry data. Data provided: May 2019.

Pronatura Noreste, The Nature Conservancy and World Wildlife Fund. 2004. Ecoregional Conservation Assessment of the Chihuahuan Desert, Second Edition. Online at http://nmconservation.org/projects/ecoregions/, accessed: 29 Aug. 2017.

Rodriguez, R., and Lougheed, V. L. 2010. The potential to improve water quality in the middle Rio Grande through effective wetland restoration. Water Science and Technology 62:501-509.

Scurlock, D., 1998. From the Rio to the Sierra: An Environmental History of the Middle Rio Grande Basin. General Technical Report RMRS-GTR-5. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 440 p.

Semlitsch, R. and J.R. Bodie. 1998. Are small, isolated wetlands expendable? Conservation Biology vol. 12, No. 5: 1129-1133.

Singh, M. 2015. Isolated Wetlands: Assessing Their Values & Functions. Journal of Aquatic Science, Vol. 3, No. 1: 6-13. Available online at http://pubs.sciepub.com/jas/3/1/2; DOI:10.12691/jas-3-1-2

Sproul, J. 2011. Meeting Water Needs at Rio Bosque Wetlands Park: Strategies Involving El Paso Water Utilities. White paper, Center for Environmental Resource Management, University of Texas at El Paso.

Sogge, M.K., Ahlers, Darrell, and Sferra, S.J., 2010. Natural history summary and survey protocol for the southwestern willow flycatcher: U.S. Geological Survey Techniques and Methods 2A-10, 38 p.

Stotz, N.G. 2000. Historic Reconstruction of the Ecology of the Rio Grande/Rio Bravo Channel and Floodplain in the Chihuahuan Desert. Report prepared for the Chihuahuan Desert Program, World Wildlife Fund, 14 June 2000.

Street, J. B., and Peery, R. 2014. El Paso Water Utilities 2014 Rio Bosque test holes. John Shomaker & Associates, Inc., Albuquerque, New Mexico.

Texas Commission on Environmental Quality (TCEQ). 2017. El Paso: Current Attainment Status. http://www.tceq.texas.gov/airquality/sip/elp/elp-status, accessed April 20, 2017.

TCEQ. 2016. 2015 Emissions Inventory Guidelines. TCEQ publication RG-360/15. Prepared by Emission Assessment Section, Air Quality Division, Office of Air. Online at https://www.tceq.texas.gov/publications/rg/rg360-15/index.html, accessed May 24, 2017.

Texas Parks and Wildlife Department (TPWD). 2012. Texas Conservation Action Plan 2012 – 2016: Chihuahuan Deserts and Arizona – New Mexico Mountains Handbook. Editor, Wendy Connally, Texas Conservation Action Plan Coordinator. Austin, Texas.

TPWD. 2017. Rare, Threatened, and Endangered Species of Texas by County. Online at http://tpwd.texas.gov/gis/rtest/, accessed July 5, 2017.

Texas Water Well Drillers Advisory Council. 2002. RB-12 Well Report. Dated 22 October 2002.

United States Environmental Protection Agency (USEPA). 2017. Criteria Air Pollutants. https://www.epa.gov/criteria-air-pollutants Accessed May 24, 2017.

United States Department of Labor Occupational Safety & Health Administration (OSHA). 2017. Occupational noise exposure. Occupational Safety and Health Standards part 1910. Online at https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9735 , accessed April 20, 2017.

U.S. Army Corps of Engineers (USACE). 2013. El Paso Rio Bosque Wetlands Ecosystem Restoration Project El Paso, Texas, Federal Interest Determination Document.

U.S. Bureau of Reclamation. 2008. Desert blooms: a sunscape guide to plants for a water-scarce region. online at http://www.usbr.gov/uc/dblooms/pages/Sources.jsp, accessed 8 August 2014.

U.S. Census Bureau. 2020a. Quick Facts- El Paso City, Texas. https://www.census.gov/quickfacts/elpasocitytexas, accessed June 26, 2020.

U.S. Census Bureau. 2020b. Quick Facts- El Paso County, Texas. https://www.census.gov/quickfacts/elpasocountytexas, accessed June 26, 2020.

US Department of Agriculture, Natural Resource Conservation Service. Agriculture Waste Management Field Handbook, Chapter 10 Agriculture Waste Management System Component Design, Appendix 10D: Design and Construction Guidelines for Impoundments Lined with Clay or Amendment-treated Soil. August 2009.

U.S. Department of Commerce, Bureau of Economic Analysis, 2020. BEARFACTS, El Paso, TX (Metropolitan Statistical Area). https://apps.bea.gov/regional/bearfacts/countybf.cfm , accessed June 26, 2020.

U.S. Department of Labor, Bureau of Labor Statistics, 2020. Economy at a Glance: El Paso, TX. Online at: https://www.bls.gov/eag/eag.tx_elpaso_msa.htm , accessed June 26, 2020.

U.S. Environmental Protection Agency (USEPA). 2019. National recommended water quality criteria - aquatic life criteria table. URL: https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table. Accessed: May 11, 2019.

U.S. Fish and Wildlife Service (USFWS). 1980. Habitat Evaluation Procedures (HEP). ESM 102, Release 2-80. Washington, DC: Division of Ecological Services, U.S. Fish and Wildlife Service, Department of the Interior.

USFWS. 1995. Final Rule Determining Endangered Status for the Southwestern Willow Flycatcher: Federal Register 60:10694 (February 27, 1995).

USFWS. 2013. Designation of critical habitat for Southwestern Willow Flycatcher (Empidonax traillii extimus). Final Rule: Federal Register 78:344-534 (January 3, 2013).

USFWS. 2014a. Endangered and Threatened Wildlife and Plants; Determination of Critical Habitat for the Western Distinct Population Segment of the Yellow-billed Cuckoo (Coccyzus americanus); Proposed Rule. Federal Register 79:48548-48652 (August 15, 2014).

USFWS. 2014b. Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for the Western Distinct Population Segment of the Yellow-billed Cuckoo (Coccyzus americanus); Final Rule. Federal Register 79:59992-60038 (October 3, 2014).

USFWS. 2017. IPaC Information for Planning and Consultation (Web application) online at: https://ecos.fws.gov/ipac/, accessed 4 July 2017.

USFWS. 2020. Endangered and Threatened Wildlife and Plants; Revised Designation of Critical Habitat for the Western Distinct Population Segment of the Yellow-Billed Cuckoo. Proposed Rule. Federal Register Vol. 85 No.39: 11458-11594 (February 27, 2020).

U.S. Water Resources Council. 1983. *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies,* March 10, 1983.

University of Texas at El Paso, Center for Environmental Resource Management. 2013-2020. Rio Bosque News (Quarterly newsletter).

University of Texas at El Paso, Center for Environmental Resource Management. 2002. Letter to Ken Kriese, USFWS Re: Final Performance Report, Rio Bosque Water Supply Well, El Paso County, Texas. Agreement No. TX-N131C. Dated 21 January 2009.

Vitousek, P. M., Mooney, H. A., Lubchenco, J., and Melillo, J. M. 1997. Human domination of Earth's ecosystems. Science 277:494-499.

Vose, R.S., D.R. Easterling, K.E. Kunkel, A.N. LeGrande, and M.F. Wehner, 2017: Temperature changes in the United States. In: Climate Science Special Report: Fourth National Climate Assessment, Volume I [Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, D.J. Dokken, B.C. Stewart, and T.K. Maycock (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 185-206, doi: 10.7930/J0N29V45.

Vymazal, J. 2007. Removal of nutrients in various types of constructed wetlands. Science of the total environment 380:48-65.

Watts, S.H., J. Sproul and E. Hamlyn. 2002. A Biological Management Plan for Rio Bosque Wetlands Park. Report prepared for the City of El Paso and University of Texas at El Paso Center for Environmental Resource Management. 96pp.

Western Regional Climate Center (n.d.) Evaporation stations. online at http://www.wrcc.dri.edu/htmlfiles/westevap.final.html, accessed 8 August 2014.

Yoon, Y., Ryu, J., Oh, J., Choi, B.-G., and Snyder, S. A. 2010. Occurrence of endocrine disrupting compounds, pharmaceuticals, and personal care products in the Han River (Seoul, South Korea). Science of the Total Environment 408:636-643.