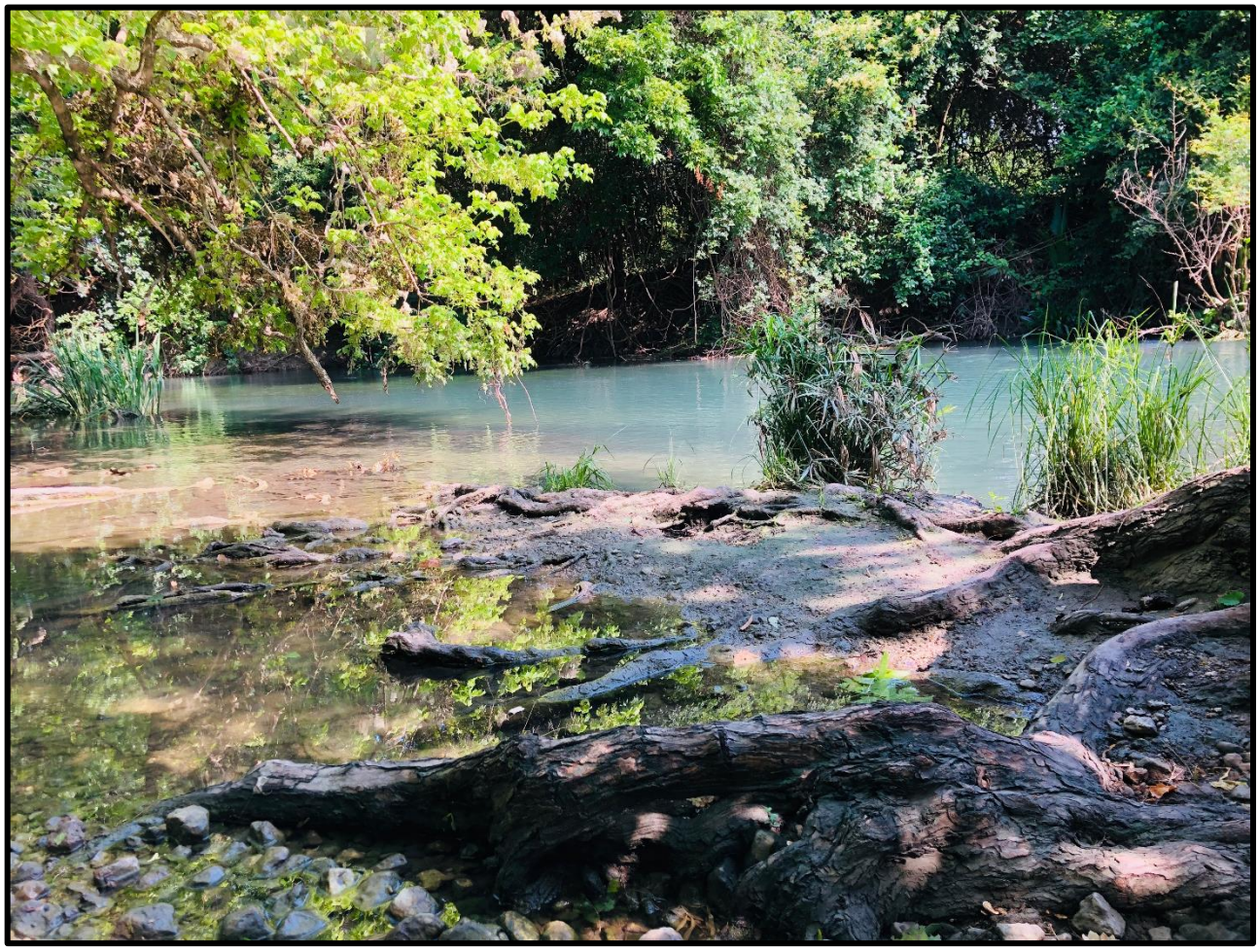
US Army Corps
of Engineers®
Fort Worth District

River Road Aquatic Ecosystem Restoration

Integrated Feasibility Report and Environmental Assessment

Continuing Authorities Program
Section 206



JULY 2021

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DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, FORT WORTH DISTRICT
P. O. BOX 17300
FORT WORTH, TEXAS 76102

CAP - River Road, San Antonio, Texas

February 2020

FINAL

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EXECUTIVE SUMMARY

STUDY DESCRIPTION

The River Road Aquatic Ecosystem Restoration (ER) Feasibility Study is a Continuing Authority Program (CAP) Section 206 Study. The Integrated Feasibility Report (IFR) document contains information relevant to both a Planning and Design Analysis used as a planning document by the U.S. Army Corps of Engineers (USACE) and an Environmental assessment (EA) to satisfy the National Environmental Policy Act (NEPA).

AUTHORITY

The study is being performed under Section 206 of the Water Resources Development Act (WRDA) of 1996, as amended (335 U.S. Code 2011). Under this authority, USACE is authorized to develop aquatic ecosystem restoration projects that improve the quality of the environment, are in the public interest, and are cost effective.

STUDY PURPOSE

The purpose of this feasibility study is to investigate and determine modifications that would improve the habitat structure and function of the River Road segment of the San Antonio River. The IFR is prepared in response to a request for Federal assistance from the San Antonio River Authority for an aquatic ecosystem restoration project. This IFR documents the feasibility study and serves as the decision document for project design and construction.

STUDY SCOPE

The study is a CAP feasibility study for aquatic ecosystem restoration. CAP feasibility studies focus on water resource related projects of relatively smaller scope, cost, and complexity. A determination of Federal Interest to support a request for initial study was approved on November 30th, 2015.

The study generally includes the River Road segment of the San Antonio River. The River Road segment of the river is part of an interconnected system of USACE ecosystem restoration projects in the San Antonio, Texas area. The project will investigate the ecosystem degradation along the river and look for solutions that will restore the area to maximum ecosystem function.

LOCATION

The study area is located in the River Road area of San Antonio, Texas on the San Antonio River between East Mulberry Avenue and US 281. The project site spans approximately 3700 feet of the San Antonio River that is bound by Avenue A and River Road to the east and west and is one of the last unchannelized segments of the river (**Figure ES 1 and Figure ES 2**).

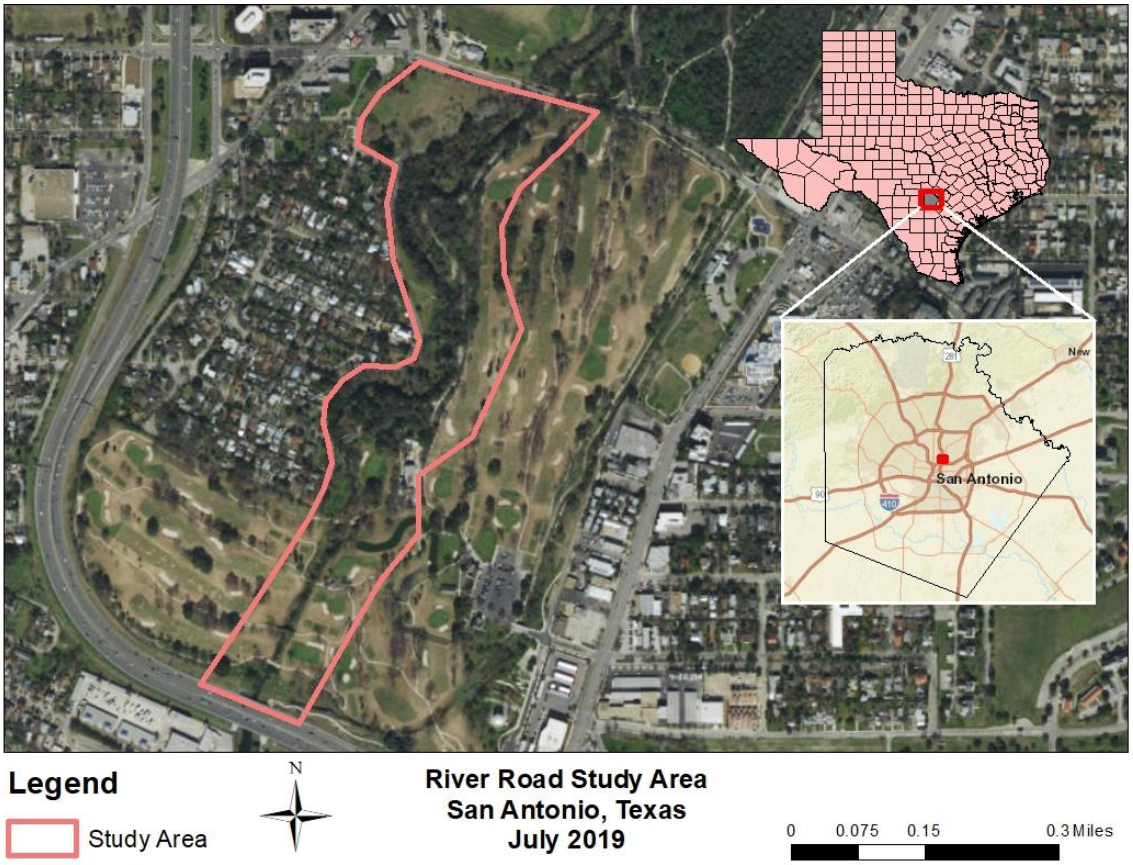

Figure ES 1: Project Area

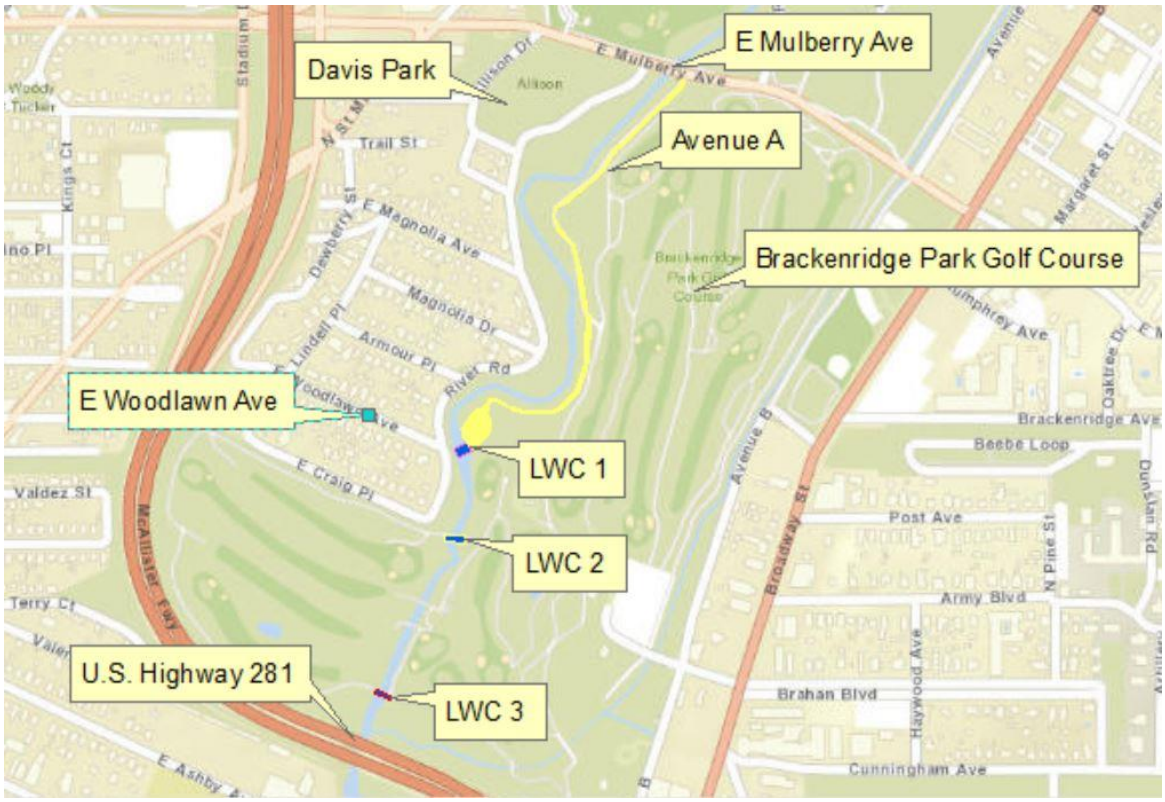

Figure ES 2: Study Area

STUDY SPONSOR

The USACE Fort Worth District (SWF) was responsible for the overall management of the study and the report preparation. As the non-Federal Sponsor (NFS), the San Antonio River Authority (SARA) has been involved throughout the study process.

PROBLEMS AND OPPORTUNITIES

Problem Statement: The aquatic ecosystem along the River Road segment of the San Antonio River is severely degraded from excess erosion resulting in a riparian corridor that has been reduced to a narrow strip adjacent to the riverbank. This has reduced the natural bank erosion protection provided by the riparian vegetation along the river.

In addition to hydrological impacts associated with urbanization within the watershed, River Road and Avenue A that parallel the River Road segment of the river have constrained the river, resulting in magnified erosion and sedimentation. This has caused a reduction in the area of the riparian corridor adjacent to the river, reducing the natural bank erosion protection of the river. The riparian corridor is further degraded by public disturbance, including parking vehicles in the already reduced riparian area that parallels the river.

The opportunities identified include:

- Restore function and structure to the aquatic ecosystem
- Provide additional recreational and ecotourism benefits to the community
- Improve water quality in the San Antonio River through ecosystem restoration
- Reduce erosive threat to public infrastructure

PLANNING OBJECTIVES

Planning objectives reflect an expression of public and professional issues or concerns about the use of water and related land resources resulting from the analysis of existing and future conditions in the study area. These planning objectives were used in guiding the development of alternative plans and their evaluation for the period of analysis. The following planning objectives were used in formulation and evaluation of alternative plans:

Primary Objectives:

- *Objective 1*: To restore aquatic ecosystem function and structure to the River Road segment of the San Antonio River for a 50-year period of analysis (baseline 2020 and future without-project and future with-project beginning 2023 and ending 2073):
- *Objective 2*: Restore and maintain riparian habitat quality over the 50-year period of analysis

Secondary Objectives:

- *Objective 3:* Reduce the erosive threat to the roads that parallel the river over the 50-year period of analysis

ALTERNATIVES

Measures used to formulate alternatives included both nonstructural and structural measures, as well as a No Action Alternative. Nonstructural measures included native species planting, invasive species removal, and controlled public access. Structural measures included road modifications, nesting structures-platforms, instream structures, channel shaping, bar/island modifications, low water crossing modifications, pulse flows, off channel wetland design, and geolifts. Recreational measures were considered and were evaluated for the Recommended Plan. Measures were evaluated to determine if they addressed study objectives and remained within the study scope. Those measures that did not address objectives were dropped from the alternative formulation. Remaining measures were grouped together to form discrete alternatives to address specific needs in the study area. Alternatives were screened and scales were added to each alternative (**Table ES 1**) to capture differing levels of benefits. The alternatives were evaluated and analyzed to determine costs and benefits (**Table ES 2**). The alternatives were then combined to form Alternative Plans. Evaluation of the alternatives and plans relied largely on available existing information. Plans were then evaluated based on economic and environmental benefits to determine the Recommended Plan**.**

Table ES 1. Array of Alternatives

Alternative	Scale	Environmental Restoration Measures	Access Control Measures	Access Mitigation Measures
Alternative 1 Instream modification	1A	• Removal of Low Water Crossing 1 • Removal of Low Water Crossing 2 • Removal of Low Water Crossing 3 • Instream Structures • Geolifts	• Boulder Barrier	• Bridge
	1B	• Modification of Low Water Crossing 1 • Removal of Low Water Crossing 2 • Removal of Low Water Crossing 3 • Instream Structures • Geolifts	• Boulder Barrier	• Bridge
	1C	• Removal of Low Water Crossing 1 • Modification of Low Water Crossing 2 • Modification of Low Water Crossing 3 • Instream Structures • Geolifts	• Boulder Barrier	• Bridge
	1D	• Modification of Low Water Crossing 1 • Modification of Low Water Crossing 2 • Modification of Low Water Crossing 3 • Instream Structures • Geolifts	• Boulder Barrier	
Alternative 2 Avenue A Modification	2A	• Removal of Avenue A	• Gate Installation	• Golf Course Path Widening
	2B	• Partial Removal of Avenue A	• Gate Installation	• Golf Course Path Widening
Alternative 3 River Road Removal	3A	• Partial removal of River Road ○ Reroute traffic to Allison Drive		
	3B*	• River Road remains as is • Native species planting in park		

*Does not technically affect river road but included as scale so it will not be considered in combination with 3A (River Road Removal)

Table ES 2. Array of Alternatives

Alternative	Scale	Description	AAHU Benefits	Project First Cost ($1,000)	Annual Cost ($1,000) October 2019 Prices
Alternative 1 Instream Modification	1A	Removal of Low Water Crossings 1, 2, & 3	5.3	$3,555	$143.43
	1B	Modification of Low Water Crossing 1 and Removal of Low Water Crossings 2 and 3	3.2	$2,933	$120.06
	1C	Removal of Low Water Crossing 1 and Modification of Low Water Crossings 2 & 3	4.1	$2,262	$94.9
	1D	Modification of Low Water Crossings 1, 2, & 3	2.0	$1,785	$76.96
Alternative 2 Avenue A Modification	2A	Complete removal of Avenue A	0.9	$482	$20.99
	2B	Partial removal of Avenue A	0.4	$184	$8.14
Alternative 3 River Road	3A	River Road Relocation and Planting in Davis Park	2.6	$552	$24.84
	3B	River Road As-Is and Planting in Davis Park	2.5	$158	$9.79

ALTERNATIVE PLANS

To conduct the CE/ICA analysis, ER benefits (increase in with-project AAHUs) and annual costs (expressed in thousands of dollars) were entered into IWR Planning Suite II. All areas are combinable, but alternative scales are mutually exclusive. This resulted in 45 Alternative Plans. Cost effective Alternative Plans are defined as the least expensive plan for a given set of benefits, or environmental output. In other words, no other plan would provide the same or more benefits for a lower cost. Of the 45 Alternative Plans (including various scales), 16 were identified as cost effective Alternative Plans, including the No Action Alternative Plan. Of the 16 cost effective Alternative Plans, 7 Alternative Plans were identified as "Best Buy" plans, which is determined by selecting the plan with the least incremental cost per incremental output, then working through the cost effective plans by calculating the incremental cost per incremental output compared to the previous plan. The 7 "Best Buy" Alternative Plans are:

- Plan 1: No Action
- Plan 2: River Road Scale 3B
- Plan 3: River Road Scale 3B + Avenue A Scale 2B
- Plan 4: River Road Scale 3B + Avenue A Scale 2B + Instream Modification Scale 1C
- Plan 5: River Road Scale 3B + Instream Modification Scale 1C + Avenue A Scale 2A
- Plan 6: River Road Scale 3B + Avenue A Scale 2A + Instream Modification Scale 1A
- Plan 7: Avenue A Scale 2A + Instream Modification Scale 1A + River Road Scale 3A

RECOMMENDED PLAN

Plan 6: River Road Scale 3B + Avenue A Scale 2A + Instream Modification Scale 1A was identified as the Recommended Plan. This plan creates 8.7 AAHUs over the No Action Plan (Plan 1). The incremental cost per incremental output increases to $40,442 from Plan 1. The average annual cost for Plan 6 is $174,210. This plan is worth the Federal and local investment because it contributes not only to wildlife species utilizing riparian habitat, but also to the aquatic ecosystem through improved impacts from water runoff, erosion, sedimentation, and pollution. This plan will support the ecosystem restoration objectives of the project by addressing the lack of aquatic shading, reduced allochthonous material inputs, lack of stratification of vertical structure, lack of terrestrial shading, and lack of soft and hard mast diversity. The complete removal of all three low water crossings will be the most effective method of restoring instream conditions of the San Antonio River

RECOMMENDED PLAN COMPONENTS

Instream Modification Scale 1A removes low water crossing (LWC) 1, 2 and 3 and replaces those structures with a pedestrian bridge. The removal of LWCs 2 and 3 significantly improves stream flow and habitat connectivity. The lack of an immovable structure will address the problems of erosion and poor sediment transport within the study area. The section of river impacted by LWCs 2 and 3 has been channelized and allows an equal distribution of water. This plan will support the ecosystem restoration objectives of the project by addressing the lack of aquatic shading, reduced allochthonous material inputs, lack of stratification of vertical structure, lack of terrestrial shading, and lack of soft and hard mast diversity.

Avenue A Modification Scale 2A incorporates the complete removal of Avenue A. This site will be restored using native vegetation and non-native invasive species removal. Increased vegetative cover will reduce nonpoint source pollution and the intensity of stormwater runoff by capturing and storing rainfall in the canopy and releasing water into the atmosphere through evapotranspiration. Trees, shrubs, and herbaceous species will also slow and temporarily store runoff, which further promotes filtration and can decrease downstream flooding and erosion impacts. The reduction of impervious surfaces will also add to the ancillary water quality benefits, by replacing those surfaces with vegetation increasing shade, biodiversity, and habitat quality. Restoration of Avenue A will also restrict vehicular access adjacent to the river, which will terminate one of the significant problems addressed by this study.

River Road Scale 3B includes the restoration of Davis Park that will provide increased vertical structure diversity in an area that is dominated by non-native vegetation. The efforts conducted within Davis Park should assist in filtering storm and runoff drainage from adjacent businesses and impervious surfaces before entering the San Antonio River. Increased vegetative cover and diversity will provide high quality habitat for local and migratory birds and wildlife.

The plan provides:

- Two distinct habitat types (riparian and riverine) out of the two targeted habitat types
- Resilient habitat for migratory birds
- The creation of a complex of pool/riffle/run features that can be managed to improve water quality as an ancillary benefit
- The restoration of the San Antonio River through improved channel flow, sedimentation, and erosion
- The restoration of 99.2% of the proposed restoration areas
- An incremental cost per incremental output of $40,422 over the No Action Plan
- An approximate first cost of $6.4 million

The selected NER Plan combines the alternatives River Road Scale 3B, Avenue A Scale 2A, and Instream Modification Scale 1A to meet the objectives of the River Road ER through the restoration of Davis Park, Avenue A, and the San Antonio River.

ENVIRONMENTAL COMPLIANCE

Environmental compliance for this project is ongoing until completion of the project construction. An Environmental Assessment has been prepared in accordance with the National Environmental Policy Act and is included within the Integrated Feasibility Report. A Clean Water Act Section 404(b)(1) Analysis was prepared and submitted to the Texas Commission on Environmental Quality for water quality certification before the conclusion of this project. Water quality certification was provided in a letter dated 01 March 2021. A Fish and Wildlife Service Coordination Act Report has been prepared in conjunction with the U.S. Fish and Wildlife Service Coordination Act of 1958. A concurrence letter from the U.S. Fish and Wildlife Service was submitted on 24 February 2021. Coordination with local, state, and federal agencies was initiated in the summer of 2019 and will continue. There have been three public meetings in order to adequately meet project review purposes. Other applicable permitting requirements, such as instruments for surface water rights and availability, will be obtained before project construction if necessary.

BENEFITS AND COST OF THE RECOMMENDED PLAN

Plan 6: River Road Scale 3B + Avenue A Scale 2A + Instream Modification Scale 1A was identified as the Recommended Plan. The incremental cost per incremental output increases to $40,442 from Plan 1. The average annual cost for Plan 6 is $174,210. It is the plan that maximizes net economic benefits consistent with protecting the Nation’s environment. **Table ES 3** provides an overview of the analysis for the selection of the . **Table ES 4** provides a summary of project costs.

Table ES 3. Overview of the Analysis for Selection of the Recommended Plan

Plan	Output (AAHU)	Annual Cost ($1000)	Incremental Cost ($1000)	Incremental Output (AAHU)	Incremental Cost per Output	Objective 1	Objective 2	Objective 3
1	0	0	0	0	0	No	No	No
2	2.5	9.79	9.79	2.5	3.916	No	Yes	No
3	2.9	17.93	8.14	0.4	20.35	No	Yes	Yes
4	7	112.83	94.9	4.1	23.146	Yes	Yes	Yes
5	7.5	125.68	12.85	0.5	25.7	Yes	Yes	Yes
6	8.7	174.21	48.53	1.2	40.442	Yes	Yes	Yes
7	8.8	189.22	15.01	0.1	150.1	Yes	Yes	Yes

Table ES 4. Project First Costs

Feature	Non-Federal Cost	Federal Cost	Total Cost
Demo LWC	$114,450	$212,550	$327,000
Complete Removal of Avenue A	$117,250	$217,750	$335,000
Widen Golf Course Path	$15,750	$29,250	$45,000
Recreation Facilities (50/50 cost share)	$164,000	$164,000	$328,000
Instream Structure	$325,500	$604,500	$930,000
Roads, Railroads, & Bridges	$603,050	$1,119,950	$1,723,000
Boulder Barrier	$63,700	$118,300	$182,000
Planting	$208,250	$386,750	$595,000
Lands and Damages	$198,000		$198,000
Planning, Engineering, and Design	$442,400	$821,600	$1,264,000
Construction Management	$179,900	$334,100	$514,000
Total	**$2,432,250**	**$4,008,750**	**$6,442,000**
Cash	$2,234,250		
35% Maximum NFS Contribution	2,234,250	4,008,750	
			* **FY21 Price Levels**

RECREATION

There is an opportunity to incorporate recreation alongside the River Road ecosystem restoration project. The project area is located within San Antonio's Brackenridge Park. The park provides opportunity for walking/jogging, picnicking, and fishing, including within the project area. The purpose of these recreation features is to allow the public to continue to access the area while preserving the ecosystem recreation features. The additions to the existing recreation are compatible with the ecosystem restoration project and would enhance the experience for visitors of Brackenridge Park by providing ease of access to the ecosystem restoration areas and additional wildlife viewing opportunities. The proposed recreation features are described below.

- *Access Path* – A 2,450 foot by 8 foot Americans with Disabilities Act compliant asphalt path would be constructed along the original path of Avenue A if it were to be partially or completely removed. Currently, LWC 1 and Avenue A provide public access to both sides of the channel. Removal of Avenue A or LWC 1 would result in a loss of public access to the river. The Access Path would mitigate for this loss as an additional measure to an alternative that partially or fully removes Avenue A.
- *Fishing Access* – This measure would include the installation of recreational fishing piers along the perimeter of the San Antonio River.
- *Signage* – Installation of signage to include restoration information, recreation information, and general rules and regulations.
- *Trash Cans* – Installation of single or clustered trash cans to focus litter disposal within a specified area.
- *Bird Blinds* - This measure would include the installation of bird blinds in the public access areas of the project

The cost of recreational features would be shared equally, up to 10% of the total federal restoration project costs, between the Federal Government and the NFS. The total Project First Cost is $6,442,000 and the total Recreation First Cost is $328,000.

PUBLIC COORDINATION

The Project Delivery Team (PDT) held a public scoping meeting in conjunction with the NFS, SARA, on 13 August 2019 at 6 p.m. at Lion's Field Adult and Senior Center, 2809 Broadway Street, San Antonio, TX 78209. A Public Notice was sent on July 11th, 2019 to inform the public of the Public Scoping Meeting and 30-day comment period from August 13th, 2019 - September 12th, 2019. General information was presented about the feasibility study and the feasibility study process.

The NFS, SARA, held a public meeting on December 3rd, 2019 at 6 p.m. at Lion's Field Adult and Senior Center. The USACE River Road PDT attended the Public Meeting to assist SARA with presenting the project information and facilitating discussion. Measure and Alternative descriptions were presented to the public in a group table setting to allow for public feedback on plan formulation. The public was given another 30-day comment period from December 3rd, 2019 - January 3rd, 2020.

A third public meeting was held on 19 November 2020 via webinar due to COVID-19 restrictions. The USACE, Fort Worth District, placed advertisements on the USACE webpage and social media, and provided a Notice of Availability to interested parties prior to the third public meeting occurrence. A webpage link to the Draft IFR-EA was sent to the following resource agencies for review and comment in accordance with coordination requirements as set forth by NEPA: Texas Parks & Wildlife Department; U.S. Fish and Wildlife Service; U.S. Environmental Protection Agency; Texas Historic Commission, and the Texas Commission on Environmental Quality. The link was also provided to the general public for their review of the Draft IFR-EA. The Draft IFR-EA underwent a 45-day public comment period. Categorized comments received during all of the comment periods are included in the Appendix C5 – NEPA Compliance and Public Review.

NON-FEDERAL SPONSOR SUPPORT

SARA, the NFS for the River Road Aquatic Ecosystem Restoration Feasibility Study, was actively engaged in the formulation of the Alternatives and Tentatively Selected Plan. The NFS has the capability to furnish lands, easements, and rights-of-way for this project.

MAJOR FINDINGS AND CONCLUSIONS

The proposed actions described in this report are in the national interest. The recommendations contained herein reflect the information available at the time the report was prepared. To ensure all applicable laws and policies are addressed for the Recommended Plan, this feasibility study has undergone concurrent reviews (public, policy, and agency technical review [ATR]). The PDT addressed any outstanding issues raised during the reviews and confirmed the analysis in this IFR-EA and recommendations to move forward with development of the feasibility-level analysis and design.

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APPENDICES

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DRAFT FINDING OF NO SIGNIFICANT IMPACT

River Road – Integrated Feasibility Report and Environmental Assessment
San Antonio, Bexar County, Texas

The U.S. Army Corps of Engineers, Fort Worth District (Corps) has conducted an environmental analysis in accordance with the National Environmental Policy Act of 1969, as amended. The final Integrated Feasibility Report and Environmental Assessment (IFR/EA) dated DATE OF IFR/EADATE OF IFR/EA, for the River Road Aquatic Ecosystem Restoration Feasibility Study addresses aquatic ecosystem restoration opportunities and feasibility in the San Antonio, Bexar County, Texas area. The final recommendation is contained in the report of the Chief of Engineers, dated DATE OF CHIEF'S REPORTDATE OF CHIEF'S REPORT.

The Final IFR/EA, incorporated herein by reference, evaluated various alternatives that would reduce the impacts of habitat degradation and promote increased structure and function in the study area. The recommended plan is the National Ecosystem Restoration (NER) Plan and includes:

- A first cost of $6.4 million and restoration of 99.2% of the project area identified for restoration under this study.

In addition to a "no action" plan, eight alternatives were evaluated. The alternatives included Instream Modification (1A-1D) Avenue A Modification (2A and 2B), River Road Modification (3A and 3B). All alternatives include measures that would benefit the aquatic ecosystem within the River Road study area and address restoration of aquatic and terrestrial wildlife habitat. Alternatives 1A, 1B, 1C, and 1D restore the San Antonio River through either removal or modification of low water crossings throughout the study area, along with the placement of instream aquatic habitat features, native species plantings, and invasive species management. Alternatives 2A and 2B focus on either the full removal or partial removal of Avenue A and replacing the existing road base with native soil and native species plantings, thereby expanding the riparian zone necessary for stream health. Alternatives 3A and 3B are focused on Davis Park, a cleared area adjacent to the San Antonio River with little to no shrubs or trees. One alternative (3A) would include the partial removal of River Road and reestablishment of Allison Drive, while the other (3B) would only include native species plantings and invasive species management. Although eight alternatives were evaluated and compared, only three were integrated into the Recommended Plan. The Recommended Plan incorporates restoration of the San Antonio River (1A), restoration of Avenue A by replacing the road with native soil and vegetation (2A), and restoration of riparian habitat in Davis Park (3B). All of the alternatives are discussed in more detail in Chapter 3 of the IFR/EA.

For all alternatives, the potential effects were evaluated, as appropriate. A summary assessment of the potential effects of the recommended plan are listed in Table 1:

Table 1: Summary of Potential Effects of the Recommended 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	☒	☐	☐
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	☒	☐	☐
Migratory Birds	☒	☐	☐
Recreation	☒	☐	☐
Light	☒	☐	☐
Transportation	☒	☐	☐

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 IFR/EA will be implemented, if appropriate, to minimize impacts. Some BMPs that will be implemented during construction of the project include: avoidance and/or minimization of impacts to migratory bird nests and the migratory bird nesting season, heavy machinery fitted with devices to reduce emissions, and placement of silt fences to avoid degradation of water quality within the San Antonio River.

No compensatory mitigation is required as part of the Recommended Plan.

Public review of the draft IFR/EA and FONSI was completed on 12 January 2021. All comments submitted during the public review period were responded to in the Final IFR/EA and FONSI. A 30-day state and agency review of the Final IFR/EA was completed on 28 February

2021. Comments from state and federal agency review did not result in any changes to the final IFR/EA..

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 historic properties may be adversely affected by the Recommended Plan. The Corps and the Texas Historical Commission entered into a Programmatic Agreement (PA)Programmatic Agreement (PA), dated DATE OF AGREEMENT. All terms and conditions resulting from the agreement shall be implemented in order to minimize adverse impacts to historic properties.

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 be compliant with section 404(b)(1) Guidelines (40 Code of Federal Regulations 230). The Clean Water Act Section 404(b)(1) Guidelines evaluation is found in Appendix C3 of the IFR/EA.

A water quality certification pursuant to section 401 of the Clean Water Act will obtained from the Texas Commission on Environmental Quality prior to construction. In a letter dated 1 March 2021, the Texas Commission on Environmental Quality stated that the recommended plan appears to meet the requirements of the water quality certification, pending confirmation based on information to be developed during the pre-construction engineering and design phase. All conditions of the water quality certification will 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.

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

Kenneth N. Reed, PMP
Colonel, Corps of Engineers
District Commander

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1 General Information

The Integrated Feasibility Report (IFR) details the planning process undertaken for the CAP Section 206 River Road Aquatic Ecosystem Restoration Feasibility Study and documents the Environmental Assessment (EA) to satisfy the National Environmental Policy Act (NEPA). The San Antonio River Authority (SARA) sent a letter of intent to the Fort Worth District's (SWF) District Commander on December 1st, 2015. The letter contained SARA's desire to initiate a study partnership under the USACE Section 206 Program for Aquatic Ecosystem Restoration (ER). A Feasibility Cost Share Agreement (FCSA) was signed between USACE Fort Worth District (SWF) and SARA on September 24th, 2018. The River Road Aquatic ER Feasibility Study, hereafter called "Study", is a single purpose, Continuing Authorities Program (CAP) Section 206 Aquatic ER Feasibility Study.

1.1 Study Authority

The study is being performed under the standing authority of the USACE CAP Section 206 of the Water Resources Development Act (WRDA) of 1996, as amended (335 U.S Code 2201):

> *"The Secretary may carry out an aquatic ecosystem restoration and protection project if the secretary determines that the project -*
>
> *(1) Will improve the quality of the environment and is in the public interest; and*
>
> *(2) Is cost effective."*

This is a CAP which focuses on water resource related projects of relatively smaller scope, cost and complexity. Unlike traditional USACE civil works projects that are of wider scope and complexity, the CAP is a delegated authority to plan, design, and construct certain types of water resource and environmental restoration projects without specific Congressional authorization.

1.2 Study Purpose and Need

The primary purpose of the study is to investigate and determine modifications that would restore degraded ecological structure and function to aquatic and riparian habitat on the River Road reach of the San Antonio River. This includes assessing opportunities, evaluating alternatives, and selecting a plan from those alternatives. The selected plan must be technically sound, environmentally acceptable, economically feasible, and supported by the local sponsor, SARA, and the Federal Government. The need is to address current erosion, sedimentation, and altered hydrology in the study area that has caused the degraded ecological structure.

1.3 Federal Interest

Federal interest in water resources development is established by law. Within the larger Federal interest in water resource development, the USACE is authorized to carry out projects in seven mission areas: navigation, flood damage reduction, ecosystem restoration, hurricane and storm damage reduction, water supply, hydroelectric power generation and recreation. Ecosystem restoration projects improve ecosystem structure and function.

The River Road area is one of the last remaining unchannelized segments of the San Antonio River. The study area is part of an interconnected system of USACE ecosystem restoration projects in the San Antonio area including the Eagleland, Mission Reach, and Westside Creeks ecosystem restoration projects within the San Antonio Channel Improvement Project (SACIP). The Central Flyway passes through the San Antonio area, including the San Antonio River, which functions as productive stopover habitat for the migratory populations. This study, along with the previously mentioned connected studies, would increase the quality of the degraded habitats already utilized by these and other species.

A Federal Interest Determination was completed in November 2015. The project has a local sponsor, and there are proven measures that have been implemented successfully within the region that would address the problems in the River Road study area and fall within the CAP funding limits.

1.4 Study Area

The study area is located in the River Road area of the San Antonio River in San Antonio, Texas (***Figure* 1**). The project site spans approximately 3700 feet of the river between East Mulberry Avenue and U.S. Highway 281 and is bound by Avenue A and River Road to the east and west, respectively (***Figure* 2**). This area is one of the last remaining unchannelized segments of the upper San Antonio River.

By the request of SARA, the project area was extended downstream by approximately 1000 feet in July 2019. Prior to this change, the project area spanned approximately 2700 feet from East Mulberry Avenue and East Woodlawn Avenue. The area was extended to include an additional low water crossing that influences the project area.

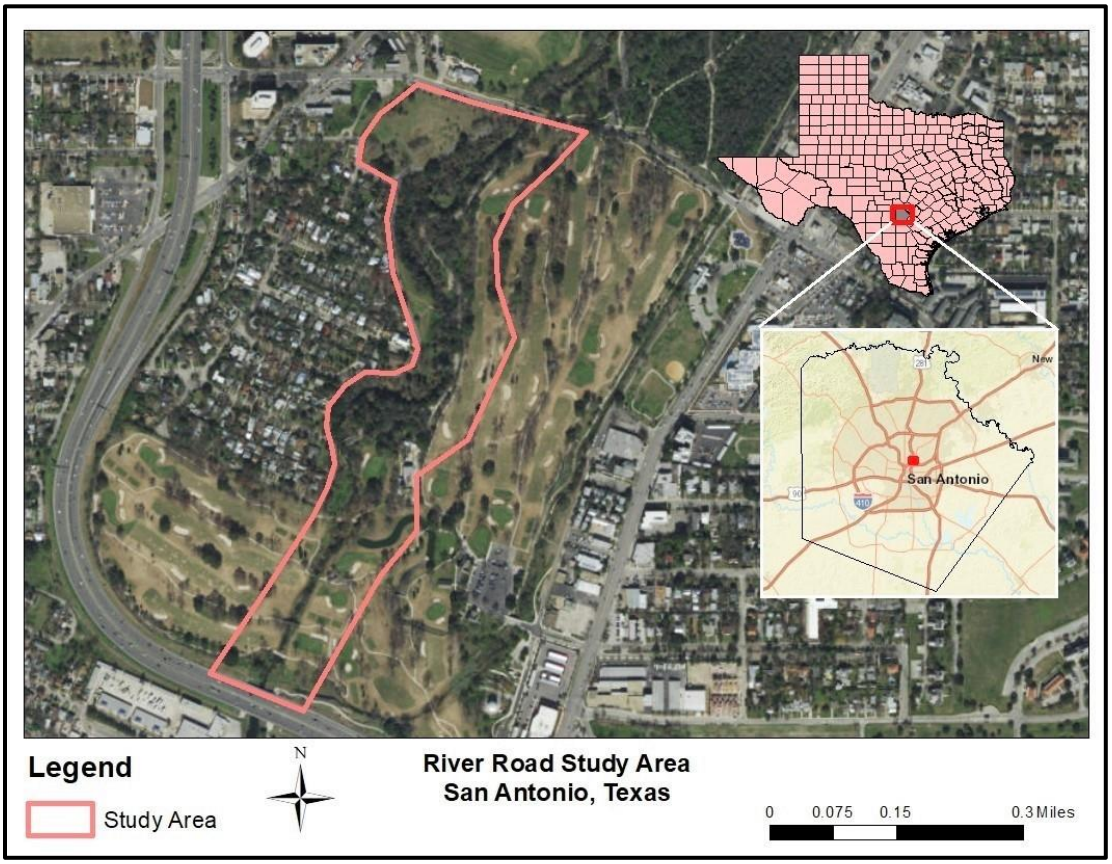


Figure 1: Study Area

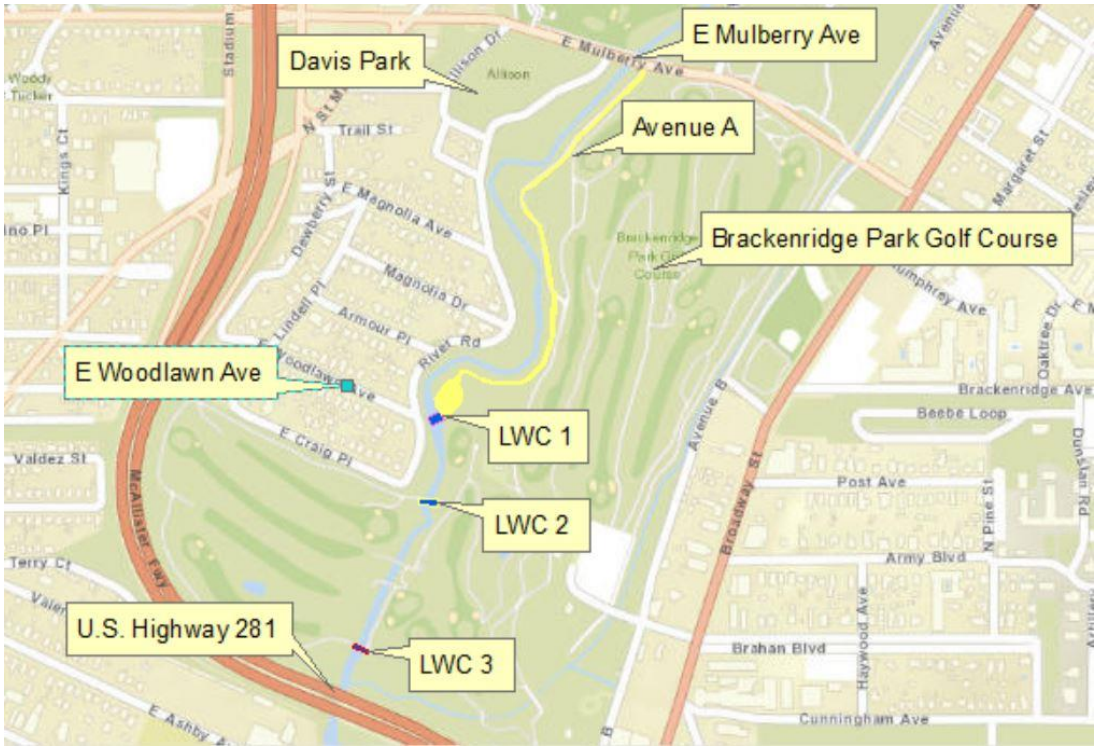


Figure 2: Project Area

1.4.1 Non-Federal Sponsor

The USACE SWF was responsible for the overall management of the study and the report preparation. SARA, submitted a letter of support for the River Road Section 206 study on December 1st, 2015. The study documented herein has been conducted jointly by the USACE SWF and SARA. As the NFS, SARA contributes 50 percent of the shared study costs in the form of cash or in-kind contributions. A FCSA was signed on September 24th, 2018.

1.5 Prior Reports and Existing Water Projects

The study area is part of an interconnected system of USACE ecosystem restoration projects in the San Antonio area including the Eagleland, Mission Reach, and Westside Creeks ecosystem restoration projects within the San Antonio Channel Improvement Project (SACIP).

Eagleland Section 1135, San Antonio, Texas - The Eagleland project is located in San Antonio, TX along the portion of the SACIP from the Alamo Street dam downstream to the Lone Star Boulevard Bridge. Clearing of the floodway and channel re-alignment for the SACIP destroyed the vast majority of the high quality riparian habitat. This project incorporated ecosystem restoration and recreation purposes into the existing Flood Risk Management (FRM) project while maintaining the existing FRM performance. The Eagleland project restored approximately one mile of the San Antonio River, relocating the base flow channel to meander primarily along the outside of the existing bends.

Olmos Creek Section 206, Bexar County, Texas – The purpose of this feasibility study was to identify areas of ecosystem degradation, evaluate measures to restore important ecological resources, and recommend a plan for implementation, if one could be found that was technically feasible, environmentally acceptable, and supported by the non-Federal partner. The goal of the recommended restoration alternative was to restore aquatic habitat and the associated riparian community to benefit the variety of resident and migratory wildlife that utilize the study area.

Olmos Creek is located near the central portion of Bexar County, Texas, approximately 5 miles north of the City of San Antonio central business district. The study area was located on lands owned by the City of San Antonio and the City of Alamo Heights within the Olmos Basin Reservoir. The study area comprised of grassland, remnant bottomland forests, and instream aquatic habitat, lies within the Olmos Creek watershed and was found to be suitable for ecosystem restoration. The recommended alternative consisted of the restoration of approximately 73 acres of bottomland hardwood habitat, 17 acres of native riparian grasslands, and six acres of instream aquatic habitat.

SACIP – Mission Reach – The SACIP was originally authorized under the Section 203 of the Flood Control Act of 1954 as part of a comprehensive plan for flood protection on the Guadalupe and San Antonio Rivers. The project was subsequently modified in Section 103 of the Water Resources Development Act of 1976, and again in Section 335 of the Water Resources Development Act of 2000 to include ecosystem restoration and recreation as authorized project purposes. The SACIP-GRR was initiated at the request of the SARA. A feasibility cost sharing agreement for the feasibility study was executed in November 2001.

The Mission Reach begins near Lone Star Boulevard and extends downstream to just south of Interstate Highway-410. The pilot channel has been highly altered over the years due to erosion and implementation of erosion control measures. To maintain the flood carrying capacity of the SACIP, vegetation is regularly mowed to a height of 6 inches or less. With rare exception, there are no trees or shrubs within the floodway channel. A large portion of the pilot channel is lined with large blocks of concrete riprap. Due to the mowing regime and the riprap lining the channel, no semblance of a functioning riparian zone exists for the entire length of the Mission Reach.

The study area totaled 483 acres in size including 355 acres within the existing SACIP and 128 outside of the SACIP. Of this acreage, 69.23 acres was aquatic, 394.21 acres was riparian, and 19.56 as other (concrete, non-vegetated, etc.). The without-project average annual habitat unit totaled 55.4 (26.7 aquatic and 27.8 riparian).

The recommended plan provided 113.40 total acres of total aquatic habitat and 320.14 total acres of riparian habitat. Another 49.46 acres was categorized as other (vegetated pilot channel, nonvegetated surfaces). The aquatic habitat produced 77.25 total average annual habitat units and the riparian habitat produced 103.72 total average annual habitat units. These represented an increase over the existing condition of 44.17 acres of aquatic habitat and 50.56 annual habitat units; and a decrease in riparian acres of 74.07 acres, but an increase in annual habitat units of 75.89. The National Ecosystem Restoration (NER) plan was also the Recommended Plan.

SACIP – Westside Creeks (WSC) – The purpose of the SACIP General Re-evaluation Report (GRR) and EA, WSC, ER, San Antonio, Texas, was to identify ecosystem restoration measures to restore the riverine ecosystem within the WSC that was severely degraded due to the construction and continuing maintenance of the authorized and constructed SACIP and identify recreation opportunities that were compatible with the ecosystem restoration objectives.

The WSC study area encompassed those portions of Martinez Creek, Alazán Creek, Apache Creek, and San Pedro Creek within the originally constructed SACIP footprint. These creeks, collectively known as the WSC, are located west of the San Antonio River on the west side of San Antonio. Changes in the hydraulic regime of the WSC over the last half-century are largely due to shifts in urbanization, the construction of the SACIP, and required operation and maintenance practices. Channelization has led to an increased bed slope and loss of sinuosity.

The recommended plan is the combined NER / National Economic Development (NED) plan. The NER plan restored 67% of the lower trophic organism carrying capacity possible for the WSC riverine system and provided 114% improvement in habitat quality over the no action alternative for 11 miles along the WSC. At maturity (75 years), the NER plan will provide 222 acres of mixed riparian meadow and riparian woody vegetation. The 6.5-mile pilot channel network incorporated 146 pool-riffle-run sections and 143 off-channel slack water areas. The implementation of the NER plan provided a total migratory bird diversity benefit of 101 average annual avian community units, which represented 82% of the diversity benefits available in the system.

The NED plan for recreation provided 44,600' of concrete walk, jog, and bike trails. In addition to trails, other components included shade structures, interpretive / directional signage, benches, water fountains, picnic tables with pads, and trash receptacles.

Mitchell Lake Aquatic Ecosystem Restoration Feasibility Study - The purpose of the Mitchell Lake Aquatic ER Feasibility Study and Environmental Assessment, San Antonio, Texas, was to restore the habitat structure and function of Mitchell Lake. The lake is north of the confluence of the Medina River and Leon Creek, two tributaries of the San Antonio River. The watershed that drains into Mitchell Lake consists of 9.76 square miles. The lake previously served a wastewater function, causing degradation that is evident. This includes a historic wetland system that has caused hyper-eutrophic waters and reduced habitat diversity.

The project is currently in the Feasibility Study phase. The study is scheduled to be complete in 2021. The Recommended Plan is the NER plan and provides three habitat types (emergent wetlands, submergent wetlands, and mudflats), resilient habitat for migratory birds, the creation of complex wetlands, and the restoration of 95.7 percent of the proposed restoration areas.

1.6 Planning Process

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

This section presents the rationale for the development of the Recommended Plan. It describes the USACE iterative six-step planning process used to develop, evaluate, and compare the array of management measures and preliminary alternative plans that have been considered. The six steps used in the alternative plan formulation process include:

1. **Identifying Problems and Opportunities:** The specific problems and opportunities to be addressed in the study are identified, and the causes of the problems are discussed and documented. Planning goals are set, objectives are established, and constraints are identified.
2. **Inventorying and Forecasting Resources:** Existing and FWOP (FWOP / No Action) conditions are identified, analyzed, and forecast for a 50-year period of analysis. The

existing condition resources, problems, and opportunities critical to plan formulation, impact assessment, and evaluation are characterized and documented.

3. **Formulating Alternative Plans:** Alternative plans are formulated that address the alternative planning objectives. An initial set of alternative plans are developed and evaluated at a preliminary level of detail, and are subsequently screened into a more final array of alternative plans. Each plan is evaluated for its costs, potential effects, and benefits, and is compared with the No Action Plan for the 50-year period of analysis.
4. **Evaluating Alternative Plans:** Alternative plans are evaluated for their potential to meet specified objectives and constraints, effectiveness, efficiency, completeness, and acceptability. The impacts of alternative plans are evaluated using the system of accounts framework NED, Environmental Quality, Regional Economic Development [RED], and Other Social Effects [OSE]) specified in the USACE' Principles and Guidelines (P&G) and Engineering Regulation (ER) 1105-2-100.
5. **Comparing Alternative Plans:** Alternative plans are compared with one another and with the No Action Plan (FWOP). Results of analyses are presented (e.g., benefits and costs, potential environmental effects, trade-offs, risks and uncertainties) to prioritize and rank alternative plans.
6. **Selecting the Recommended Plan:** A plan is selected for recommendation, and related responsibilities and cost allocations are identified for project approval and implementation.

1.6.1 Problems and Opportunities

Water resources projects are planned and implemented to solve problems, meet challenges, and seize opportunities. In the alternative planning setting, a problem can be thought of as an undesirable condition. An opportunity offers a chance for progress or improvement of the situation. The identification of problems and opportunities gives focus to the alternative planning effort and aids in the development of planning objectives. Problems and opportunities can also be viewed as local and regional resource conditions that could be modified in response to expressed public concerns. This section identifies the problems and opportunities in the study area based on the assessment of existing and expected FWOP conditions.

The objective of the USACE with respect to ecosystem restoration is to restore degraded ecosystem structure, function, and dynamic processes to a less degraded, more natural condition. Restored ecosystems should mimic, as closely as possible, conditions, which would occur in the area in the absence of human changes to the landscape and hydrology. Indicators of success would include the presence of a large variety of native plants and animals, the ability of the area to sustain larger numbers of certain indicator species or more biologically desirable species, and the ability of the restored area to continue to function and produce the desired outputs with a minimum of continuing human

intervention. Those restoration opportunities that are associated with wetlands, riparian, and other floodplain and aquatic systems are most appropriate for USACE involvement.

Problem Statement:

The aquatic ecosystem along the River Road segment of the San Antonio River is severely degraded from excessive erosion and sedimentation resulting in a riparian corridor that has been reduced to a narrow strip along the river banks.

In addition to hydrological impacts associated with urbanization within the watershed, River Road and Avenue A that parallel the River Road segment of the river have constrained the river, resulting in magnified erosion and sedimentation. This has caused a reduction in the area of the riparian corridor adjacent to the river, reducing the natural bank erosion protection of the river. The riparian corridor is further degraded by public disturbance, including parking vehicles in the already reduced riparian area that parallels the river.

The opportunities identified include:

- Restore function and structure to the aquatic ecosystem
- Provide additional recreational and ecotourism benefits to the community
- Improve water quality in the San Antonio River through ecosystem restoration
- Reduce erosive threat to public infrastructure

1.6.2 Planning Objectives and Constraints

An objective is a statement of the intended purposes of the planning process; it is a statement of what an alternative plan should try to achieve. More specific than goals, a set of objectives effectively constitutes the mission statement of the Federal/non-Federal planning partnership.

Our planning partnerships exist in a world of scarcity where it is not possible to do everything. Our choices are constrained by a number of factors. Planning is no exception. An essential element of any planning study is the set of constraints confronting the planners. A constraint is basically a restriction that limits the extent of the planning process. Constraints, like objectives, are unique to each planning study.

Federal Objective

The P&G states that the Federal objective of water and related land resources project planning is to contribute to NED consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. Water and related land resources project plans shall be formulated to alleviate problems and take advantage of opportunities in ways that contribute to this objective. The P&G use of the term objective should be distinguished from study planning objectives, which are more specific in terms of expected or desired outputs. The P&G's objective (Federal objective) may be considered more of a National goal.

The NER Plan

For ER projects, a plan that reasonably maximizes ER benefits compared to costs, consistent with the Federal objective, shall be selected. The selected plan must be shown to be cost effective and justified to achieve the desired level of output. This plan shall be identified as the NER Plan.

Planning Objectives

Planning objectives reflect an expression of public and professional issues or concerns about the use of water and related land resources resulting from the analysis of existing and future conditions in the study area. These planning objectives were used in guiding the development of alternative plans and their evaluation for the period of analysis. The following planning objectives were used in formulation and evaluation of alternative plans:

- Objective 1: To restore aquatic ecosystem function and structure to the River Road segment of the San Antonio River for a 50-year period of analysis (baseline 2020 and future without-project and future with-project beginning 2023 and ending 2073)
- Objective 2: Restore and maintain riparian habitat quality over the 50 year-period of analysis

Secondary Objectives

- Objective 3: Reduce erosive threat to the roads that parallel the river over the 50-year period of analysis

Planning Constraints

The following are institutional constraints that apply to this study:

- Avoid increasing water surface elevations as established by the Digital Flood Insurance Rate Maps (DFIRM) completed for FEMA, effective 29 September 2010 (See Appendix A)
- Plans must be consistent with Federal, State, and local laws such as the NEPA, Endangered Species Act (ESA), Fish and Wildlife Coordination Act (FWCA), Clean Water Act (CWA), and the National Historic Preservation Act (NHPA)
- Minimize impacts to culturally significant landmarks and areas
- The study will be completed within the CAP scope and cost limitations

The following planning constraints apply to this study:

- Avoid removing pedestrian access to the study area
- Avoid removing golf course maintenance structure access

2 Existing Conditions and Expected Future Without-Project Conditions

2.1 Hydrology, Hydraulics and Sedimentation

2.1.1 Watershed

The Olmos Creek-San Antonio River Watershed, a sub watershed to the San Antonio River watershed, covers the north portion of downtown San Antonio, Texas as well as areas to the west and north of downtown (**Figure 3**). The headwaters of the Olmos Creek-San Antonio River watershed are located on the north side of San Antonio with the mouth being at the confluence with the San Antonio River south of downtown. The watershed is approximately 43.2 square miles including extensive residential, commercial and industrial zones.

The study area is approximately 4.55 miles long and 0.80 miles wide at the widest point. The size of the study area is approximately 40.41 acres, or 0.063 square miles. Elevations within the study area range from 628 feet to 748 feet.

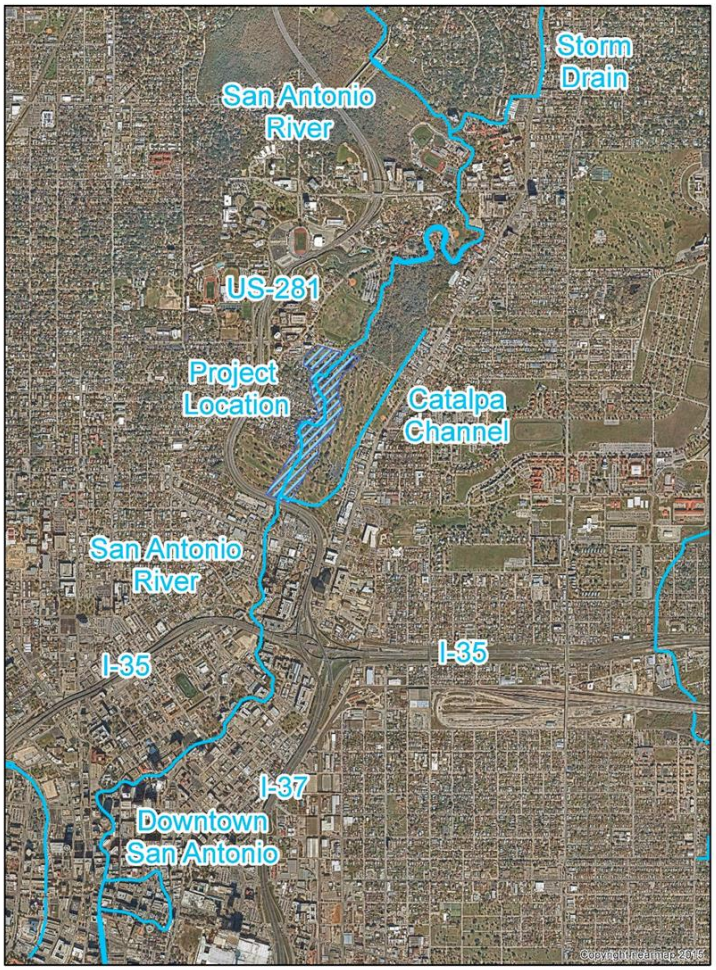


Figure 3: San Antonio River Watershed

2.1.2 Climate

The city of San Antonio is located in the south-central portion of Texas on the Balcones escarpment. Northwest of the city, the terrain slopes upward to the Edwards Plateau, and to the southeast it slopes downward to the Gulf Coastal Plains. During the summer the climate becomes more tropical like with prevailing south and southeast winds. The moderating effects of the Gulf of Mexico prevent extremely high temperatures. Summers are usually long and hot with daily maximum temperatures above 90ºF more than 80 percent of the time. In many years, summer conditions continue into September and sometimes to October. The average monthly temperatures range from the 50sºF in winter to 80sºF in summer. The historic recorded high and low temperatures occurred 6 September 2000 (111ºF) and 21 January 1949 (0º F).

2.1.3 Precipitation

San Antonio is situated between a semi-arid area to the west and a much wetter and more humid area to the east, allowing for large variations in monthly and annual precipitation amounts. The average long-term annual precipitation for San Antonio is around 30 inches, although, it may range from as low as 10 to near 50 inches from one year to another. Precipitation extremes vary from 10.11 inches in 1917 to 52.28 inches in 1973. Most precipitation occurs in May, June, September, and October. During some of these events, rain has exceeded 5 inches in several hours and caused flash flooding.

2.1.4 Hydrology

For the purposes of this project, the hydrology was derived from 2 different sources. The first was an estimation of the 1.5-year design discharges through empirical methods, such as regression analysis of gage data that was developed by the USGS for the urban areas of Austin, TX. This regression analysis was assumed to be a close approximation for the San Antonio urban watersheds, since no local urban equations have been developed. The 1.5-year discharges calculated by these equations were utilized to develop stable bankfull channel designs for the Westside Creeks.

For analysis of the water surface elevations that could be expected during a 1% ACE (100-yr) event, discharges were used that matched those developed for the FEMA Flood Insurance Study (Bexar County FIS, Sept 2010).

2.1.5 Hydraulic Conditions

This section of the San Antonio River has a natural meander with gradual bank slopes. The vegetation of the banks is natural with non-native species grass; some sections of the stream are well-maintained due to an adjacent golf course. This section of the San Antonio River also has a series of inline structures, culvert crossings, and pedestrian (golf cart) bridge structures.

There is a 10 cfs minimum base flow within the San Antonio River through the study area. The base flow is maintained by the introduction of recycled waste water treatment effluent

upstream of the project area, as well as natural springs near the Upper San Antonio River. This base flow continues to flow downstream where it enters the San Antonio River Tunnel Inlet. The tunnel inlet is approximately 775 feet downstream of the project limits.

There has been multiple letter of map revisions (LOMR) within the Upper San Antonio Basin. There are two LOMRs that are within the study limits, LOMR 13-06-3484 and 11-06-0604P with effective dates of August 25, 2014 and March 12, 2012 respectively. The detailed hydraulic study for FEMA consists of hydraulic models based on detailed survey information that will produce new base flood elevations. Hydraulic structure information was obtained from detailed field surveys of the channel banks, base flow, and sub-aquatic terrain. The study also incorporates updated topographic data based on the 2017 LiDAR Data. The as-built data was not obtained for the series of culverts, bridges, and inline structure because the data has not been changes since the approval of the most recent LOMR within the study limits (LOMR 13-06-3484P).

The mission required software developed by the Army Corps of Engineers - Hydrologic Engineering Center River Analysis System (HEC-RAS), Version 5.0.7. HEC-RAS, accepted by FEMA for hydraulic analysis, performs one-dimensional hydraulic calculations to model the water surface elevations. RAS Mapper was used to analyze the 2017 LiDAR and convert into terrain surface to update the existing cross sections and stream centerline. AutoCAD Civil 3D was used to analyze all survey data obtained in the field.

2.1.6 Climate Change Analysis

Engineering and Construction Bulletin (ECB) No. 2018-14 “Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects” was used to incorporate climate change information in hydrologic analysis. The ECB helps support a qualitative assessment of potential climate change threats and impacts, focusing on those aspects of climate and hydrology relevant to the project’s problems, opportunities, and alternatives, and include consideration of both past (observed) changes as well as projected, future (modeled) changes.

While there are several concerns related to climate change with the River Road Ecosystem Restoration Project, overall the project will make the project area more resilient. This project cannot prevent a shift in average temperature or increase in flood magnitude. But by restoring native vegetation to the area, a refuge for wildlife will be provided that is near water. Increased vegetation will work to support the animals most threatened by climate change. Vegetation works to convert carbon dioxide to oxygen which is required by all animals and human life.

Overall, the ecosystem restoration project will work to combat many of the threats that climate change presents and make the area more resilient.

Appendix A - Hydraulics and Hydrology includes a detailed climate change analysis for the study. The River Road project area is located within the Hydrologic Unit Code (HUC) 121003 - Central Texas Coastal. The nearest stream gage to the project area is the USGS 08178000 San Antonio River at San Antonio, Texas. The gage is located along the San Antonio River, downstream of US 281, upstream of Interstate 10 and on the S Alamo St crossing. The gage is 3 miles downstream of the project area. General temperature and precipitation trends can be observed but flow trends were not significant and there are data concerns with the streamflow gage record.

2.2 Environmental Resources – Affected Environment

This section presents a description of the environmental resources and baseline conditions that could be affected from implementing the Recommended Plan. Unless stated otherwise, it is assumed some of the existing conditions will continue to degrade in the FWOP. The No Action Alternative is intermittently referred to as the FWOP scenario.

In compliance with NEPA, Commission on Environmental Quality (CEQ), and 32 Code of Federal Regulations (CFR) 775 guidelines, the discussion of the affected environment (i.e., existing conditions) focuses on those resource areas that are potentially subject to significant impacts. In addition, the level of detail used in describing a resource is commensurate with the anticipated level of potential environmental impact.

For each resource area section, the resource is: (1) generally defined, (2) given an appropriate project area, and (3) described for existing conditions. The project area for each resource is a geographic area within which the Proposed Action may exert some influence. The existing conditions discussion for each resource area presents the condition of the resource within the respective project area.

2.2.1 Resource Significance

In compliance with the CEQ NEPA regulations (40 CFR 1500.1(b), 1501.7(a)(2) and (3), and 1502.2(b)), as well as guidance for USACE ecosystem restoration projects, ER 1105-2-100 Section 2.3.m. Significant Resources and Significant Effects, require the identification of significant resources and attributes that are likely to be affected by one or more of the Plans. “Significant” is defined as “likely to have a material bearing on the decision-making process”. Resource significance is determined by the importance and non-monetary value of the resource based on institutional, public, and technical recognition in the study area. Further description of Resource Significance are provided in (Appendix C1 – Environmental Resources). The criteria are defined as:

- **Institutional Recognition:** The importance of the resource or attribute is acknowledged in the laws, adopted plans, and other policy statements of public agencies or private groups.
- **Public Recognition:** The resource or attribute is considered important by some segment of the public.
- **Technical Recognition:** The importance of the resource or attribute is based on scientific or technical knowledge or judgment of critical resource characteristics.

2.2.1.1 Institutional Recognition

Significance based on institutional recognition means that the importance of the environmental resource is acknowledged in the laws, adopted plans, and other policy statements of public agencies or private groups. The institutional recognition of resource significance for the River Road study area is demonstrated by the following laws, policies, treaties, plans, and cooperative agreements established for the conservation and protection of these environmental resources.

- **ESA** - Federally listed species that may utilize the study area during their migration as stopover habitat are the golden-cheeked warbler (Setophaga chrysoparia), red knot (Calidris canutus), and piping plover (Charadrius melodus). It is anticipated that the ecosystem restoration proposed, such as native species plantings and invasive species management within this study area would greatly benefit these species and may possibly provide suitable core habitat over time.
- **Texas State Threatened and Endangered Species** - In 1973, the Texas legislature authorized the TPWD to establish a list of fish and wildlife that are endangered or threatened with statewide extinction. In 1988, the Texas legislature added the authority for the TPWD to establish a list of threatened and endangered plant species for the state. There are 25 Texas listed threatened and endangered species that can occur in Bexar County.
- **FWCA of 1958 (as amended)** - This recognizes the contribution of wildlife resources to the nation. The U.S. Fish and Wildlife Service (USFWS) and the TPWD have committed to dedicate time and resources in developing a set of measures toward the ultimate identification of a preferred plan that meets the USACE, the USFWS, the TPWD, and the sponsor's objectives for restoration of aquatic habitat. Measures identified as part of the feasibility study will be considered by these agencies to have significant environmental outputs for fish and wildlife resources.
- **Migratory Bird Treaty Act (MBTA)** - The U.S. has recognized the critical importance of this shared resource by ratifying international, bilateral conventions for the conservation of migratory birds. These migratory bird conventions impose substantive obligations on the U.S. for the conservation of migratory birds and their habitats. River Road is positioned on a natural migratory route and serves as a resting point for migratory birds each year.
- **WRDA of 1986** - The restored ecosystem functions that would be provided by the eventual recommended plan for the River Road study can be considered significant by the USACE because the restoration of these functions meet with the spirit of the WRDA of 1986.
- **WRDA of 1990** - This WRDA established an interim goal of no overall net loss of wetlands in the U.S. and set a long-term goal to increase the quality wetlands, as defined by acreage and function. Any proposed action for River Road will enhance and create acres of wetlands, or riverine habitat, within the project area.
- **Executive Order (EO) 13112: Invasive Species** - EO 13112 recognizes the significant contribution native species make to the well-being of the Nation's natural environment and directs Federal agencies to take preventive and responsive action to the threat of non-native species invasion and to provide restoration of native species and habitat conditions in ecosystems that have been invaded. This study addresses non-native invasive species by formulating plans to meet goals and objectives that will assist in the management and removal of these species.
- **EO 13751: Invasive Species** - This order amends EO 13112 and directs actions to continue coordinated Federal prevention and control efforts related to invasive

species. This order maintains the National Invasive Species Council (Council) and the Invasive Species Advisory Committee; expands the membership of the Council; clarifies the operations of the Council; incorporates considerations of human and environmental health, climate change, technological innovation, and other emerging priorities into Federal efforts to address invasive species; and strengthens coordinated, cost-efficient Federal action.

- **EO 13186: Migratory Birds** - ER 13186 directs Federal agencies to promote the conservation of migratory bird populations through restoring and enhancing habitat. Because the River Road study area supports species of concern and their habitats, their institutional significance is recognized from a regional, national, and international perspective.
- **Audubon Red List** - In 2007, the Audubon Society, and the American Bird Conservancy, published the Watchlist 2007. This List documented U.S. bird species that were rapidly declining in numbers, and/or had very small populations, or limited ranges, and faced major conservation threats. A Yellow list was also published of bird species that were either declining or rare. Watchlist 2007 includes 15 Red-listed species and 48 Yellow-listed species that may be found in Bexar County.
- **Partners in Flight (PIF)** - PIF is a cooperative partnership between federal, state, and local government agencies, philanthropic foundations, professional organizations, conservation groups, industry, academia, and private individuals. In an effort to prioritize conservation needs, PIF assessed the conservation vulnerability for land bird species based on biological criteria such as population size, breeding distribution, non-breeding distribution, threats to breeding habitats, threats to non-breeding areas, and population trends. There are 29 species in Bexar County on the PIF Watch Lists.
- **The Red Watch List** – species with extremely high vulnerability due to small population and range, high threats, and range wide declines has three species that correlate to Bexar County.
- **The "not declining" Yellow Watch List** – species not declining but vulnerable due to small range or population and moderate threats has three species that correlate to Bexar County.
- **The "declining" Yellow Watch List** – species with population declines and moderate to high threats has 23 species that correlate to Bexar County.
- **Department of Defense (DoD) PIF** - This PIF program consists of a cooperative network of natural resources personnel from military installations across the US. The DoD PIF works beyond installation boundaries to facilitate cooperative partnerships, determine the status of bird populations, and prevent the listing of additional birds as threatened or endangered. There are 33 species on the DoD PIF Priority species occurring in Bexar County.
- **North American Waterfowl Management Plan (NAWMP)** - Established in 1986, the NAWMP is an international plan to reverse the downward trend in waterfowl populations. The goal of the plan is to protect, restore, and enhance wetland habitat

and increase waterfowl population numbers. Ecosystem restoration of River Road will directly affect North American Waterfowl Management. Any USACE plan would attract waterfowl and benefit those species by increasing the quality of forage found during their migration.

- **North American Bird Conservation Initiative (NABCI)** - The NABCI is a tri-national declaration of intent between the U.S., Canada, and Mexico to strengthen cooperation on the conservation of North American birds throughout their ranges and habitats. The River Road study area is located near the intersection of three Bird Conservation Regions: Oaks and Prairies, Edwards Plateau, and Tamaulipan Brushlands.
- **North American Waterbird Conservation Plan (NAWCP)** - The goal of the Waterbird Conservation of the Americas is to sustain and restore waterbird populations and breeding, migratory, and nonbreeding habitats in North America, Central America, and the Caribbean. Waterbirds will benefit from the measures proposed for the River Road Aquatic ER. Increased quality of riverine and riparian habitats will attract waterbirds and supplement their food and cover resources.
- **Shorebird Conservation Plan** - This plan is to protect and restore shorebird populations and their migratory, breeding, and nonbreeding habitats. The improvement of riverine habitat from the Recommended Plan will benefit shorebird population within Bexar County and will have some effects on shorebirds nationwide.
- **USFWS Birds of Conservation Concern (BCC)** – This project will directly benefit BCC species through the implementation of native species plantings and invasive species management along the riparian corridor and within the river itself. By planting native species and managing monocultures, the study area's biodiversity will be improved which will effectively improve foraging and nesting sites for birds.
- **Texas Conservation Action Plan** - The Texas Conservation Action Plan identifies Species of Greatest Conservation Need (SGCN) for ecoregions throughout the state, including the Blackland Prairie, Edwards Plateau, and South Texas ecoregions. There are nine species of SGCN that would directly benefit from the implementation of the proposed aquatic and riparian ecosystem restoration measures.

Further support for the institutional recognition of resources in the River Road Study area is documented in Appendix C1 – Environmental Resources:

2.2.1.2 Public Recognition

Significance based on public recognition means that some segment of the public recognizes the importance of an environmental resource. Public recognition is evidenced by people engaged in activities that reflect an interest in or concern for a particular resource. Recognition of public significance for the River Road study area can best be demonstrated by the actions of SARA and the City of San Antonio partnership.

The proposed River Road Aquatic ER Feasibility Study makes a significant contribution to a larger migratory bird conservation and restoration effort being implemented by Bexar County, City of San Antonio, SARA, and USACE. The above entities have made

commitments to improving habitat across the San Antonio River watershed, approximately 1-3 miles from River Road. Several other public organizations around the country have immense interest in maintaining, restoring, and creating wetlands and assisting waterfowl and shorebird persistence by managing appropriate habitat for essential nesting cover and other needs as of 2020. A list of local and national organizations interested in maintaining and restoring aquatic habitats for migratory birds and aquatic wildlife can be found in Appendix C1 – Environmental Resources.

2.2.1.3 Technical Recognition

Significance based on technical recognition requires identification of critical resource characteristics such as scarcity, representativeness, status and trends, connectivity, limiting habitat, and biodiversity. Therefore, technical recognition of resources varies across geographic areas and spatial scale. The significant resources in the study area, specifically riverine and riparian habitat are scarce throughout the San Antonio area and contiguous U.S. These habitats have steadily declined due to channelization, impoundments, agriculture, and urbanization. Due to this decline, quality riverine and riparian habitat is rare and can provide excellent representation within an urban community. The study area provides desirable stopover habitat for migratory species, as well as nesting and den sites for local fauna. The riverine and riparian habitat within the study area represent a larger faction of declining habitat throughout North America and are representative of the environmental effects of human impacts and disturbance. Further support for the technical significance of resources in the River Road study area is documented in Appendix C1 – Environmental Resources.

2.2.2 Climate and Climate Change

San Antonio has a modified subtropical climate with a relatively continental influence during the winter and maritime influence from the Gulf of Mexico during the summer. The mean annual temperature is 68.7ºF. Mild weather prevails most of the winter, with freezing temperatures occurring approximately 20 days per year. Summers are usually long and hot with daily maximum temperatures over 90ºF occurring approximately 80% of the time. The mean annual precipitation is 32.91 inches per year (U.S. Climate Data 2019).

The U.S. Global Change Research Program (USGCRP) looks at potential impacts of climate change globally, nationally, regionally, and by resource (e.g., water resources, ecosystems, human health). The River Road study area lies within the Great Plains region of analysis. The Great Plains region has already seen evidence of climate change in the form of rising temperatures that are leading to increased demand for water and energy and impacts on agricultural practices. Over the last few decades, the Great Plains have seen fewer cold days and more hot days, as well as an overall increase in total precipitation. The decrease in the cold days has resulted in an overall longer frost-free season by one to two weeks. Within this region, there has been an increase in average temperatures 1.5°F from a 1960-1970 baseline to the year 2000 (USGCRP 2014). In addition to more extreme rainfall, extreme heat events have also been increasing. Most of the increases of heat wave severity in the U.S. are likely due to human activity, with a detectable human influence in recent heat waves in the southern Great Plains (USGCRP 2014). In particular, in 2011, the State of Texas experienced a heat wave and drought. The growing season and summer were both the hottest and driest on record. Extreme heat events in Texas have also been occurring more frequently.

Future Without-Project Conditions

This trend of rising temperatures and more frequent extreme events such as heat waves, drought, and heavy rainfall is predicted to continue into the future (USGCRP 2014). The USGCRP looks at two potential future conditions as part of its predictive modeling process. Under conditions of lower greenhouse gas (GHG) emissions, the average temperature in the Great Plains region may increase as much as 4°F by 2020, 6°F by 2050, and 8°F by 2090 from averages observed in 2000. Under conditions of higher continuous GHG emissions, the potential increase is greater in the long-term, and may be as much as 13.5°F by 2090.

2.2.3 Geology, Topography, and Soils

The geology of an area includes bedrock materials and mineral deposits. The principal geologic factors influencing the stability of structures are soil stability, depth to bedrock, and seismic properties. Topography describes the physical characteristics of the land such as slope, elevation, and general surface features.

The topography of the study area is characterized by relatively flat to gently sloping terrain, with an elevation of 689' above mean sea level (amsl). Geologic formations outcropping the study area are Quaternary in age (Bureau of Economic Geology 1987). The formations within the study area include the Fluviatile Terrace Deposits and Alluvium. The Fluviatile Terrace Deposits lie within the southern portion of the study area, while Alluvium lies within the northern portion.

The Farmland Protection Policy Act (FPPA) (Public Law 97-98, Title XV, Subtitle I, Section (1539-1549) requires federal actions to minimize unnecessary and irreversible conversion of farmland to nonagricultural uses, specifically prime farmlands. The Act defines prime farmlands as "…land that has the best combination of physical and chemical characteristics for producing food, feed, fiber, forage, oilseed, and other agricultural crops with minimum inputs of fuel, fertilizer, pesticides, and labor, and without intolerable soil erosion…" The act also exempts prime farmlands located within existing urban areas or areas that have been committed to urban development or water storage. The River Road study area is located within the city limits of San Antonio, therefore the proposed project is exempt from the FPPA requirements. There are two soils types that occur within the study area (Natural Resources Conservation Service [NRCS] 2019), which can be found in **Figure 4** and **Table 1**.

Figure 4: River Road Study Area Soil Map

Table 1: River Road Study Area Soil Types

Map Unit Symbol	Map Unit Name	Acres in Area of Interest (AOI)	Percent of AOI
LvA	Lewisville silty clay, 0 to 1 percent slopes	6.7	23.7%
Ti	Tinn and Frio soils, 0 to 1 percent slopes, frequently flooded	21.6	76.3%
Totals for Area of Interest		28.3	100.0%

Future Without-Project Condition

Soil erosion is a major concern and a significant adverse impact on water quality in the study area. The cause of erosion along the banks of the San Antonio River are due to changes in hydrology from the San Antonio River and impacts from human disturbance. Although geology and topography are not expected to radically change in the study area, soil will be impacted by the effects of erosion through extreme storm events and human disturbance. Growing urbanization through development and impervious surfaces will have the most significant effects. A lack of suitable drainage will modify the effects of stormwater runoff, increasing the adverse effects on native soil. Unnatural modifications to the ability of runoff to adequately drain will increase erosion. Human disturbance through vegetative clearing will also continue to increase soil erosion because there will continue to be a lack of vegetation to hold soil in place. Vehicular use will also compact the soil, which will also negate the ability of soil to absorb stormwater runoff.

2.2.4 Land Use

Bexar County includes three physiographic provinces: the Edwards Plateau, Blackland Prairie, and Interior Coastal Plain. The Edwards Plateau is located to the northwest and the Interior Coastal Plain encompasses the southeastern part of Bexar County. The Balcones Escarpment and Fault Zone makes up the dividing line between the Edwards Plateau and the Blackland Prairie (Texas Water Development Board [TWDB] 2019). The River Road study area is located exclusively within the Texas Blackland Prairie.

The study area is bordered by Brackenridge Park Golf Course, a residential neighborhood, an assortment of shops, and U.S. Highway 281. The study area itself is included within the larger limits of Brackenridge Park, which also include the San Antonio Zoo, Japanese Tea Gardens, and the Sunken Garden Theater. The land within the study area is heavily utilized for recreation; it is expected that this trend will continue into the Future Without-Project.

Future Without-Project Condition

Recreational use of the study area will continue over a 50-year period of analysis. The City of San Antonio will incorporate recreation amenities throughout Brackenridge Park, which include the golf course.

2.2.5 Air Quality

The U.S. Environmental Protection Agency (EPA) has the primary responsibility for regulating air quality nationwide. The Clean Air Act (42 U.S.C. 7401 et seq.), as amended, requires the EPA to set National Ambient Air Quality Standards (NAAQS) for wide-spread pollutants from numerous and diverse sources considered harmful to public health and the environment. The Clean Air Act established two types of national air quality standards classified as either “primary” or “secondary.” Primary standards set limits to protect public health, including the health of at-risk populations such as people with pre-existing heart or lung diseases (such as asthma), children, and older adults. Secondary standards set limits to protect public welfare, including protection against visibility impairment, damage to animals, crops, vegetation, and buildings.

EPA has set NAAQS for six principal pollutants, which are called “criteria” pollutants. These criteria pollutants include carbon monoxide (CO), nitrogen dioxide (NO2), ozone (O3), particulate matter less than 10 microns (PM10), particulate matter less than 2.5 microns (PM2.5), sulfur dioxide (SO2) and lead (Pb). If the concentration of one or more criteria pollutant in a geographic area is found to exceed the regulated “threshold” level for one or more of the NAAQS, the area may be classified as a non-attainment area. Areas with concentrations of criteria pollutants that are below the levels established by the NAAQS are considered either attainment or unclassifiable areas.

The study area is located within the Metropolitan San Antonio State Implementation Plan (SIP). The San Antonio SIP is in attainment for all criteria air pollutants, except for O3. The non-attainment area includes 4 counties (Bexar, Comal, Guadalupe, and Wilson Counties). Current attainment status is classified as marginal under the 2015 eight-hour ozone NAAQS. The attainment deadline for SIP marginal non-attainment area is September 24, 2021.

Future Without-Project Condition

Pollution byproducts of the ever-growing population of the City of San Antonio are expected to increase and degrade air quality to the overabundance of vehicle emissions, industry, and other commercial facilities. However, it is likely San Antonio will effectively address their non-attainment status through corrective measures.

2.2.6 Noise

The study area is located primarily within the Brackenridge Park Golf Course and is bordered by a residential neighborhood, highway, and an urban road within the city of San Antonio. Noise sources are most likely generated from vehicles within and around the study area as well as maintenance equipment utilized by the Brackenridge Park Golf Course staff. Ambient noise within an urban area is expected to increase as the population of the City of San Antonio grows. If able to ignore the ambient noise produced from vehicles nearby, the sound of birds singing or chirping and the low water crossing at Woodlawn Avenue produces relaxing sounds that are generally appreciated by the guests. The significance of this “wild” setting in an urban landscape allows the public to escape from the over stimulation of a metropolitan environment and enjoy unique and interesting sounds.

Future-Without Project Condition

Noise pollution is expected to degrade the study area. Due to the study area’s location within an urban landscape, it is expected ambient noise from construction, traffic, and a growing population will increase throughout the 50-year period of analysis. Source contributing this source of pollution will most likely dominate and drown out the natural noises produced by wildlife and the San Antonio River.

2.2.7 Transportation

Transportation refers to the movement of people, goods, and/or equipment on a surface transportation network that can include many different types of facilities serving a variety of transportation modes, such as vehicular traffic, public transit, and non-motorized travel (e.g.,

pedestrians and bicycles). The relative importance of various transportation modes is influenced by development patterns and the characteristics of transportation facilities. In general, urban areas tend to encourage greater use of public transit and/or non-motorized modes of transportation, especially if pedestrian, bicycle, and transit facilities provide desired connections and are well operated and well maintained.

U.S. Highway 281, a four-lane road, and East Mulberry Avenue, a two-lane road, intersect the River Road study area. East Mulberry Avenue provides access to Avenue A and River Road, both dominant vehicular transportation features within the study area. Avenue A and River Road are both single lane residential roads that run parallel to one another on either sides of the San Antonio River and provide access to the Davis Park as well as to the residential neighborhood. East Mulberry Avenue and U.S. Highway 281 can be congested during "rush hour," which is typical of traffic within the City of San Antonio.

Future Without-Project Condition

The San Antonio-New Braunfels area will have an approximate population increase of 205% by 2050 (Texas Demographic Center 2020). This will lead to a significant impact on transportation sources over a 50-year period of analysis, likely increasing the amount of individuals utilizing various modes of transportation. Although River Road and Avenue A will most likely not be significantly affected by a growing population and congestion; East Mulberry Avenue and U.S. Highway 281 are will be impacted. Escalating congestion and traffic is expected to increase into the future unless a significant transportation plan is enacted by the City of San Antonio.

2.2.8 Light

The study area is located in an urbanized area of San Antonio. Fugitive light from the urban areas can be seen from the study area. Existing fugitive light sources within the study area are associated with adjacent traffic, neighborhoods, and lighting around the Brackenridge Park Golf Course.

Future Without-Project Condition

Fugitive light sources will increase in the study area due to a growing population in the City of San Antonio. Citizens are expected to continue to use light at night for household use, driving, and construction.

2.2.9 Water Resources

Water resources include both surface water and groundwater resources; associated water quality; and floodplains. Surface water includes all lakes, ponds, rivers, streams, impoundments, and wetlands within a defined area or watershed. Subsurface water, commonly referred to as groundwater, is typically found in certain areas known as aquifers. Aquifers are areas with high porosity rock where water can be stored within pore spaces. Water quality describes the chemical and physical composition of water as affected by natural conditions and human activities.

The River Road study area is located within the San Antonio River Basin. According to the San Antonio River Authority (SARA 2019), there are approximately 4,180 square miles draining into the San Antonio River Basin. Major sub-watersheds located within the San Antonio River Basin are Cibolo Creek, Leon Creek, Medina River, Salado Creek, and Upper San Antonio River (**Figure 5**).

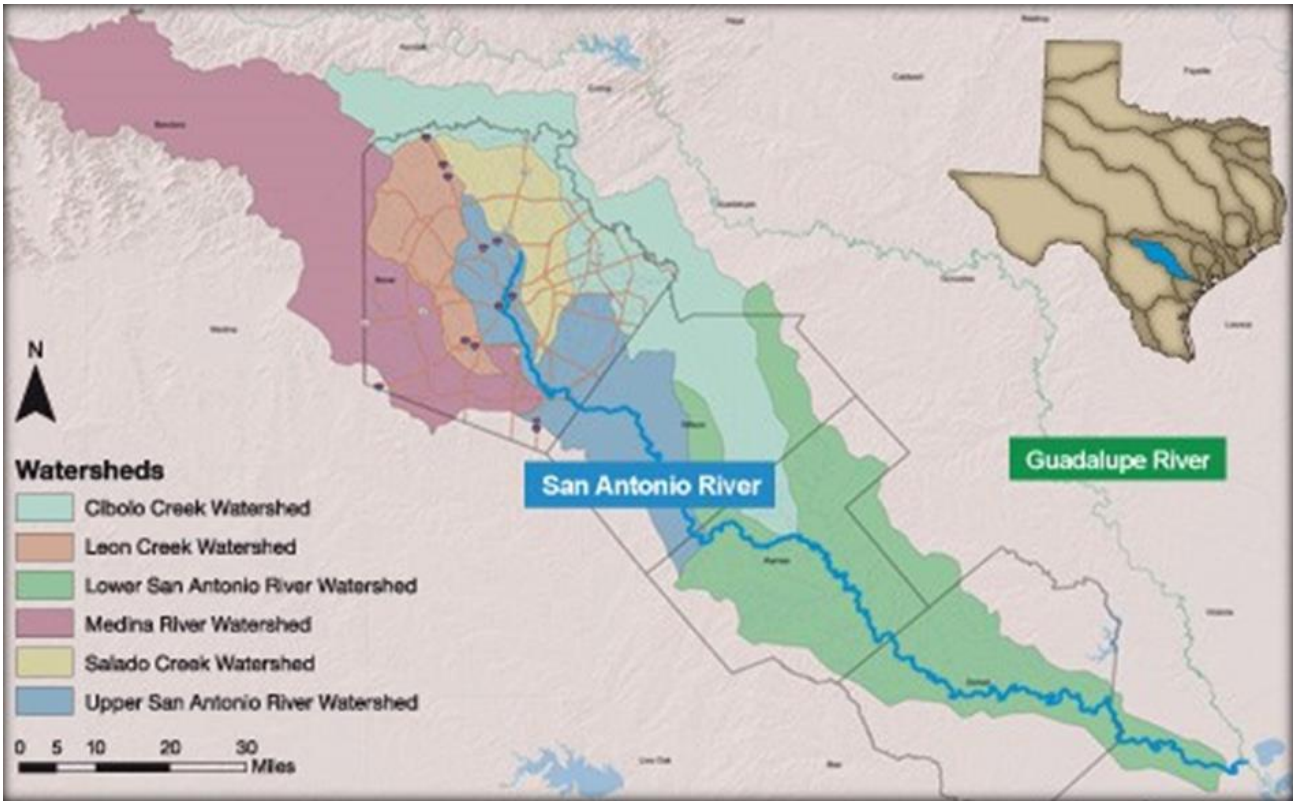


Figure 5: San Antonio River Basin (SARA 2019)

Havard (1885) describes an extremely rich and diverse aquatic ecosystem within the San Antonio River watershed during the late 19th century. Historically, San Antonio aquatic habitats supported a diverse array of high quality emergent aquatic plant species. Beckham (1887) provides further insight into the historic morphology of the San Antonio River and its tributaries writing “These [San Antonio] springs or fountains unite to form a river, which, after winding through the town in a very tortuous course, is joined some distance below by the San Pedro, a large creek having a source of supply similar to that of the river.” Menger (1913) described San Pedro Creek as once “broader in most places than our present riverbed; and it was studded all along the serpentine course from San Pedro Springs to its communication with the San Antonio River, with man-high reeds, or tule, with wide open places where we caught eels and catfish weighing over 30 pounds and shot ducks close to the Salinas Street bridge.”

The River Road study area is located within the Upper San Antonio Watershed. Approximately 558 square miles drain into this watershed (SARA 2017). The Upper San Antonio Watershed, located within the city limits of San Antonio, is characterized by development while the southern portion of the watershed is characterized by agricultural and rangeland use.

2.2.9.1 Surface Water

The San Antonio River is the main water body within the River Road study area. This stretch of river is characterized by a thin riparian buffer and non-native invasive grasses as it passes through the Brackenridge Park Golf Course. There are three low water crossing within this reach. The upstream low crossing (Low Water Crossing 1) at Woodlawn Avenue is much larger than the other two crossings, has little to no water flow and essentially acts as a dam creating a significant amount of pooling (**Figure 6**). The two downstream low water crossings (Low Water Crossings 2 and 3) are much smaller in size, but still have a significant impact on river flow (**Figure 6**). Due to existing infrastructure surrounding the river, the river will be constrained to elements imposed upon it by human disturbance.

Figure 6: Low Water Crossings 1, 2, 3

The River Road aquatic ecosystem has been affected by increased urbanization and its associated encroachment on riparian habitats throughout the 20th century, the downstream portion of the study area has been depleted of any semblance of the historical streams that Havard and Beckham described almost 130 years ago. The San Antonio River, the portion located within the study area, has been completely straightened for approximately 0.2 miles and its banks have been converted from riparian habitats to maintained grass-lined channels. By straightening the once winding watercourses, water velocities increased, disrupting the substrate composition of the aquatic habitats resulting in increased erosion and sedimentation downstream. The homogeneous, shallow channel that replaced the sinuous natural pool-riffle-run habitats severely degraded the quality of the aquatic habitat. The loss of overstory vegetation provided by shrubs and trees, and to a limited extent herbaceous vegetation, has led to increased water temperatures, lower dissolved oxygen concentrations, and limited organic inputs into the aquatic system. The upstream portion of the study area has not fared much better. Due to the significant impacts from the Woodlawn low water crossing, the water within the river has become murky and deep. This portion of the study area has experienced increasing erosion and sedimentation. Without the removal of the low water crossings it is expected that natural river flow will continue to be obstructed and all elements of aquatic ecosystem health will continue to deteriorate.

An agreement between the San Antonio Water Systems (SAWS) and SARA, ensures a constant 10 cubic feet per second (cfs) minimum flow in the river, which SAWS maintains by supplementing the river flows with re-use water. It is assumed that regardless of conditions, including increased temperatures and drought, this constant will remain the same throughout the FWOP conditions.

A desktop survey was performed to determine the location of wetlands within the study area using the USFWS National Wetlands Inventory mapping system (**Figure 7**). There is a significant amount of pooling caused by the upstream low water crossing. It has been reported to be eight to 14 feet throughout, significantly impacting the natural structure and function of riverine habitat.

Figure 7: River Road Wetland Types

Future Without-Project Condition

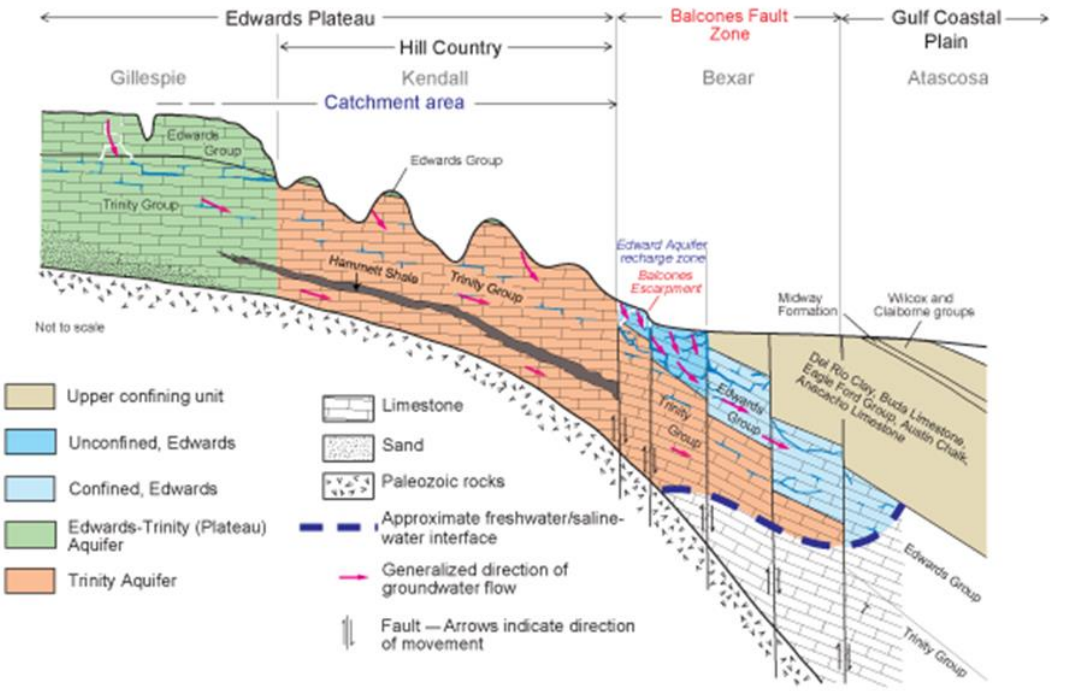
Surface water has been adversely impacted by numerous human disturbances. It is expected that the conditions currently existing will continue and the riverine habitat will degrade over a 50-year period.

2.2.9.2 Groundwater

The River Road reach of the San Antonio River lies within the boundaries of the Edwards (Balcones Fault Zone) Aquifer. The Edwards (Balcones Fault Zone) Aquifer extends through 14 Texas Counties (**Figure 8** and **Figure 9**) (TWDB 2020). It mostly consists of partially dissolved limestone with efficient permeability and can range between 200 to 600 feet in thickness. Several springs, including San Pedro and San Antonio, discharge from the Balcones Fault Zone. Rainfall, drought, and pumping can have significant impacts to water levels and spring flows due to its permeability. Water from the aquifer is primarily used for municipal, irrigation, and recreational purposes. The Balcones Fault Zone generates water for almost all of the water supply for San Antonio.

Future Without-Project Condition

Groundwater is expected to remain the same as the existing conditions.



Modified from Barker and Ardis, 1996; Lindgren and others, 2004

Figure 9: Cross Section of Edwards (Balcones Fault Zone) (Texas Water Development Board 2020)

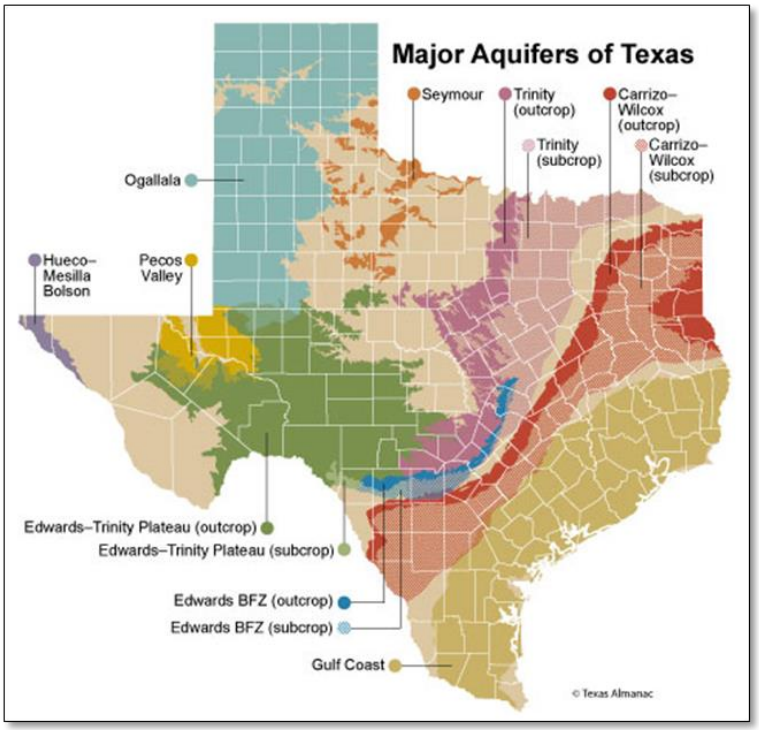


Figure 8: Major Aquifers of Texas

2.2.9.3 Water Quality

The Texas Integrated Report of Surface Water Quality, which is a requirement of the Clean Water Act Sections 305(b) and 303(d), evaluates the quality of surface waters in Texas and identifies those that do not meet uses and criteria defined in the Texas Surface Water Quality Standards (TSWQS). The Texas Integrated Report describes the status of Texas' natural waters based on historical data and assigns waterways to various categories depending on the extent to which they attain the TSWQS. Segment 1911 under station ID 12908 is listed as "nonsupporting" in regard to the fish community (SARA 2020). The level of E. coli within this segment of the river is also listed as impaired and not suitable for recreational activities. Total phosphorus and nitrate are also potential sources of impairment and concern. As of October 2019, no fish consumption advisories have been issued for the River Road study area by Texas Department of State Health Services (DSHS) (DSHS, 2019).

Due to the nature of the riparian bank of the San Antonio River and its surrounding urban landscape, the study area is more likely to be impacted by water quality issues. Existing water quality in the San Antonio River is affected by rainfall and associated stormwater flows originating from residential, commercial, and industrial point and nonpoint sources. The upstream portion of the river within the study area is primarily characterized by dark and deep water, caused by heavy sedimentation and pooling due to the low water crossing at Woodlawn Avenue, while the downstream portion has somewhat clear and shallow water. The main cause of the difference is the heavy sedimentation that the upstream portion experiences. Although the downstream portion is not as obstructed, it has experienced heavy influence from human disturbance. The areas surrounding the two downstream low water crossings are beginning to erode and will eventually be in as poor health as the upstream portion of the river. In addition to erosion, sedimentation, and channelization, the thin riparian buffer throughout the study area cannot perform the necessary actions that would allow it to slow down stormwater runoff, effectively increasing erosion and sedimentation. A thin riparian buffer also does not limit the entry of contaminants, such as herbicides, pesticides, and petroleum from nearby communities and businesses into the river.

Future Without-Project Condition

The City of San Antonio has designed and installed Low Impact Development (LID) Best Management Practice (BMP) features to reduce pollution in stormwater runoff in other parts of the city. A LID is a comprehensive approach to site planning, design, and pollution prevention strategies that, when combined, create a more economically sustainable and ecologically functional landscape. LID works with nature to manage stormwater as close to its source as possible. This approach treats stormwater as a resource, rather than a waste product, and integrates hydrologic and water quality functions into all aspects of the urban landscape (SARA 2006). The NFS continues to give trainings in LID practices to improve water quality conditions within the San Antonio River. It is expected that water quality in the study area will continue to significantly degrade, unless actions are taken to improve the conditions.

2.2.10 Visual Aesthetics

Visual resources are defined as the natural and manufactured features that comprise the aesthetic qualities of an area. These features form the overall impressions that an observer receives of an area or its landscape character. Landforms, water surfaces, vegetation, and manufactured features are considered characteristic of an area if they are inherent to the structure and function of a landscape.

The River Road study area gradually transitions from slightly forested banks with dark and deep water to highly maintained banks with clear and shallow water. Depending on the visitor, either type of visual can be attractive. The river is enclosed by four roadways on its northern, eastern, southern, and western boundaries. The northern and southern boundaries are enclosed by two major roadways, U.S. Highway 281 and E Mulberry Avenue. The eastern and western boundary roads, River Road and Avenue A, run parallel to the river. Avenue A is heavily degraded and presents an inferior appearance compared to the other roads.

Future Without-Project Condition

It is expected that the aesthetic integrity of the study area will continue to degrade due to the disturbances the river faces on its eastern and western boundaries. Extensive erosion will continue to occur producing severe head cuts and deteriorated banks. Invasive species dominate and will continue to dominate the area, unless managed and replaced with native species. Monocultures of giant cane (*Arundo donax*) and Chinese privet (*Ligystrum sinense*) are likely to occur with the spread of invasive species, thereby reducing the visual variety of vegetation.

2.2.11 Recreation

The study area, including Davis Park, is a smaller subset of an overall larger portion of the City of San Antonio's Brackenridge Park. River Road is heavily utilized for a variety of recreational opportunities that it provides, as well as its proximity to the center of San Antonio. Popular activities include: fishing, kayaking, bird watching, bicycling, walking, golfing, and picnicking. The low water crossing at Woodlawn Avenue is a popular recreation site itself due to its significant size, proximity to the river, and the auditory experience it provides to visitors.

The study area has significant value to the citizens of San Antonio in regard to recreation. Individuals regularly utilize the area through a variety of activities, occurring throughout daylight hours. Recreation in this area has a meaningful impact on individuals through friend and family connections. Individuals and groups regularly walk along River Road and Avenue A and across the San Antonio River to enjoy the natural scenery and natural aspects, which are normally restricted within an urban landscape.

Future Without-Project Condition

Brackenridge Park was initially designed to facilitate vehicular use; however, park use has shifted to focus on pedestrian-use of park areas and sites (CoSA 2017). It is assumed that this trend will continue with future efforts while still maintaining the needs for parking and access. Pedestrian access between Brackenridge Park and other San Antonio River Channel Improvement projects will continue to improve as CoSA implements features that will be attractive to both walkers and bikers. Three categories for improvement to Brackenridge Park

were identified within the plan 1) restore natural park features and improve water quality in the San Antonio River, 2) restore, preserve, and articulate park cultural and historical features, and 3) increase visibility and pedestrian access to and within the park. There is a significant amount of interest in restoring and enhancing features within Brackenridge Park for the benefit of the general public. It is expected that modification and improvement to the park by the CoSA will increase overall visitation and recreation opportunities in the study area over a period of 50 years.

2.2.12 Vegetation

The River Road study area is dominated by non-native invasive species resulting in habitats with low plant diversity. Invasive species make up approximately 80% of the total vegetation, including bermudagrass (*Cynodon dactylon*), chinaberry (*Melia azedarach*), bastard cabbage (*Rapistrum* spp.), Chinese privet (*Ligustrum sinense*), elephant ear (*Alocasia* spp.) and giant cane (*Arundo donax*). The grasslands present are artificially maintained by heavy mowing and seeding.

The vegetation within the vicinity of the river include pecan (*Carya illinoiensis*), poison ivy (*Toxicodendron radicans*), Chinese privet, Chinaberry, beggar's lice (*Hackelia virginiana*), greenbriar (*Smilax* spp.), Virginia creeper (*Parthenocissus quinquefolia*), straggler's daisy (*Calyptocarpus vialis*), giant ragweed (*Ambrosia trifida*), and Turk's cap (*Lilium superbum*).

Vegetated areas parallel to Avenue A have species such as poison ivy, giant ragweed, beggar's lice, straggler's daisy, giant cane, Chinese privet, peppervine (*Ampelopsis arborea*), lantana (*Lantana camara*), hackberry (*Celtis occidentalis*), dewberry (*Rubus* spp.), and various oaks. Davis Park is dominated by bermudagrass with intermittent green ash (*Fraxinus pennsylvanica*), straggler's daisy, and false mallow (*Malvastrum* spp.).

Future Without-Project Condition

It is assumed that a majority of native herbaceous, shrub, and tree species will be eliminated through trampling, mechanical removal, and erosion along the banks of the river. As disturbance continues, invasive species will overtake bare areas with increased light conditions due to the removal of native vegetation. A combination of all of these factors will eventually lead to a severe lack of native plant species.

2.2.13 Wildlife

Wildlife inhabiting the study area include species typical of herbaceous habitats tolerant of human activity and disturbance. These include eastern fox squirrel (*Sciurus niger*), Virginia opossum (*Didelphis virginiana*), striped skunk (*Mephitus mephitus*), Guadalupe spiny softshell turtle (*Apalone spinifera guadalupensis*), water snakes (*Nerodia* spp.), red-eared sliders (*Trachemys scripta*), eastern cottontail rabbits (*Sylvilagus floridanus*), and small rodents. Avian species utilizing the existing River Road study area aquatic habitats are limited to birds that prefer open water and shoreline habitats such as herons, egrets, cormorants, and migrating shorebirds.

The San Antonio Audubon Society (2019) lists 452 bird species as occurring within Bexar County. Many of these species utilize the riparian corridors in San Antonio, such as the River Road study area, for migration, wintering, breeding, and foraging habitats. Bird species

associated with the study were dominated by species typical of mowed, maintained, urban habitats including great-tailed grackles (*Quiscalus quiscula*), white-winged doves (*Zenaida asiatica*), rock pigeons (*Columda livia*), house sparrows (*Passer domesticus*), and European starlings (*Starrus vulgaris*). Species often found in aquatic habitats included neotropic cormorants (*Phalacrocorax brasiliensis*), snowy egrets (*Egretta thula*), mallards (*Anas platyrhynchos*), double-crested cormorants (*Phalacrocorax auritus*), great egrets (*Ardea alba*), black-bellied whistling ducks (*Dendrocygna autumnalis*), and yellow-crowned night-herons (*Nyctanassa violacea*). Other species typical of urban greenspaces utilizing the study area include northern mockingbird (*Mimus polyglottos*), northern cardinal (*Cardinalis cardinalis*), house finch (*Carpodacus mexicanus*), cedar waxwing (*Bombycilla cedrorum*), mourning dove (*Zenaida macroura*), and blue jays (*Cyanocitta cristata*).

During sampling conducted by SARA within this reach of the San Antonio River between 2015 and 2019, 21 species of fish were observed which include multiple occurrences of blacktail shiner (*Cyprinella venusta*), longear sunfish (*Lepomis megalotis*), Mexican tetra (*Astyanax mexicanus*), mimic shiner (*Notropis volucellus*), redbreast sunfish (*Lepomis auritus),* and western mosquitofish (*Gambusia affinis*).

The State of Texas identifies “species of greatest conservation need” (SGCN). SGCN are species that are declining or rare and in need of attention to recover or to prevent the need to list under state or federal regulation. TPWD has identified 127 SGCN; a complete list of these species is located in Attachment A of Appendix C1 – Environmental Resources. The Texas Natural Diversity Database (TXNDD) is a GIS-based inventory of known locations of state-listed threatened, endangered, and SGCN species. The TXNDD is limited to elements of occurrence that are located on public lands and private lands where the landowner has given written consent to include in the database. Therefore, the TXNDD data is not a comprehensive representation of the range of the species, but a tool to identify potential listed species in a specific area. A search of the TXNDD for the study area resulted in the identification of six SGCN:

- **Texas fescue (*Festuca verseuta*)** - Its preferred habitat consists of moist limestone based soils that is on steep inclines and or on flat surfaces near streams (NatureServe 2019a).
- **Texas shiner (*Notropis amabilis*)** - Its preferred habitat consists of clear freshwater headwaters of rivers and creeks (NatureServe 2019b).
- **Correll’s false dragon-head (*Physostegia correllii*)** - Its preferred habitat consists of shallow creek like areas with silty clay loam soils (NatureServe 2019c).
- **Western spotted skunk (*Spilogale gracilis)*** - Its preferred habitat is similar to the eastern spotted skunk with the exception that it can also live in the desert while the eastern does not (NatureServe 2019d).
- **Eastern spotted skunk (*Spilogale putorius*)** - Its preferred habitat areas that are heavily wooded, as well as areas that are open, and or covered in brush (NatureServe 2019e).
- **Plains spotted skunk (*Spilogale putorius interrupta*)** - Its preferred habitat consists of pastures, shrublands, farmlands, grasslands, and meadows (Missouri Department of Conservation 2015).

Future Without-Project Condition

Although the riparian and riverine habitat is degraded, it still provides food and shelter to wildlife. Growing urbanization impacts and population increases are expected to occur throughout Bexar County. Areas such as River Road and Brackenridge Park will become more valuable for wildlife over time due to limiting habitat and connectivity issues. As human disturbance continues to degrade these regionally significant habitats, wildlife will continue to utilize the areas. However, poor habitat quality will have negative impacts on wildlife through the lack of adequate food, cover, and water resources.

2.2.14 Threatened & Endangered Species

Wildlife species may be classified as threatened or endangered under the ESA of 1973. The ESA protects threatened and endangered species and their habitats by prohibiting the "take of listed animals and the interstate or international trade in listed plants and animals, including their parts and products, except under federal permit." Take is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or to attempt to engage in any such conduct." The term harm is defined as "an act which actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering."

The USFWS is responsible for the implementation of the ESA. Section 7 of the ESA ensures that federal agencies use their authorities to address the impacts of federal actions on listed species and ensure that those actions would not jeopardize the continued existence of listed species or their critical habitat. No critical habitat is designated within the study area. See Appendix C1 – Environmental Resources for a complete list of the Federally listed threatened and endangered species with the potential to occur within the study area.

Chapters 67 and 68 of the TPWD Code and Sections 65.171-65.176 of Title 31 of the Texas Administrative Code gives TPWD the authority to develop a list of state-listed threatened and endangered species and to manage, regulate, and protect listed species in Texas. The state-listed species for Bexar County are provided in Appendix C1 – Environmental Resources.

Future Without-Project Condition

Conditions to the current list of federally threatened and endangered species in Bexar County are expected to remain the same over a 50-year period.

2.2.15 Migratory Birds

The MBTA (16 U.S.C. 703-712) prohibits the take, possession, importation, exportation, transportation, selling, purchasing, bartering, or offer to sell, purchase, or barter any migratory bird, or parts, nests, or eggs of such a bird except under terms of a valid Federal permit. The MBTA applies to native birds migrating or residing within the U.S., Mexico, Russia, and Japan. Additional protections for eagles are provided under the Bald and Golden Eagle Protection Act.

The past several decades have seen a decline in Neotropical migratory bird numbers. Recently, it has been recognized that the loss, fragmentation, and degradation of migratory stop-over habitat is potentially the greatest threat to the survival and conservation of

Neotropical birds. In arid areas of the United States, stop-over sites are restricted, and the riparian corridors of south central Texas are the primary stop-over resource for migrating birds. As is the trend throughout the nation, naturally functioning aquatic ecosystems in the southwest are decreasing. Due to the historic rarity of these systems in the southwest the impact of their loss or degradation is more acutely felt. Their loss and/or degradation places extreme pressures on the carrying capacity for the few remaining functional systems and places further stress on the South Texas ecoregion when considered in connection with the life requisites of the migratory birds of the Central Flyway. The dense and overgrown vegetation, severe disturbance in the immediately surrounding area as well as the overall small size has severely impacted the great potential that it once had to migratory birds. However, it is still an ecologically unique system that is important to a successful migration and breeding of neotropical migrants utilizing the Central Flyway. **Table 2** provides the USFWS list of potential migratory birds that may occur within the study area.

Table 2: Migratory Birds with the Potential to Occur within the Study Area

Name	Scientific Name	Breeding Season
American Golden-plover	*Pluvialis dominica*	Breeds elsewhere
Harris's Sparrow	*Zonotrichia querula*	Breeds elsewhere
Lesser Yellowlegs	*Tringa _flavipes*	Breeds elsewhere
Mountain Plover	*Charadrius montanus*	Breeds elsewhere
Semipalmated Sandpiper	*Calidris pusilla*	Breeds elsewhere
Sprague's Pipit	*Anthus spragueii*	Breeds elsewhere
Swallow-tailed Kite	*Elanoides forficatus*	Breeds Mar 10 to Jun 30
Willet	*Tringa semipalmata*	Breeds elsewhere

Future Without-Project Condition

Similar to other wildlife species, migratory birds will continue to utilize the study area. Although poor quality habitat will provide inadequate fuel during their stopover resting period.

2.2.16 Invasive Species

Invasive species are non-native species whose populations tend to outcompete native species and decrease the diversity of the native vegetation communities. Invasive species are one of the most pervasive, widespread threats to indigenous biota and often a major driver in the listing of threatened and endangered species. The introduction and establishment of invasive species can have substantial impacts on native species and ecosystems. Invasive species capable of spreading and invading into new areas are typically generalists that can easily adapt to new environments, are highly prolific and superior competitors and/or predators and lack the natural predators that keep the species in check in the native habitats. Some are very specialized and more efficient and effective than their native competitors at filling a particular niche. They compete for resources, alter community structure, displace native species, and may cause extirpations or extinctions. Invasive species often benefit from altered and declining natural ecosystems by filling niches of more specialized and displaced species with limited adaptability to changing environments.

Habitats in the study area are significantly impacted by exotic plants and animals including: bermudagrass (*Cynodon dactylon*), Chinaberry (*Melia azedarach*), bastard cabbage (*Rapistrum* spp.), Chinese privet, giant cane, hygrophila (**Figure 11** *Hygrophila polysperma),*

*Vitex (***Figure 12** *Vitex rotundifolia),* feral cats (*Felis catus*), and fire ants (*Solenopsis invicta*). The neighboring Brackenridge Park has an active Trap-Neuter-Release program for feral cats. While this program does help to reduce feral cat reproduction in the area, it does not stop the natural tendencies of the released feral cats to kill various native birds and mammals.

Figure 10: Elephant Ear at the River Road Study Area

Figure 11: Hygrophila at the River Road Study Area

Figure 12: Vitex at the River Road Study Area

Future Without-Project Condition

Non-native invasive species are expected to rise in abundance and dominate the study area without proper management.

2.3 Cultural Resources

Federal agencies are required under Section 106 of the National Historic Preservation Act to "take into account the effects of their undertakings on historic properties" and consider alternatives "to avoid, minimize or mitigate the undertaking's adverse effects on historic properties" [(36 CFR 800.1(a-c)] in consultation with the State Historic Preservation Officer (SHPO) and appropriate federally recognized Indian Tribes (Tribal Historic Preservation Officers - THPO) [(36 CFR 800.2(c)]. In accordance with this and other applicable regulations, including the National Environmental Policy Act of 1969 (NEPA), the Native American Graves Protection and Repatriation Act (NAGPRA), the Antiquities Code of Texas, and Engineer Regulation (ER) 1105-2-100, USACE has performed a desktop review of the Texas Historical Commission (THC) Atlas Database to better determine the existing conditions and potential risks of encountering historical properties.

The review of the THC Atlas database revealed numerous prior terrestrial cultural resource investigations within the study area. There are four previously recorded terrestrial archeological sites, and three historic resources (three low-water crossings), within the study area (**Table 3**). The dozens of archeological studies conducted in the vicinity of the project footprint have demonstrated a nearly uninterrupted sequence of occupation beginning with the Late Paleo-Indian Period and extending to the Protohistoric Period. Overall, the east bank of the San Antonio River south of Mulberry Avenue is dominated by relatively undisturbed archeological deposits that reach from the surface to over two meters below the surface. Nonetheless, most of the archeological deposits in the immediate vicinity of the project area have not been extensively studied.

2.3.1 Archeological Sites

41BX13

Site 41BX13 was recorded in 1966 but its boundaries were more systematically investigated by SWCA Environmental Consultants in 2008 (Carpenter et. al. 2008). The investigations consisted of a background review, survey, monitoring, site testing, and limited data recovery. The investigations consisted primarily of backhoe trenching which exposed a zone of cultural materials between 60 and 100 cm below surface. Near surface cultural deposits also were noted during the survey, consisting of proto-historic materials in combination with Late Prehistoric deposits. The site is classified as a buried camp or village. SWCA's initial investigations consisted of pedestrian survey of available exposures, backhoe trenching, and shovel testing. The survey revealed several concentrations of burned rock and lithic debris in eroded areas within tree lines bordering fairways. While monitoring during the installation of water lines, several lithic artifacts and burned rocks were observed in trench spoils throughout the site. Two diagnostic artifacts were recovered from monitoring. These consisted of a Paleo-Indian point and a large unifacial blade that appeared to have been detached from a large core.

41BX264

Site 41BX264 was documented in 1963 and formal archaeological work took place in 1976 during the survey conducted by Katz and Fox (1979). The site was described as an extensive scatter of chipped stone flakes and tools associated with a considerable amount of burned limestone fragments. Subsequently, a number of investigations occurred within the limits of

the site (Miller and Barile 2002; Houk 2002) including the excavation of contiguous blocks (Uecker and Molineu 2004) that exposed and documented a large number of burned rock cooking features spanning the period from the Early Archaic to the Late Prehistoric Period.

41BX293

Site 41BX293 is poorly known since it was defined only by cultural materials found on private property. Temporal diagnostic artifacts include an early Late Archaic dart point and a Late Archaic dart point. A unifacial scraper and several unmodified debitage pieces were encountered among the lithic debris. The actual boundaries of the site have not been defined.

41BX1396

Site 41BX1396 is a multi-component site has been formally designated as a State Antiquities Landmark. Several archaeological investigations have taken place within the boundaries of the site. The earliest investigation was the survey conducted by Katz and Fox (1979) that originally identified several lithic concentrations. The site was more formally documented by SWCA in 2002 (Miller and Barile 2002) and again in 2008 (Carpenter et. al. 2008) for a water line installation project. The deposits that were investigated ranged from near-surface to approximately 70 cm deep cultural materials.

In 2010, the Center for Archaeological Research - The University of Texas at San Antonio conducted investigations of a portion of 41BX1396. The investigations were conducted in advance of the installation of recreational facilities and associated utilities. Initial investigations were comprised of the monitoring of a trenches, and the excavation of a 1x2 meter unit, excavated within a backhoe trench. During the investigations, several diagnostic lithic artifacts indicative of Early and Middle Archaic components were discovered (Thompson and Nichols 2016). Additional investigations efforts were comprised of the excavation of four additional units. The additional units were excavated to depths reaching over two meters and revealed an Early Archaic component and Paleo-Indian component

Brackenridge Park

Brackenridge Park itself is listed as a Historic District in the National Register of Historic Places (NRHP) as of 2011, and there are several other Historic Districts surrounding the park. Brackenridge Park is comprised of 344 acres located approximately four miles north of downtown San Antonio. It is immediately south of the headwaters of the San Antonio River which runs through the entire park from north to south. The original park bequest (1899) comprised 199 acres east of the San Antonio River. The park was extended west of the river in the early twentieth century when additional bequests were combined with Spanish land grant property already owned by the city

Contributing resources range from archeological sites to mid- to late-eighteenth-century Spanish colonial irrigation features to Depression-era improvements made in the 1930s to mid-twentieth century amusements including a miniature train. One contributing element within the APE, a low-water crossing was apparently constructed in 1939. Though the river crossing also was closed many years ago, the concrete structure remains intact and is used today by pedestrians and fishermen. A faint stamp in the concrete reads "NYA 1939."

The park was nominated to the National Register at the local level of significance under Criterion A in the areas of Conservation and Entertainment/Recreation for its association with

the development and design of San Antonio's parks system, and in the area of Industry for its association with the production of limestone and cement from about 1850 until 1908. The park is also nominated at the state level of significance under Criterion C in the areas of Architecture, Art, and Landscape Architecture for its rich collection of objects, structures, and buildings that span from the pre-park era through the Great Depression, and in the area of Engineering for its association with water delivery from 1719 through 1899. In addition, Brackenridge Park is nominated under Criterion D at the state level in the area of Archeology-Prehistoric-Aboriginal because of its documented archeological deposits and potential sites related to the Paleoindian, Archaic and Late Prehistoric periods; and in the area of Archeology-Historic-Non-Aboriginal, for its documented and potential archeological deposits from the Spanish colonial period through the turn of the twentieth century. The historic period begins with the arrival of Europeans in Texas, and its earliest evidence in the park is the Alamo acequia and dam system, which dates to 1719. Paso de Tejas, a historic period crossing, connects the two banks of the river.

All four known archeological sites, three low-water crossing structures, and the Paso de Tejas are located within the Brackenridge Park National Historic District The park is also a State Archeological Antiquities Landmark under the Antiquities Code of Texas. Other archeological sites are either adjacent or near the study area. Any impacts to an archeological site, historic structure, or historic resource must be evaluated in the context of the Historic District(s) as a whole.

Paso de Tejas, a historic period crossing, connects the two banks of the river. Brackenridge Park itself is a listed Historic District in the National Register of Historic Places (NRHP), and there are several other Historic Districts surrounding the park. The park is also a State Archeological Antiquities Landmark under the Antiquities Code of Texas. Any impacts to an archeological site, historic structure, or historic resource must be evaluated in the context of the Historic District(s) as a whole.

2.3.2 Tribal Consultation

Formal letters were sent to Tribal Nations on February 28, 2018 (Appendix D - Attachment 1). These Tribal Nations consisted of The Kiowa Tribe of Oklahoma, The Apache Tribe of Oklahoma, The Tonkawa Tribe of Oklahoma, The Comanche Nation, and The American Indians in Texas at the Spanish Colonial Missions. Letters concerning potentially participating in the development of the Programmatic Agreement were sent on July 20, 2020. Tribal consultation with all of these tribes will continue throughout the duration of the project.

Table 3: Previously Recorded Archeological Sites, Historic Districts, and NRHP Listed Properties

Site Number	National Register of Historic Places Eligibility	Cultural Affiliation	Recorded By
41BX13	Eligible	Prehistoric & Protohistoric	Carpenter et. al. 2008
41BX264	Undetermined	Prehistoric	Katz and Fox 1979; Miller and Barile 2002; Houk 2002; Uecker and Molineu 2004
41BX293	Undetermined	Prehistoric	N/A
41BX1396	Eligible	Prehistoric	Katz and Fox 1979; Miller and Barile 2002; Carpenter et. al. 2008 ; Thompson and Nichols 2016
Paso de Tejas	Undetermined	Historic	N/A
Brackenridge Park Historical District	Eligible, NRHP Listed	Multicomponent	N/A
River Road Local Historic District	Undetermined	Historic	N/A

2.4 Environmental Engineering

In order to complete a feasibility level Hazardous, Toxic, and Radioactive Waste (HTRW) evaluation for the River Road Aquatic Ecosystem Restoration Feasibility Study, a records search was conducted following the rules and guidance of ER 1165-2-132: HTRW Guidance for Civil Works Projects, and ASTM E1527-13: Standard Practice for Environmental Site Assessment: Phase 1 Environmental Site Assessment Process. In the records review, files, maps and other documents that provide environmental information about the project area are obtained and reviewed. To complete the records review, USACE reviewed publicly available databases and sources, using the proposed footprint of the project, along with an approximate 1 mile search distance for each of the sources. The records search revealed several potential HTRW sites in Bexar County, although none of these sites have the potential to affect the proposed project. See the HTRW appendix for more information about risks from these sites.

The river has the potential to disturb adjacent soils and receive discharges from surrounding sites. There are several potential HTRW sites in relative proximity (one mile) to the proposed project footprint, including, 1 archived Superfund site, 7 Underground Storage Tank sites, 3 past Voluntary Cleanup Sites, and 1 leaking storage tank which impacted groundwater in the past, as well as 18 other leaking storage tank listings. In most cases, the records indicate that final concurrence for closure was issued, meaning that either the tank was removed and cleaned up to the satisfaction of the State, or that the leak was fixed and it was determined that no exposure to the contents had occurred. The identified sites within one mile of the proposed project are unlikely to impact the proposed project.

Although not classified as HTRW, wells and other infrastructure within the immediate area are contributing factors to existing conditions. Within 1 mile of the study area there are over 700 wells listed on the state database. With such a large number of wells in the area, excavations may come into contact with one or more of these wells. Awareness of such locations may prevent unintentional releases, such as brine or other groundwater contaminants, if these features are disrupted. **Figure 13** displays these underground features along with additional related information. Going forward, it is important to note that disruptions to the water table (and its depth) will affect overall groundwater flow, which is a key mechanism in spreading HTRW contaminants.

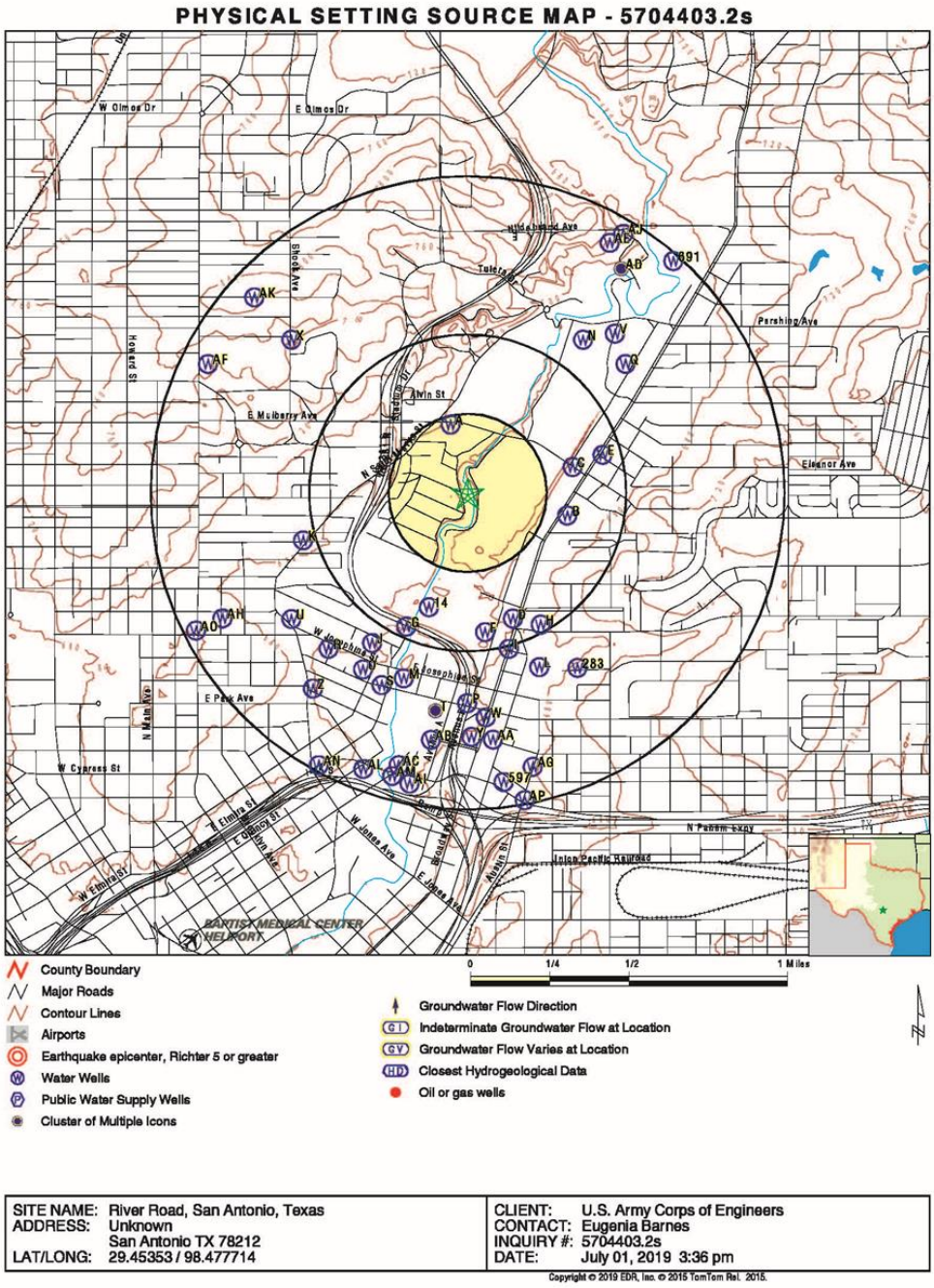


Figure 13: Map of River Road Wells

2.5 Geology and the Structural Setting

2.5.1 General Geology

The geology of an area includes bedrock materials and mineral deposits. The principal geologic factors influencing the stability of structures are soil stability, depth to bedrock, and seismic properties. Topography describes the physical characteristics of the land such as slope, elevation, and general surface features.

The topography of the study area is characterized by relatively flat to gently sloping terrain, with an elevation of 689' above mean sea level (amsl). Geologic formations outcropping the study area are Quaternary in age (Bureau of Economic Geology 1987). The formations within the study area include the Holocene era Fluviatile Terrace (Qt) Deposits with an overburden of Alluvium. The Fluviatile Terrace Deposits lie within the southern portion of the study area, while Alluvium lies within the northern portion. To the northwest of the study area lies a fault zone that exposes the Uvalde Gravel (Q-Tu), Alamo heights located about 3 miles north of the study area was the location of a former quarry.

Terrace deposits of Pleistocene and Holocene age in San Antonio area consist of sand, silt, clay and gravel and frequent induration of caliche (calcium carbonate) terraces along the streams. Gravel component is commonly rounded to sub-angular.

2.5.2 Soils

For the purposes of this study, the area of interest (AOI) for the soil survey search on the Web Soil Survey (https://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx) data base used, as shown in Figure 3 in paragraph 2.3.3. This provides two types of soils within the study area as described above in Table 1 which follows Figure 3. The two soils classified as Tinn and Frio soils (Tf) covering 82.8% or 40.7 acres of the AOI and Lewisville silty clay (LvA) covering about 17.2% or 8.4 acres of the AOI. The coverage of LvA is limited to the stream banks and Tf covers most of the study area that is either within Breckenridge Park Golf Course property including part of the greens and the wooded area west of the fairways. It also includes part of Avenue A, which is is proposed to be vacated in some of the alternatives studied.

Lewisville silty clay is associated with stream terraces and is relatively impervious. As the clay content and the plasticity characteristics may vary, it may be classified as lean clay (CL) or fat clay (CH). The range of liquid limit (52 to 59%) and plasticity index (18 to 34%) cited in the soil survey report indicates that the clays are active (subject to expansion and shrinkage). The pH of the LvA soil is expected to be in the range of 7.9 to 8.4. Soil chemical properties identified in the soil survey report indicate that soil parameters would support vegetation growth as indicated by the cation exchange capacity in the range of 15 to 26 meq/100g.

Tinn and Frio soils (Tf) are grouped together as their physical and chemical properties are similar. Tinn and Frio soils are mostly fat clays (CH) though at lower depths (2 to 6 feet below the surface or the C-zone) could be lean or fat clays. The range of liquid limits (60 to 91%) and the plasticity index (18 to 49%) indicate high expansion potential for Tf soils. This would have a higher potential for heave on ground-supported structures such as trails and walkways. Chemical properties include pH in the range of 7.4 to 8.4 and cation exchange capacity in the range of 26 to 44 meq/100g, which indicates a good potential for fertilizer absorption.

Slopes for steam banks in clayey soils should be less than 53° to the horizontal (1.3 vertical to 1 horizontal, generally 1.2V:1H is recommended). Steeper slopes will require slope stability study as the likelihood of slope failures is high with varying moisture conditions that could range from forming tension cracks during dry conditions and lowered factor of safety during rapid drawdown conditions, especially on slopes higher than 10 feet above the stream bed.

Refer to Appendix I for soil survey map

2.6 Socioeconomics

The socioeconomics of the communities surrounding the River Road study area are summarized in this section. The project area is located in San Antonio, Bexar County, Texas. This section will describe the socioeconomics and demographics of Bexar County, the city of San Antonio, and the census tract in which the study area lies: Census tract 1920. These three areas will be referred to as the "area of interest" in this section of the report. Demographic information for the state of Texas is provided for comparison. The parameters used to describe the demographics and socioeconomic environment include population trends, private sector employment, and wage earnings. Other social characteristics such as race composition, age distribution, and poverty will be examined in order to recognize any potential environmental justice issues that the improvement project may induce.

2.6.1 Population

Population estimates for the state of Texas and the area of interest are displayed in **Table 4** below. Bexar County is expected to experience 56% growth between the 2017 population estimate and the 2050 projection, compared to a 57% growth rate in Texas.

Table 4: Population Estimates between 2000-2050

Geographical Area	2000 Population Estimate	2010 Population Estimate	2017 Population Estimate	2050 Population Projection
Texas	20,851,820	25,145,561	27,419,612	47,342,105
Bexar County	1,392,931	1,714,773	1,892,004	3,353,060
San Antonio	1,144,646	1,327,407	1,461,623	4,467,980
Census Tract 1920	4,879	4,559	5,440	N/A

Source: U.S. Census Bureau, Population Division (2000, 2010, 2017 Estimates); U.S. Census Bureau, 2013-2017 American Community Survey 5-Year Estimates (2017 Estimate); Texas State Data Center, The University of Texas at San Antonio (2050 Projections)

2.6.2 Employment by Industry

The labor force by industry for the state and the area of interest is characterized in **Table 5**. The largest majority of the area of interest is employed in the Educational services, health care and social assistance sector, followed by the Arts, entertainment, recreation, accommodation food services sector, and then retail trade.

Table 5: Area of Interest Employment by Industry

Industry	Texas	Bexar County	San Antonio	Census Tract 1920
Agriculture, forestry, fishing and hunting, and mining	3%	1%	1%	1.1%
Construction	8%	8%	8%	4.9%
Manufacturing	9%	6%	6%	10.1%
Wholesale trade	3%	2%	2%	0.5%
Retail trade	11%	12%	12%	15.8%
Transportation and Warehousing, and utilities	6%	4%	4%	1.5%
Information	2%	2%	2%	1.7%
Finance and insurance, and real estate and rental and leasing:	7%	9%	9%	3.3%
Professional, scientific, and management, and administrative, and waste management services	11%	11%	11%	13.3%
Educational services, and health care and social assistance	22%	23%	23%	27.6%
Arts, entertainment, and recreation, and accommodation and food services	9%	12%	12%	15.3%
Other services, except public administration	5%	5%	5%	2.6%
Public administration	4%	5%	4%	2.4%
Source: U.S. Census Bureau, 2013-2017 American Community Survey 5-Year Estimates (2017 Estimate)				

2.6.3 Income and Poverty

Median household and per capita incomes for the selected geographies are displayed in **Table 6**. The median household incomes are lower in each of the areas of interest when compared to the state of Texas except for per capita, with the largest discrepancy within the categories of median household income and percent of people with incomes below poverty level.

Also displayed in the table is the percentage of individuals and families whose incomes were below the poverty level within 2017. The percent of people with incomes below poverty level in Bexar County is comparable to the state of Texas but is slightly higher in the city of San Antonio and a bit higher still in the census tract surrounding the River Road study area.

Table 6: Income and Poverty within the Area of Interest

Geographical Area	Median Household Income	% of Families with Incomes Below Poverty Level (201)	Per Capita Income	% of People with Incomes Below Poverty Level (2017)
Texas	$57,051	12.4%	$28,985	16.0%
Bexar County	$53,999	12.9%	$26,158	16.4%
San Antonio	$49,711	14.7%	$24,325	18.6%
Census Tract 1920	$30,806	13.6%	$29,179	23.8%
Source: U.S. Census Bureau, 2013-2017 American Community Survey 5-Year Estimates (2017 Estimate)				

2.6.4 Labor Force and Unemployment

Details on the labor force and unemployment rates for Texas and Bexar County are displayed in **Table 7** below. The 2017 annual average unemployment rate in Texas was 4.3%. The unemployment rates in Bexar County were slightly lower at 3.5%.

Table 7: Unemployment Rates in the Area of Interest

Geographic Area	Civilian Labor Force	Number Employed	Number Unemployed	Unemployment Rate
Texas	13,538,385	12,960,595	577,790	4.3%
Bexar County	924,590	892,277	32,313	3.5%
Source: Bureau of Labor Statistics, Current Population Survey (State estimate, 2017), LAUS (County estimates, 2017)				

2.6.5 Race and Ethnicity

Table 8 displays race and ethnicity for the comparative geographies. Within each of the areas of interest, the Hispanic population is significantly higher when compared to the state of Texas and comprises the majority of the population. In the census tract surrounding the study area, the Hispanic population accounts for 46% of the total population, while the White population accounts for 42%.

Table 8: Race and Ethnicity in the Area of Interest

Area	White	Black	Hispanic or Latino	American Indian and Alaska Native alone	Asian alone	Native Hawaiian and Other Pacific Islander alone	Some other race alone	Two or more races
Texas	43%	12%	39%	0%	4%	0%	0%	2%
Bexar County	28%	7%	60%	0%	3%	0%	0%	2%
San Antonio	25%	7%	64%	0%	3%	0%	0%	1%
Census Tract 1920	42%	6%	46.4%	0.6%	2.1%	0%	0%	3%
Source: U.S. Census Bureau, 2013-2017 American Community Survey 5-Year Estimates (2017 Estimate)								

2.6.6 Age

The distribution of population by age group is displayed in **Table 9**. The age distribution is similar between San Antonio, Bexar County, and the state of Texas. In terms of percentage of total population, the census tract that encompasses the study area has a significantly larger population of ages 15 to 19 and 20 to 24 when compared to the state of Texas. However, the study area also has a significantly smaller population of ages 35 to 44 and 45 to 54 when compared to the state of Texas.

Table 9: Population by Age Group

Area	Age Group												
	<5	**5 to 9**	**10 to 14**	**15 to 19**	**20 to 24**	**25 to 34**	**35 to 44**	**45 to 54**	**55 to 59**	**60 to 64**	**65 to 74**	**75 to 84**	**85 and over**
Texas	7%	7%	7%	7%	7%	15%	14%	13%	6%	5%	7%	3%	1%
Bexar County	7%	7%	7%	7%	8%	16%	13%	12%	6%	5%	7%	3%	1%
San Antonio	7%	7%	7%	7%	8%	16%	13%	12%	6%	5%	7%	3%	1%
Census Tract 1920	6.4%	1.8%	1.6%	15.9%	16.2%	17.6%	8.9%	9.2%	6%	4.7%	8.2%	2.8%	1.0%
Source: U.S. Census Bureau, 2013-2017 American Community Survey 5-Year Estimates (2017 Estimate)													

3 Plan Formulation

3.1 Management Measures

Plan formulation is the process of building alternative plans that meet the planning objectives of the study within the planning constraints. First, management measures are formulated. These measures are features that can be implemented at a specific geographic site to address the planning objective(s). A measure can be a structural element that requires construction or a nonstructural action. Then alternative plans are developed, comprising a set of one or more management measures functioning together to address the planning objective.

Preliminary plans are formulated by combining management measures. Each plan must be formulated in consideration of the following four criteria described in the 1983 Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (referred to as Principles and Guidelines or P&G):

- Completeness: Extent to which the plan provides and accounts for all necessary investments or actions to ensure realization of the planning objective
- Effectiveness: Extent to which the plan contributes to achieving the planning objective
- Efficiency: Extent to which the plan is the most cost-effective means of addressing the specified problems and realizing the specified opportunities, consistent with protecting the nation's environment
- Acceptability: Workability and viability of the alternative plan with respect to acceptance by Federal and non-Federal entities and the public, and compatibility with existing laws, regulations, and public policies

The four criteria were used in different steps in the plan formulation process. Completeness was used through the alternative formulation process and was evaluated for each alternative plan by meeting the planning objectives (Section 3.6). Effectiveness was evaluated by determining the habitat units for each alternative to determine alternative benefits (Section 3.3). Efficiency was evaluated by determining the incremental cost per output for each alternative (Section 3.4). Acceptability was used throughout the formulation process. This was a key focus during the resource agency meetings, public meetings, and involvement with the NFS.

Initial study efforts involved a determination of the magnitude and extent of the problems along the project area in order to develop and evaluate an array of alternative solutions that meet the existing and long-range future needs of the NFS and the public. At the initiation of the feasibility phase of the project, lines of communication were opened with Federal, state, and local agencies, private groups, and the affected public.

A Resource Agency Kick-Off Meeting was held on June 11th, 2019 with a site visit/field work on June 12th, 2019. A project overview was given, followed by the development of a conceptual model and an initial array of measures. The Resource Agencies were invited to conduct initial field work for the environmental models with the PDT. Following the kick-off meeting, a biweekly resource agency meeting has been held to discuss the progress of the study.

3.1.1 Structural and Non-Structural Measures

Non- Structural Measures

The P&G [2.1.4 Definitions] describes non-structural management measures as "A modification in public policy, an alteration in management practice, a regulatory change, or a modification in pricing policy that provides a complete or partial alternative plan for addressing water resources problems and opportunities". **Table 10** presents the preliminary non-structural measures considered for the project.

Table 10: Preliminary Non Structural Measures

Measure Name	Carried Forward	Reason for Screening
Pulse flows to support wetlands along bank	No	The PDT did not believe it would be necessary to incorporate pulse flows into the system because the San Antonio Water Systems (SAWS) maintains a flow of 10 cfs in the river.
Native plantings	Yes	
Invasive species removal	Yes	
Predator control	No	Feral cats were identified in the area by the public. Invasive predator control will be handled by local interests.

Structural Measures

The IWR Report 10-R-4, Deep-Draft Navigation, dated April 2010, defines structural measures as "Certain physical measures…designed by engineers." Like non-structural measures, structural measures may be used in combination with other measures, or independently. **Table 11** presents the preliminary structural measures that were considered for the project. Measures that were carried forward to formulate alternatives are included in Section 3.1.2.

Table 11: Preliminary Structural Measures

Measure Name	Carried Forward	Reason for Screening
Widening Brackenridge Park Golf Course road	Yes	
Remove Brackenridge Park Golf Course road	No	This measure is not supported by the NFS. Public golf course will need to maintain access to the maintenance building.
Fish ladders	No	This measure was deemed to be unnecessary within an open system.
Natural bottom culvert system-focus through center	Yes	
Rerouting Allison Drive	Yes	
Installing guardrails, bollards, fallen logs, natural stone, etc. for access control	Yes	
Rerouting Avenue A	Yes	
Widening of the riparian bank	Yes	
Remove or modify low water crossing (may be justified by Water Master), and pedestrian access	Yes	
Install stop logs	No	This measure would be utilized with the creation of wetland cells adjacent to the river. Wetland creation was screen early in the plan formulation process as it was considered not feasible in this area.
Pool, riffle, run structures	Yes	
Modify islands/bars	No	USACE and SARA team determined this measure may cause more ecological harm than good.
Install automatic gate for maintenance staff	Yes	
J-hooks, In stream structures, root wads, rock veins	Yes	
Geolifts	Yes	
Stone bank protection *erosion*	No	Measure would address erosion control that is accomplished more effectively by instream structures. Would not add to restoration.
Channel shaping or corrections	No	This measure was not supported by the Resource agencies or the public. This section of the river is one of the last unchannelized sections of the San Antonio River.
Habitat structures	Yes	
Benching-terracing connect to floodplain	Yes	
Off channel wetland design	No	Measure is not supported by the Resource agencies. Large amount of sedimentation in the only feasible area for wetland design.
Bioswale / headcut prevention	No	Resource agencies and PDT want to avoid modifying channel and flow. Opening flow through low water crossing (LWC) modifications will create similar results with less impacts to the channel.
Direct stormwater, add to habitat	No	Resource agencies and PDT want to avoid modifying channel and flow. Opening flow through LWC modifications will create similar results with less impacts to the channel.

3.1.2 Management Measures Carried Forward for Further Study

After the preliminary screening of management measures, the following management measures were carried forward.

Direct Environmental Restoration Measures

- Low Water Crossing Modification – This would include removing existing concrete rip-rap and fill material. One 5'W x 4' H box culvert would be placed in the center of the low water crossing. Suitable fill material would be placed, compacted, and shaped accordingly and 6" of concrete rip-rap would be positioned for appropriate slope. This measure would help restore the aquatic ecosystem function and structure by allowing for a more natural river system and water flow in the channel.

- Low Water Crossing Removal – Existing low water crossings would be demolished and the materials removed. Low water crossing 1 at East Woodlawn Avenue currently serves as a heavily utilized bridge for public access to both sides of the river. Removal would require mitigation with a bridge (included as a separate measure). This measure would help restore the aquatic ecosystem function and structure by allowing for a more natural river system and water flow in the channel.

- Instream Structures – Placement of instream structures such as j-hooks, pool/riffle/run, and rock vane features within the San Antonio River. This measure would improve aquatic habitat while also reducing the amount of sheer stress on the banks of the river. The features will also provide quality auditory benefits for the general public. This measure would help restore the aquatic ecosystem function and structure by allowing for a more natural river system and water flow in the channel.

- Rerouting River Road – Partial removal of River Road beginning at E Mulberry Avenue and ending at Allison Road. A Texas Department of Transportation approved road would be built within the boundary of the past alignment of Allison Road to the northwest (Reestablishment of Allison Drive). This measure would help restore the reduced riparian habitat by allowing for a larger space adjacent to the channel for native species plantings. This measure would directly reduce the erosive threat to River Road by the channel by rerouting the road.

- Avenue A Partial Removal – This measure would include the removal of 621 cubic yards of road material and replacing it with native soil. This measure would help restore the reduced riparian habitat by allowing for a larger space adjacent to the channel for native species plantings. This measure would directly reduce the erosive threat to a portion of Avenue A.

- Avenue A Full Removal – This would include the complete removal of Avenue A, 1,921 cubic yards of road material and replacing it with native soil. This measure would help restore the reduced riparian habitat by allowing for a larger space adjacent to the channel for native species plantings. This measure would directly reduce the erosive threat to Avenue A.

- Habitat Structures – This measure would include the installation of structural habitat features such as bat boxes, bird boxes, and platforms.

- Native Species Plantings – Native aquatic and riparian vegetation would be planted within the specified project area. This measure would help restore the reduced riparian habitat by establishing native species in the area adjacent to the channel.

- Invasive Species Management – Invasive species would be removed, and an invasive species management plan would be implemented within designated sites. This measure would help restore the reduced riparian habitat by removing invasive species that compete with native species adjacent to the channel.

- Geolifts - This measure will complement the instream structures. They would be used to stabilize the stream bank along the outside of stream meanders and would be placed within an appropriate proximity of the instream structures. Geolifts are basically a series of overlapping soils constructed of erosion control matting and native soils and assist in erosion control.

Access Control Measures

- Boulder Barrier – A barrier consisting of 3’ to 4’ diameter boulders with 7’ center to center spacing would be placed along the boundaries of River Road to protect restoration features from recreational vehicle use. This measure would help restore and maintain the reduced riparian habitat that currently exists by restricting public access and parking to restored project areas. Currently, public vehicles park in the riparian area that parallels both sides of the channel. Public usage on both side of the channel is currently unrestricted, contributing to the reduced riparian habitat. This measure would assist in reducing the erosive threat to River Road by protecting the limited riparian buffer between the road and the channel.

- Gate Installation – This measure would include installation of a gate at the intersection of Avenue A and E Mulberry Avenue to restrict public vehicular access, but allow the golf course maintenance staff to access the golf course maintenance building (current access utilizes Avenue A). Depending on the alternatives implemented, a gate could also be installed at the entrance of the Brackenridge Golf Course golf cart path. This measure would help restore and maintain the reduced riparian habitat that currently exists by restricting public vehicular access and parking along Avenue A and the riparian habitat adjacent to Avenue A. This measure would assist in reducing the erosive threat to River Road by protecting the limited riparian buffer between the road and the channel. A parking lot currently exists for Brackenridge Park to the northwest of the project area, along with a crosswalk at Mulberry Avenue for pedestrians to walk from the parking area to the project area. It was determined that this would be a sufficient area for parking to access the project area with the recommended project.

Access Mitigation Measures

This section includes recreation measures that would be required to mitigate the loss of existing access in the project area as a result of alternative plans. These measures were included in alternative formulation, evaluation, and comparison.

- *Golf Course Golf Cart Path Widening – The Brackenridge Park Golf Course is adjacent to the project area. A golf cart path runs parallel to Avenue A. This path would be expanded by two feet to accommodate vehicular traffic from the golf course maintenance staff. Removing access to Avenue A would remove the golf course staff access to their maintenance building. The Golf cart path widening would mitigate for the lost access.

- *Bridges – This measure would be dependent upon the low water crossing removal measure. An Americans with Disabilities Act (ADA) compliant pedestrian bridge would be necessary for the East Woodlawn Avenue low water crossing while the bridges within the golf course would be utilized mostly for golf cart access. Currently, LWC 1 and Avenue A provide public access to both sides of the channel. Removal of Avenue A or LWC 1 would result in a loss of public access to the river. The Access path would mitigate for this loss as an additional measure to an alternative that partially or fully removes Avenue A.

Additional Recreation Features

This section includes recreation features that were considered as additions for all alternatives. These features are not included in the alternative formulation, evaluation, and comparison. A benefit-cost ratio was developed for the recreation features following the selection of a TSP.

- Access Path – A 2,450’ by 8’ Americans with Disabilities Act compliant asphalt path would be constructed along the original path of Avenue A if it were to be partially or completely removed. Currently, LWC 1 and Avenue A provide public access to both sides of the channel. Removal of Avenue A or LWC 1 would result in a loss of public access to the river. The Access path would mitigate for this loss as an additional measure to an alternative that partially or fully removes Avenue A.

- Fishing Access – This measure would include the installation of recreational fishing piers along the perimeter of the San Antonio River.

- Signage – Installation of signage to include restoration information, recreation information, and general rules and regulations.

- Trash Cans – Installation of single or clustered trash cans to focus litter disposal within a specified area.

- Bird Blinds - This measure would include the installation of bird blinds in the public access areas of the project

3.2 Alternative Formulation

This section addresses the Alternative Plans Section in a NEPA document, per 40 Code of Federal Regulations (CFR) 1502.10 “Recommended format”. The final array of management measures was combined into individual alternatives. Each of these alternatives could be a standalone plan, or combined with other alternatives to form a suite of alternative plans to establish connectivity of habitats, achieve a landscape/watershed scale of restoration, and to maximize the ecological benefits associated with the eventual Recommended plan. Scales of alternatives were developed to achieve differing levels of captured and uncaptured benefits. In an effort to reduce the number of alternative inputs into Cost Effectiveness and Incremental Cost Analysis (CE/ICA), alternatives (**Table 12**) were evaluated, then combined to form a final suite of alternatives (Alternative Plans). Benefits were determined and evaluated by alternative and scale before being combined and compared as Alternative Plans. All alternatives developed will include a version of the recreation features: invasive species management, native species planting (aquatic and riparian), and installation of habitat features (platforms, bat boxes, bird boxes). Scales of alternatives were developed to achieve differing levels of captured and uncaptured benefits.

Because there is more ecological value in evaluating the removal and modification of low water crossings in combination and because instream structures location is dependent on low water modifications, these measures were combined to form Alternative 1. The location of the instream structures will be based on the areas determined in the H&H analysis performed by the NFS. This alternative can also include measures such as native species plantings, invasive species management, and installation of habitat features. The full and partial removal of Avenue A measures were combined with the gate installation and golf cart path widening to form Alternative 2. This alternative can include measures such as native species planting, invasive species management, and the installation of habitat features.

Table 12 presents a final array of alternatives. The alternatives evaluated for this feasibility study include:

- Alternative 1 Instream Modification: Scales 1A, 1B, 1C, 1D
- Alternative 2 Avenue A Modification: Scales 2A and 2B
- Alternative 3 River Road Modification: Scales 3A and 3B

Table 12: Final Array of Alternatives

Alternative	Scale	Environmental Restoration Measures	Access Control Measures	Access Mitigation Measures
Alternative 1 Instream modification	1A	• Removal of Low Water Crossing 1 • Removal of Low Water Crossing 2 • Removal of Low Water Crossing 3 • Instream Structures • Geolifts	• Boulder Barrier	• Bridge
	1B	• Modification of Low Water Crossing 1 • Removal of Low Water Crossing 2 • Removal of Low Water Crossing 3 • Instream Structures • Geolifts	• Boulder Barrier	• Bridge
	1C	• Removal of Low Water Crossing 1 • Modification of Low Water Crossing 2 • Modification of Low Water Crossing 3 • Instream Structures • Geolifts	• Boulder Barrier	• Bridge
	1D	• Modification of Low Water Crossing 1 • Modification of Low Water Crossing 2 • Modification of Low Water Crossing 3 • Instream Structures • Geolifts	• Boulder Barrier	• Bridge
Alternative 2 Avenue A Modification	2A	• Removal of Avenue A	• Gate Installation	• Golf Course Path Widening
	2B	• Partial Removal of Avenue A	• Gate Installation	• Golf Course Path Widening
Alternative 3 River Road Removal	3A	• Partial removal of River Road ○ Reroute traffic to Allison Drive		
	3B*	• River Road remains as is • Native species planting in park		

*Does not technically affect river road but included as scale so it will not be considered in combination with 3A (River Road Removal)

3.2.1 No Action Alternative

The CEQ regulations (40 CFR 1500–1508) for Implementing NEPA do not define the "No Action Alternative," stating only that NEPA analyses shall "include the alternative of No Action" (40 CFR 1502.14). The USACE regulations [33 CFR 325 9.b (5) (b)] define the No Action Alternative as "one which results in no construction requiring a USACE permit".

For purposes of this integrated feasibility document and EA, under the No Action Alternative, the USACE would implement no changes to the project area. FWOP conditions are expected.

3.2.2 Alternative 1 - Instream Modification

The Instream Modification alternative focused on modifications to three low water crossings within the project area (**Figure 14** and **Figure 14**). Four scales were evaluated for this alternative, with each scale including native species plantings, invasive species management, instream structures, and either modification or removal of LWC 1, 2, or 3. Combinations of low water crossing modification and removal will yield different benefits based on the low water crossing that is manipulated (upstream or downstream of LWC 1).

Figure 14: Low Water Crossing Locations

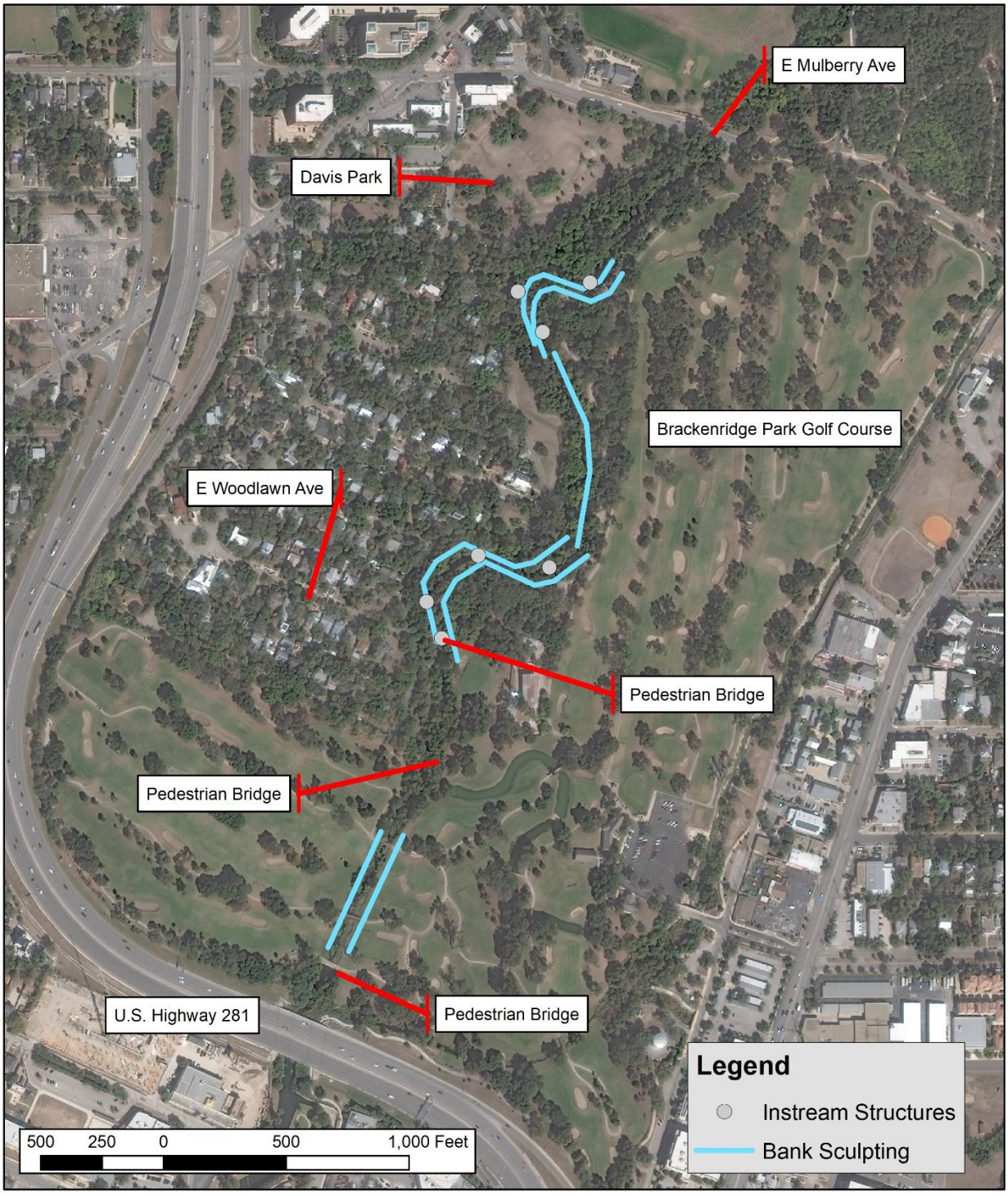


Figure 15: Bank Sculpting and Instream Structures

Scale 1A

Scale 1A includes the removal of all three low water crossings. The removal of the low water crossings will open up the stream bed, increase channel flow, and reduce the pooling, erosion, and sedimentation in the area. This scale will also include instream structures underneath the pedestrian bridge where low water crossing 1 currently exists to increase wildlife habitat and provide auditory benefits to the general public. Scale 1A includes the following measures:

- Low water crossing removal
- Bridge
- Instream structures
- Native Species plantings
- Invasive species removal
- Boulder barrier
- Geolifts

Scale 1B

Scale 1B includes the modification of low water crossing 1 and the removal of low water crossing 2 and low water crossing 3. Modification of low water crossing 1 will include the installation of a box culvert within the center of the existing low water crossing, to improve flow and reduce pooling. The reduction in pooling will lead to improve erosion and sedimentation upstream of low water crossing 1. Scale 1B includes the following measures:

- Low water crossing modification (low water crossing 1)
- Low water crossing removal (low water crossing 2 and 3)
- Bridge
- Instream structures
- Native Species plantings
- Invasive species removal
- Boulder barrier
- Geolifts

Scale 1C

Scale 1C includes the removal of low water crossing 1 and the modification of low water crossing 2 and 3. An additional instream structure will be included under the bridge in the existing location of low water crossing 1. Scale 1C includes the following measures:

- Low water crossing removal
- Low water crossing modification
- Bridge
- Instream structures
- Native Species plantings
- Invasive species removal
- Boulder barrier
- Geolifts

Scale 1D

Scale 1D includes the modification of all three low water crossings. Scale 1D includes the following measures:

- Low water crossing modification
- Bridge
- Instream structures
- Native Species plantings
- Invasive species removal
- Boulder barrier
- Geolifts

3.2.3 Alternative 2 - Avenue A Modification

Avenue A currently provides public access to the study area to the east of the San Antonio River. Avenue A runs from East Mulberry Avenue and ends in a loop that connects to the LWC 1. The road is relatively degraded and does not include public access control features, such as curbs, or physical boundaries separating the edge of the road and the riparian corridor of the San Antonio River. There is constant public disturbance along Avenue A resulting in soil compaction and a lack of vegetation. Two scales were evaluated for this alternative, both include native species plantings, invasive species management, habitat features and gate installation. Scale 2A incorporates Avenue A full removal and Golf Course path widening. Scale 2B includes Avenue A partial removal and Golf course path widening. This alternative will limit the vehicular access to the project area. The installation of a gate at the entrance of Avenue A will limit vehicular access to the Brackenridge Park Golf Course maintenance staff to access the maintenance building that currently exists close to LWC 1.

Scale 2A

Scale 2A includes the complete removal of Avenue A from the entrance at E Mulberry Avenue to the loop near low water crossing 1. Native soil will be deposited as top soil with the demolition of Avenue A. The Brackenridge Park Golf Course path would be widened with appropriate materials to maintain staff access to the maintenance building that is currently provided by Avenue A. Scale 2A includes the following measures:

- Golf course path widening
- Habitat Structures
- Gate Installation
- Native Species plantings
- Invasive species removal
- Avenue A Removal

Scale 2B

Scale 2B includes the removal of the lower portion of Avenue A beyond the maintenance building. This alternative would allow for access to the maintenance building by golf course staff using Avenue A. The removed section of Avenue A would be replaced with native soil. Scale 2B includes the following measures.

- Habitat Structures
- Gate Installation
- Native Species plantings
- Invasive species removal
- Partial removal of Avenue A

3.2.4 Alternative 3 - River Road Modification

River Road and Davis Park are in the northwestern portion of the study area and serve as the buffer between the riparian corridor of the San Antonio River and the adjacent River Road Neighborhood. Davis Park is heavily maintained with mowing and other landscape controls that do not allow for the appropriate filtration and slow down of stormwater runoff into the river. The River Road alternative incorporates native species planting and restores a suitable riparian buffer between the river and urban elements.

Scale 3A

Scale 3A includes the removal of the northern portion of River Road and establishing the original alignment of Allison Drive to the west of Davis Park to maintain access for the adjacent neighborhood. The removed section of River Road would be replaced with native soil and native vegetative species would be planted in the removed road section and Davis Park to expand the riparian zone. Scale 3B includes the following measures:

- River Road removal
- Reestablishment of Allison Drive
- Native Species plantings
- Invasive Species removal
- Habitat structures

Scale 3B

Scale 3B includes native species plantings and invasive species management in Davis Park. The relocation of River Road is not included in this alternative and all plantings would be limited to the existing open park area. Scale 3B includes the following measures:

- Native Species plantings
- Invasive Species removal
- Habitat Structures

3.3 Ecosystem Restoration Benefits

The ER benefits and habitat modeling associated with the River Road Aquatic ER Feasibility Study are described in detail in Appendix C2 – Habitat Modeling. The River Road study uses a measure of riparian species and riverine response as the ecological metric (criteria) to compare alternatives against their ability to address the ecosystem restoration objective. Riverine structure and function from pre-restoration conditions through completed restoration can be quantified by using an integrated assessment, comparing habitat, water quality, and biological measures to measure the success of the ecosystem restoration objective. Therefore, restoration management measures are largely identified for their ability to restore the physical structures that contribute to food, cover, and nesting sites of the ecosystem.

The Rapid Bioassessment Protocols (RBPs) for Use in Streams and Wadeable Rivers allows for characterization of the existing biotic integrity of the San Antonio River and the future with-project (FWP) biotic integrity of the river resulting from the various measures and combinations of measures considered during the study. The Gray Squirrel Habitat Suitability Index (HSI) and Barred Owl HSI were also used to evaluate the conditions of the historically riparian areas on either side of the San Antonio River. The models have been approved for use in the San Antonio River Basin.

Reference conditions within the RBP guide were used to scale the conditions within the San Antonio River and the acceptable expectation for the level of restoration achievable for the river. Similar studies and projects discussed in **Section 1.5** were also evaluated and compared to determine whether restoration features would be effective and produce results yielding in high ecosystem restoration benefits. The product of HSI or RBPs and acres are utilized as a single unit of measure, average annual habitat units (AAHUs), which along with average annual cost (AAC) is used to compare and rank the numerous combinations of management measures. Based on the FWOP and with-project evaluation described in Appendix C2 – Habitat Modeling, **Table 13** was developed.

Comparison and ranking ultimately provides an array of alternatives that, for their cost, provide the best return in ecological benefit. For the purpose of the River Road study, the measured ecological benefit is the ability of the riverine and riparian restoration to provide the life requisites to a diverse community of riparian and aquatic species.

Table 13: Ecological Benefits Comparison of Alternatives

Alternative	Scale	Description	Acres	FWOP AAHU	FWP AAHU	AAHU Benefits
Instream Modification	1A	Removal of Low Water Crossings 1, 2, & 3	16	7.6	12.9	5.3
	1B	Modification of Low Water Crossing 1 and Removal of Low Water Crossings 2 and 3	16	7.6	10.8	3.2
	1C	Removal of Low Water Crossing 1 and Modification of Low Water Crossings 2 & 3	16	7.6	11.7	4.1
	1D	Modification of Low Water Crossings 1, 2, & 3	16	7.6	9.6	2.0
Avenue A Modification	2A	Complete removal of Avenue A	4.6	0.8	1.7	0.9
	2B	Partial removal of Avenue A	2	0.4	0.8	0.4
River Road	3A	River Road Relocation and Planting in Davis Park	5.1	0.0	2.6	2.6
	3B	River Road As-Is and Planting in Davis Park	4.9	0.0	2.5	2.5

3.4 Evaluation and Comparison of Alternative Plans

3.4.1 Costs

Total project economic costs were annualized using the annualizer tool in Institute for Water Resources (IWR) Planning Suite II. A period of analysis of 50 years was used, along with a federal discount rate of 2.75% (per EGM 20-01 dated 31 October 2019). Prices are expressed in October 2019 dollars. **Table 14** shows the average annual benefits and costs by alternative. Project first cost includes construction cost, plantings, planning, engineering and design (PED), construction management, and a 10% contingency. For CE/ICA, construction durations were assumed to be 12 months for all alternatives to calculate interest during construction (IDC). Details of the development of costs can be found in Appendix B – Cost Effectiveness and Incremental Cost Analysis.

Table 14: Cost and Benefit Comparison of Alternatives

Alternative	Scale	Description	AAHU Benefits	Project First Cost ($1,000)	Annual Cost ($1,000) October 2019 Prices
Alternative 1 Instream Modification	1A	Removal of Low Water Crossings 1, 2, & 3	5.3	$3,555	$143.43
	1B	Modification of Low Water Crossing 1 and Removal of Low Water Crossings 2 and 3	3.2	$2,933	$120.06
	1C	Removal of Low Water Crossing 1 and Modification of Low Water Crossings 2 & 3	4.1	$2,262	$94.9
	1D	Modification of Low Water Crossings 1, 2, & 3	2.0	$1,785	$76.96
Alternative 2 Avenue A Modification	2A	Complete removal of Avenue A	0.9	$482	$20.99
	2B	Partial removal of Avenue A	0.4	$184	$8.14
Alternative 3 River Road	3A	River Road Relocation and Planting in Davis Park	2.6	$552	$24.84
	3B	River Road As-Is and Planting in Davis Park	2.5	$158	$9.79

3.4.2 Cost Effectiveness and Incremental Cost Analysis

To conduct the CE/ICA analysis, ER benefits (increase in with-project AAHUs) and annual costs (expressed in thousands of dollars) were entered into IWR Planning Suite II. All areas are combinable, but alternative scales are mutually exclusive. This resulted in 45 Alternative Plans.

3.4.3 Cost Effective Plans

Cost effective Alternative Plans are defined as the least expensive plan for a given set of benefits, or environmental output. In other words, no other plan would provide the same or more benefits for a lower cost. Of the 45 Alternative Plans (including various scales), 16 were identified as cost effective Alternative Plans, including the No Action Alternative Plan (**Figure 16**). Cost effective plans (red triangles) include the identified “Best Buy” plans (green squares).

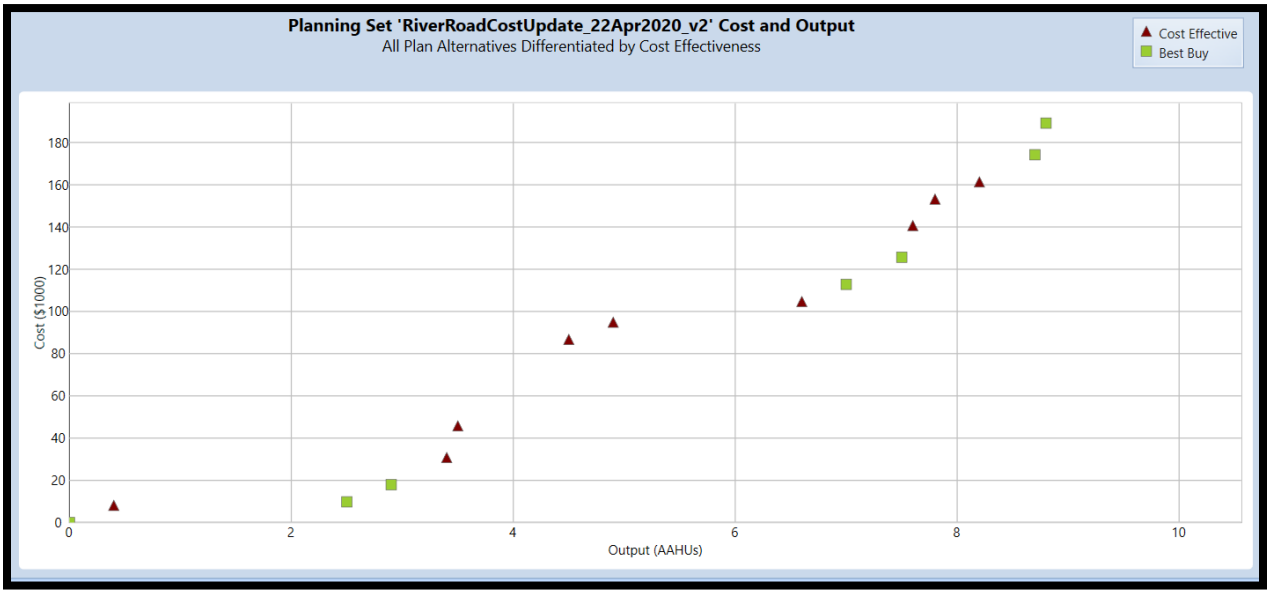


Figure 16: Cost and Output Results

3.5 Best Buy Plans

The next step in the CE/ICA analysis is to perform an incremental cost analysis on the cost effective plans. ICA compares the incremental cost per incremental benefit (output or lift in environmental output) among the plans to identify plans that maximize the last dollar spent. Starting with the no action plan, the incremental cost per incremental benefit is calculated from the no action for each cost effective plan. The plan with the least incremental cost per incremental output is identified as the first of the “with-project” best buy plans. Then starting with that plan, the incremental cost per incremental benefit is calculated between that plan and each remaining cost effective plan, and the one with the least incremental cost per incremental benefit is identified as the next plan in the array of best buy plans. This process continues until there are there are no remaining plans. The last plan in the best buy array, is typically the “kitchen sink” plan, or the plan that contains all of the management measures being analyzed. Of the 16 cost effective alternative plans, 7 plans were identified as “Best Buy” plans including the No Action plan. A more detailed discussion of each plan in the final array of Alternatives Plans is in **Appendix B – Cost Effectiveness / Incremental Cost Analysis**, which includes the discuss of the incremental cost per incremental benefit in the “Is It Worth It" analysis. The Best Buy Plans/ final array of Alternative Plans are:

- Plan 1: No Action
- Plan 2: River Road Scale 3B
- Plan 3: River Road Scale 3B + Avenue A Scale 2B
- Plan 4: River Road Scale 3B + Avenue A Scale 2B + Instream Modification Scale 1C
- Plan 5: River Road Scale 3B + Instream Modification Scale 1C + Avenue A Scale 2A
- Plan 6: River Road Scale 3B + Avenue A Scale 2A + Instream Modification Scale 1A
- Plan 7: Avenue A Scale 2A + Instream Modification Scale 1A + River Road Scale 3A

Figure 17 displays the results of the of the incremental cost benefit analysis.

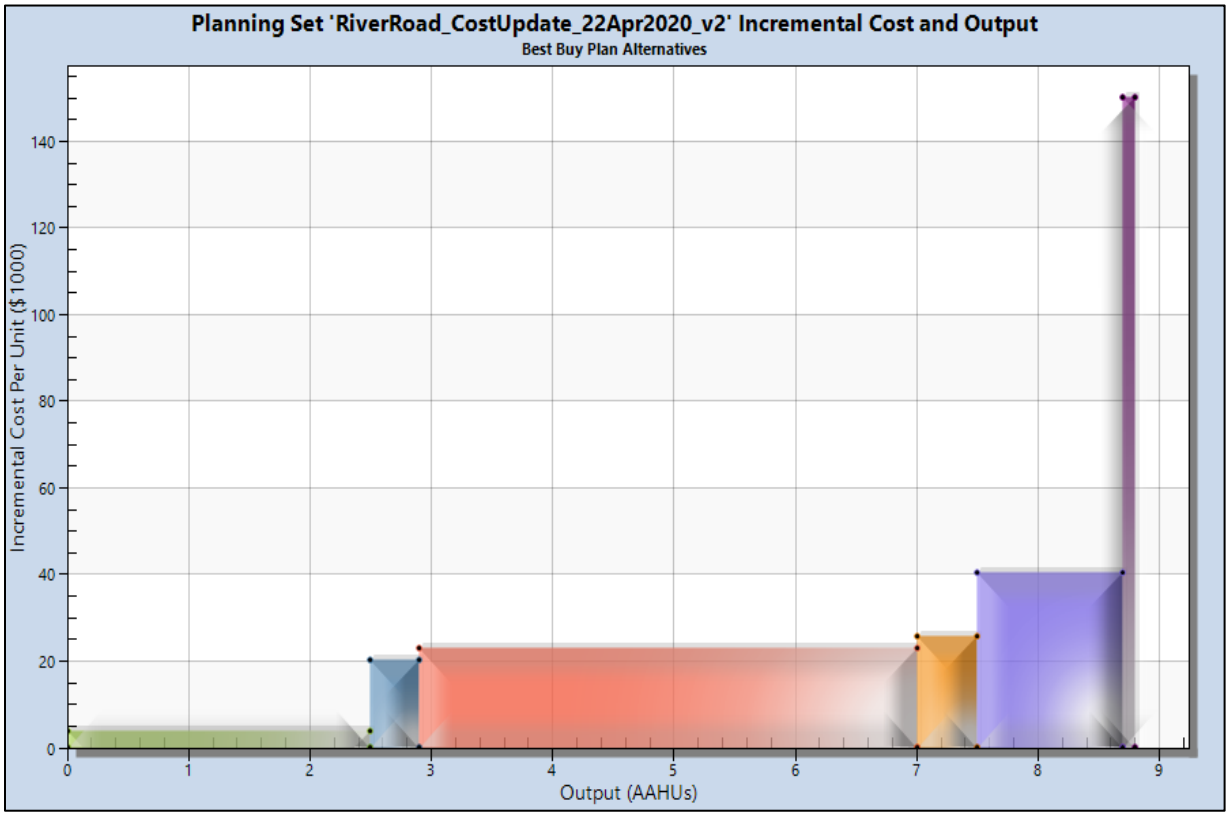


Figure 17: Incremental Cost Analysis Results

3.5.1 Plan 1: No Action

The No Action Plan would leave the River Road study area in its existing condition and would not address the study objectives of restoring habitats that would benefit migratory, breeding, and wintering neotropical birds, waterbirds, and waterfowl and aquatic organisms. The significant national loss of habitats that is occurring for these species would continue and no efforts to offset the magnitude of these losses would occur for the study area. Migratory birds key in on aquatic habitats such as the San Antonio River when identifying resting and refueling areas during their annual migrations, especially in the more arid regions of the western U.S. This is an evolutionary response for these species as riparian and aquatic habitats generally have higher biodiversity and biomass than upland habitats. These resources are especially important during times of high energy demands such as migration and preparation for the breeding season. Although the River Road study area continues to attract a large number of migratory birds due to its attractive aquatic environments, the low quality habitat and low habitat diversity cannot adequately support the energy needs of the migratory birds the river attracts. Therefore, migratory birds must expend additional, limited energy resources in search of food elsewhere. In addition to the lack of suitable habitat for a diverse range of migratory birds, the river itself is currently impacted by extreme amounts of pooling leading to an inadequate amount of pool/riffle/run features for aquatic species prosperity.

3.5.2 Plan 2: River Road Scale 3B

The change from non-native herbaceous vegetation to a restored native riparian forest would be a hydraulically neutral action. Restoration of Davis Park would partially address the restoration objective for River Road by providing some increased vertical structure diversity in the existing non-native herbaceous dominated park. Some increased insect biomass production and ancillary water quality benefits will occur. Davis Park is located within the floodplain, so increasing vegetative diversity could allow for some filtering of storm and runoff drainage before entering the San Antonio River. By increasing the vegetation that can create a buffer between the urban landscape and the river, there will be improved erosion and sedimentation conditions.

This plan increases the AAHUs by 2.5 over the No Action Plan with an incremental cost per output of $3,916. This plan's estimated first cost is $202,627 with an average annual cost of $9,785. Although this plan addresses stormwater runoff and adds riparian habitat in the study area, it does not effectively address the goals and objectives within the study area.

3.5.3 Plan 3: River Road Scale 3B + Avenue A Scale 2B

The River Road reach of the San Antonio River is heavily utilized by the general public. Severe erosion and sedimentation on the eastern bank of the river has been caused by pooling and the amount of vehicular traffic along Avenue A. By removing a small portion of this road, USACE and the NFS can improve upon the adverse impacts from recreational use.

Although Scale 2B of the Avenue A Modification alternative would only remove the lower loop of Avenue A, it would still be beneficial to the project by reducing erosion and sedimentation in the area. The lower loop of Avenue A acts as supplemental parking and its removal would most likely reduce the amount of nonpoint source pollution occurring due to idling vehicles.

This plan includes the restoration benefits of planting native species in Davis Park as well as planting and maintaining vegetation on the "southern" alignment of Avenue A past the Brackenridge Golf Course maintenance building. The effects of this restoration alternative will have long-term beneficial impacts on not only the riparian buffer zone of the San Antonio River, but also within the river itself through reduced pollution and sedimentation. The plan addresses the increase of additional riparian habitat along with increased control of vehicular access within a small segment of the study area.

This plan creates a total AAHU of 2.9 over the No Action Plan, and an increase of 0.4 AAHUs over the previous plan. The incremental cost per output increases to $20,350 over Plan 2. The first cost of River Road Scale 3B + Avenue A Scale 2B is $394,632, an increase of $192,005 from the previous plan. The estimated average annual cost for this plan is $17,930.

Although there is a significant difference in cost by adding Avenue A Scale 2B, the effects of this restoration alternative will have long-term beneficial impacts on not only the riparian buffer zone of the San Antonio River, but also within the river itself through reduced pollution and sedimentation. Although the plan addresses the increase of additional riparian habitat along with increased control of vehicular access within a small segment of the study area; it is ineffective in addressing all the goals and objectives of the project.

3.5.4 Plan 4: River Road Scale 3B + Avenue A Scale 2B + Instream Modification Scale 1C

This plan incorporates the full scale removal of LWC 1 and the modification of LWCs 2 and 3. Plan 4 is the first plan that meets all three planning objectives outlined in **Section 1.6.2**. Removal of LWC 1 will have a significant impact because it will reduce the extreme pooling that occurs in the river from E Mulberry Avenue to the low water crossing itself. Reduced pooling will encourage stream flow, thereby improving oxygenation and other abiotic factors within the river. Improved connectivity within this reach of the river will improve aquatic habitat through increased natural pool/riffle/run and transport of debris. Introduction of manmade instream structures such as j-hooks and pool/riffle/run features will provide increased benefits for aquatic wildlife by providing additional areas for foraging and cover.

Increased connectivity within the river will provide better habitat conditions for native fish, such as channel catfish (*Ictalurus punctatus*), yellow bullhead (*Ameiurus natalis*), and largemouth bass (*Micropterus salmoides*) through increased aquatic plant diversity and improved habitat structure. Pool/riffle/run features acting in a more natural capacity assist ecosystem restoration in a variety of ways. Pools can protect smaller fish or provide shelter during dry conditions and also allow sediment and organic materials to settle within the streambed because the river moves more slowly. Riffles also assist in the protection of smaller species from predators while also acting as a unique food source. Riffles are a good source of habitat for caddisflies, stoneflies, and mayflies; indicator species for river health. Smaller fish, unable to adequately compete in pools, are more likely to utilize runs because of the quick moving water over shallower areas. Due to the complexity of pool/riffle/run features, each segment acts as its own micro habitat providing protection and forage for a variety of species.

This plan creates 7 AAHUs over the No Action Plan, an increase of 4.1 AAHUs over the previous plan. The incremental cost per output increases to $23,146 over Plan 3. The estimated first cost of this plan is $2,724,881, an increase of $2.3 million from the previous plan. The estimated average annual cost for River Road Scale 3B + Avenue A Scale 2B + Instream Modification Scale 1C is $112,821. Because this plan adds habitat features that provide increased benefits for aquatic species, migratory birds, and local wildlife while also improving the overall health of the San Antonio River, the plan is worth the Federal and local investment.

3.5.5 Plan 5: River Road Scale 3B + Avenue A Scale 2A + Instream Modification Scale 1C

River Road Scale 3B + Instream Modification Scale 2C + Avenue A Scale 2A is similar to the last plan; however, this plan includes the complete removal of Avenue A. Avenue A scale 2A incorporates expanding the riparian buffer zone along Avenue A from 10 to 30 feet for its entirety. By including Avenue A scale 2A, USACE will not only increase ancillary water quality benefits from improved runoff filtering, but will also provide additional riparian habitat for migratory birds and other wildlife within San Antonio through added habitat connectivity and improved ecological modifications.

Throughout the United States, roads have negatively impacted natural ecological functions of wildlife through habitat fragmentation and alteration. Roads impact wildlife through a reduction of habitat structures like; snags, downed logs, increased edges, vehicular

mortality, and altered movement. Avenue A has adversely affected aquatic and riparian habitat within the study area. Its removal will restrict vehicular access to the site and will also minimize erosion, reduce impacts to riparian vegetation, reduce pollution, restore natural drainage, and increase bank stability.

Avenue A can also be a contributor to the introduction of sediment into the San Antonio River. The introduction of sediment is due to constant disturbance and erosion due from vehicles driving and parking on Avenue A. The obvious lack of vegetation on a roadway also decreased the amount of cover and shading for terrestrial and aquatic wildlife. Sedimentation caused by roadways can negatively impact aquatic species through direct mortality and hindrance of visibility, egg and larvae development, natural movements, and natural feeding behaviors (Switalski et. al 2004). Restoring vegetative cover on old roadways is an integral step to ecosystem restoration and can immediately produce results benefitting wildlife. Native vegetation can serve as food and cover for invertebrates, while also benefitting larger organisms that prey on these species. Vegetation assists in protecting soil from stormwater runoff as well. Trees can act as a protectant through their root system, canopies, and transpiration. Roots can bind loose soil together; stabilizing the tree, reducing erosion, and improving drainage. They allow for a slower disbursement of water, so rain can be adequately absorbed by soil. Roots can also prevent soil compaction, which can decrease the soil's ability to absorb moisture and increase runoff. Tree canopies have a similar effect by reducing the impact of rain onto soil by absorbing the initial force, allowing water to slowly drain down its base onto the ground. Canopies may also reduce the effects of wind, which could cause additional adverse sedimentation into the San Antonio River during large storm events (Shaw 2020).

Roads can also be a conduit for pollutants into the environment. Tire debris, deicing salts, oil, and gasoline all have the potential to mortality wound wildlife upon their entrance into an ecosystem. This pollution can impact locomotor function, directly altering an animal's ability to catch prey or elude predators. Light and noise pollution from vehicles traveling along roads can be detrimental to communication between wildlife, especially birds and amphibians, by interfering with warning and breeding calls. Artificial light exposure to nocturnal animals can be confusing and can impact animals that rely on light cues to initiate certain behavioral patterns. Roads may also facilitate the spread of non-native invasive species, due to the lack of competition (Hill 2020).

Impervious surfaces, such as Avenue A, can affect the San Antonio River through water quality and flooding characteristics. Impervious surfaces reduce the area in which water infiltration can occur; therefore, more runoff from storms occurs. Due to its proximity to the river, runoff flows directly into the San Antonio River off of Avenue A; thereby increasing erosion and adverse sedimentation. Because the water enters the stream much more quickly than it would with vegetation filtration, there is a higher chance that more frequent and severe flooding will occur (Hill 2020).

Although adding riparian habitat is a significant benefit, removing the road itself will not only reduce nonpoint source pollutant but will also decrease the intensity of runoff flowing into the river by removing the impervious surface throughout the entire eastern edge of the project area. Impervious surfaces can create "heat island" effect causing increases in temperatures up to 22ºF (U.S. Environmental Protection Agency 2020). The heat island effect can cause adverse impacts, such as increased energy consumption, elevated air pollutant and greenhouse gas emissions, compromised human health and comfort, and impaired water quality. Impaired water quality due to the heat island effect can increase the temperature of

stormwater runoff. Rapid temperature changes in aquatic ecosystems can be stressful and prove fatal to aquatic life. Avenue A Scale 2A will nullify these factors on the eastern boundary of the study area through increased shading, habitat quality, and biodiversity.

In addition to the riparian habitat impacts, the complete removal of Avenue A will also terminate vehicular access to the area. Thereby, improving erosion effects from the eastern bank of the river that have contributed to poor sediment transport and water flow. Removing a road adjacent to the San Antonio River that does not have any direct access to neighboring communities or publicly accessible infrastructure is an ecologically sound approach to improving aquatic and riparian habitat.
This plan creates 7.5 AAHUs over the No Action Plan, an increase of 0.5 AAHUs over the previous plan. The incremental cost peroutput increases to $25,700 over Plan 4. The estimated first cost of this plan is $3,035,382, an increase of $310,501 from the previous plan. The estimated average annual cost for River Road Scale 3B + Instream Modification Scale 1C + Avenue A Scale 2B is $125,673. This plan is worth the Federal and local investment because it contributes not only to wildlife species utilizing riparian habitat, but also to the aquatic ecosystem through improved impacts from water runoff, erosion, sedimentation, and pollution.

3.5.6 Plan 6: River Road Scale 3B + Avenue A Scale 2A + Instream Modification Scale 1A

This plan incorporates all of the habitat benefits and measures described by the previous plans. Instream Modification Scale 1A; however, removes LWC 1, 2 and 3 and replaces those structures with a pedestrian bridge. The removal of LWCs 2 and 3 significantly improves stream flow and habitat connectivity. The lack of an immovable structure will address the problems of erosion and poor sediment transport within the study area. The section of river impacted by LWCs 2 and 3 has been channelized and allows an equal distribution of water. This plan will support the ecosystem restoration objectives of the project by addressing the lack of aquatic shading, reduced allochthonous material inputs, lack of stratification of vertical structure, lack of terrestrial shading, and lack of soft and hard mast diversity.

River Road Scale 3B + Avenue A Scale 2A + Instream Modification Scale 1A incorporates all the habitat benefits and measures described by Plans 2-5. Instream Modification Scale 1A; however, removes LWC 2 and 3 and replaces those structures with a pedestrian bridge. The removal of LWCs 2 and 3 significantly improves stream flow and habitat connectivity. Removal of these stream obstructions will address the problems of erosion and poor sediment transport within the study area.

The low water crossings are significant obstructions within the San Antonio River. Although LWCs 2 and 3 have some river flow, the culverts can be easily blocked by debris. Bank degradation has begun to occur due to the limited flow through the existing culverts. Slow moving water can lead to oxygen deprivation and high water temperature within a stream. It is expected that the river will return to a more natural setting and conditions will improve for aquatic organisms.

The Texas pimpleback (*Quadrula petrina*) and Texas fatmucket (*Lampsiilis bracteata*), are likely to occur within the study area; however, current conditions of this reach of the San Antonio River would be unsuitable for their success and survival. Mussels are sensitive and act as indicators of poor water quality, dying when there are significant changes in

sedimentation, temperature, and other abiotic factors. Mussels play an important function in aquatic stream habitat through filter feeding and can filter sediment and contaminants before releasing cleansed byproducts downstream. The removal of all three low water crossings will significantly improve the flow of the San Antonio River; thereby, improving habitat conditions for sensitive aquatic species. Demolishing and removing the low water crossings will allow the stream bed to return to a more natural condition in the study area by allowing appropriate shape, material, and pooling. Stream beds are an integral function of a riverine system, provide aquatic organisms with appropriate cover and serve as locations for foraging and hunting. A natural streambed is a more continuous feature that is less likely to be scoured during large storm events.

In addition to aquatic habitat, safety for recreationalists will also be increased. This plan will remove the physical barriers for recreationalists attempting to navigate through the San Antonio River. This plan creates 8.7 AAHUs over the No Action Plan, and an increase of 1.2 AAHUs over the previous plan. The incremental cost per output increases to $40,442 over Plan 5. The estimated first cost of this plan is $4,328,059, an increase of $1,292,677 from the previous plan. The estimated average annual cost for River Road Scale 3B + Avenue A Scale 2A + Instream Modification Scale 1A is $174,210. This plan is worth the Federal and local investment because it contributes not only to wildlife species utilizing riparian habitat, but also to the aquatic ecosystem through improved impacts from water runoff, erosion, sedimentation, and pollution. Plan 6 is worth the additional $40,442 over Plan 5, and an additional 1.2 AAHUs, because it will add extra benefits to water quality, reduced sedimentation, reduced erosion, and improved aquatic habitat due to an open stream bed without restricted water flow. Although the habitat modeling has difficulty displaying large scale changes in manmade vs. natural conditions, the 1.2 AAHUs will create a more natural stream bed suitable for ecosystem restoration. This plan will support the ecosystem restoration objectives of the project by addressing the lack of aquatic shading, reduced allochthonous material inputs, lack of stratification of vertical structure, lack of terrestrial shading, and lack of soft and hard mast diversity. The complete removal of all three low water crossings will be the most effective method of restoring instream conditions of the San Antonio River. Additional discussion of the added benefits of Plan 6 can be found in Section 3.6.1.

3.5.7 Plan 7: River Road Scale 3A + Avenue A Scale 2A + Instream Modification Scale 1A

This plan adds to the previous plan's habitat measures. It incorporates the relocation of River Road to the original alignment of Allison Drive and would implement the native species plantings measure within this area. This plan would increase the riparian buffer on the northwestern edge of the study area; improving habitat quality through increased vegetative diversity, decreasing the velocity of stormwater runoff entering from E Mulberry Avenue and Davis Park, and improving erosion impacts from decreased vehicular traffic on River Road.

The estimated first cost of Avenue A Scale 2A + Instream Modification Scale 1A + River Road Scale 3A is $4,723,600, with an incremental cost per output of $150,100 over Plan 6. Due to the high incremental cost per output, the expenditure of Federal and local funds to implement Avenue A Scale 2A + Instream Modification Scale 1A + River Road Scale 3A is not justified.

3.6 Selection of the Recommended Plan

Plan 6: River Road Scale 3B + Avenue A Scale 2A + Instream Modification Scale 1A was identified as the Selected Plan. This plan creates 8.7 AAHUs over the No Action Plan (Plan 1). The incremental cost per incremental output increases to $40,442 from Plan 5. The average annual cost for Plan 6 is $174,210. This plan provides 1.2 AAHUs over Plan 5. This plan is worth the Federal and local investment because it contributes not only to wildlife species utilizing riparian habitat, but also to the aquatic ecosystem through improved impacts from water runoff, erosion, sedimentation, and pollution. This plan will support the ecosystem restoration objectives of the project by addressing the lack of aquatic shading, reduced allochthonous material inputs, lack of stratification of vertical structure, lack of terrestrial shading, and lack of soft and hard mast diversity. The complete removal of all three low water crossings will be the most effective method of restoring instream conditions of the San Antonio River. See Section 3.5.6, Section 3.6.1, and **Table 15** for an overview of the analysis for the selection of the Recommended Plan.

Table 15: Best Buy Plan Selection

Plan	Output (AAHU)	Annual Cost ($1000)	Incremental Cost ($1000)	Incremental Output (AAHU)	Incremental Cost per Output	Objective 1	Objective 2	Objective 3
1	0	0	0	0	0	No	No	No
2	2.5	9.79	9.79	2.5	3.916	No	Yes	No
3	2.9	17.93	8.14	0.4	20.35	No	Yes	Yes
4	7	112.83	94.9	4.1	23.146	Yes	Yes	Yes
5	7.5	125.68	12.85	0.5	25.7	Yes	Yes	Yes
6	8.7	174.21	48.53	1.2	40.442	Yes	Yes	Yes
7	8.8	189.22	15.01	0.1	150.1	Yes	Yes	Yes

3.6.1 National Ecosystem Restoration Plan

Migratory birds, riparian and riverine systems, and aquatic wildlife are the resources of national significance identified within the study area. Based on historical descriptions and existing conditions of the San Antonio River outside of urban areas, this portion of the river would have been extremely valuable stopover habitat for migrating birds, provided excellent connectivity between riparian systems, and would have been unobstructed for the movement of aquatic species, sediment, debris, and other natural materials. The recreation of expanded riparian buffers, along with improved riverine habitat are critical to improving habitat for migratory birds, local wildlife, and aquatic species.

Plan 6, which includes River Road Scale 3B + Avenue A Scale 2A + Instream Modification Scale 1A, is the recommended National Ecosystem Restoration (NER) plan. This plan provides:

- Two distinct habitat types (riparian and riverine) out of the two targeted habitat types;
- Resilient habitat for migratory birds;
- The creation of a complex of pool/riffle/run features that can be managed to improve water quality as an ancillary benefit;
- The restoration of the San Antonio River through improved channel flow, sedimentation, and erosion.
- The restoration of 99.2% of the proposed restoration areas;
- An estimated incremental cost per output of approximately $40,442 over the previous plan (Plan 5);
- An approximate first cost of $6.4 million.
- 8.7 AAHUs, and a project first cost per AAHU of $740,460.

3.6.1.1 Plan Selection

As part of Federal guidelines for water resources projects, there are general feasibility criteria that must be met. According to the USACE ER 1105-2-100 for planning, any the USACE project must be analyzed with regard to the following four criteria:

Completeness: Extent to which the plan provides and accounts for all necessary investments or actions to ensure realization of the planning objective

- The alternatives fully analyzed will not completely restore the novel ecosystem; however, all of the alternatives included in the Selected Plan would achieve the benefits described below without other projects being completed. For all alternatives, this included determining the likelihood of natural resources that could benefit as part of a project's implementation.

Effectiveness: Extent to which the plan contributes to achieving the planning objective

- River Road Scale 3B + Avenue A Scale 2A + Instream Modification Scale 1A contributes to the achievement of the planning objectives and avoids all constraints. The Selected Plan, as described in Section 3.7, is environmentally effective due to the varying measures that can be implemented

Efficiency: Extent to which the plan is the most cost-effective means of addressing the specified problems and realizing the specified opportunities, consistent with protecting the nation's environment.

- River Road Scale 3B + Avenue A Scale 2A + Instream Modification Scale 1A is the most cost effective means of achieving the objectives of all of this study's alternatives, plans, and scales of plans.

Acceptability: Workability and viability of the alternative plan with respect to acceptance by Federal and non-Federal entities and the public, and compatibility with existing laws, regulations, and public policies.

- River Road Scale 3B + Avenue A Scale 2A + Instream Modification Scale 1A is acceptable in terms of all known applicable laws, regulations, and public policies by the USACE and SARA.

Based on the Is It Worth It Analysis in Section 4, Plan 6 is the NER Plan because it restores a majority of the study area. The in-depth discussions of the ecosystem restoration benefits of River Road Scale 3B and Avenue A Scale 2A can be found in **Sections 3.5.3 and 3.5.5**. The selected NER Plan combines the alternatives River Road Scale 3B, Avenue A Scale 2A, and Instream Modification Scale 1A to meet the objectives of the River Road ER through the restoration of Davis Park, Avenue A, and the San Antonio River. Restoration of Davis Park will provide increased vertical structure diversity in an area that is dominated by non-native vegetation. The efforts conducted within Davis Park should assist in filtering storm and runoff drainage from adjacent businesses and impervious surfaces before entering the San Antonio River. Increased vegetative cover and diversity will provide high quality habitat for local and migratory birds and wildlife.

The River Road reach of the San Antonio River is heavily degraded due in part to severe pooling and sedimentation. This pooling, caused by LWCs 1, 2, and 3, has decreased the efficiency of natural pool-riffle-run features within the river, negatively impacting aquatic habitat and causing severe erosion on the riverbanks. LWCs 2 and 3 allow for some minor stream flow, but water continues to pool causing additional erosion on the inflow and outflow of the structures. The NER Plan incorporates the removal of the low water crossings which will allow for open flow of the river, improve sediment transport, decrease erosion, and improve overall aquatic connectivity of the San Antonio River. Once the crossings have been removed, water will be allow to flow unimpeded. A more natural river flow will allow for natural processes to return such as sediment transport and connectivity which have significant controls over habitat characteristics for flora and fauna. Animals that have evolved based on the natural processes of the river will greatly benefit through the implementation of this plan as well as native plant seed dispersal. The pool-riffle-run features will be placed throughout the upstream portion of the study area in predetermined locations to restore aquatic habitat for fish and invertebrate species.

A 50-foot riparian zone will be established on both banks of the river with native herbaceous, shrub, and tree species. Riparian species will assist ecosystem restoration in several ways 1) roots of vegetation will hold in the soil and slow down runoff, decreasing the amount of erosion and effectively decreasing the amount of sedimentation buildup within the river, 2) additional vegetation will provide shade within the river, improving the temperature, 3) increase biodiversity of insects and microorganisms near the river effectively improving foraging opportunities for aquatic and terrestrial wildlife, and 4) provide a multiple of cover for aquatic and terrestrial wildlife through their various features, such as roots and limbs.

The River Road reach of the San Antonio River is loved by the public; however, the recreational use of this area has caused severe degradation to the banks of the river. Avenue A encourages

the public to park and/or utilize the banks of the river with vehicles and other heavy equipment. This factor, along with unauthorized cutting, trimming, and/or trampling of vegetation has caused severe erosion – leading to increased sediment accumulation in the river. The base of Avenue A will be removed and replaced with appropriate soil. Increased vegetative cover will reduce nonpoint source pollution and the intensity of stormwater runoff by capturing and storing rainfall in the canopy and releasing water into the atmosphere through evapotranspiration. Trees, shrubs, and herbaceous species will also slow and temporarily store runoff, which further promotes filtration and can decrease downstream flooding and erosion impacts. The reduction of impervious surfaces will also add to the ancillary water quality benefits, by replacing those surfaces with vegetation increasing shade, biodiversity, and habitat quality. Restoration of Avenue A will also restrict vehicular access adjacent to the river, which will terminate one of the significant problems addressed by this study. This modification, along with areas adjacent to Avenue A will be planted with native riparian species. This effort will assist in ecosystem restoration by filtering runoff, improving sedimentation through erosion, increasing shade, and providing diverse habitat for migratory birds and other wildlife.

This scale of the River Road Modification entails planting native vegetation and conducting non-native invasive species management within Davis Park. Planting native riparian species will expand the riparian zone 600 feet on the western bank of the San Antonio River for 0.15 miles, while also reducing the polluting effects of runoff coming from nearby businesses and U.S. Highway 281. Restoration of Davis Park will provide increased vertical structure diversity in an area that is dominated by non-native invasive vegetation. The efforts conducted within Davis Park should assist in filtering storm and runoff drainage from adjacent businesses and impervious surfaces before entering the San Antonio River. Increased vegetative cover and diversity will provide high quality habitat for local and migratory birds and wildlife.

3.6.2.1 Resource Significance Summary for NER Plan

The proposed project area is small in size but holds tremendous resource significance for the citizens and wildlife of San Antonio and is heavily utilized by the public. This stretch of the San Antonio River has been impacted by the urbanization and its encroachment upon aquatic and riparian habitats. The urban setting of the project area means that the availability of open land to restore is limited. Given the small project area, the nominal habitats units calculated via the habitat modeling are relatively low. However, there are benefits to implementing this project that are not captured in the habitat modeling, particularly those related to the removal of the low water crossings (as summarized in Section 3.6.2.1.2).

3.6.2.1.1 Migratory Bird Habitat

The San Antonio River is positioned on a natural migratory route and serves as a resting point for hundreds of thousands of birds each year. Despite its degraded conditions and ecological losses, the high-quality opportunity of the ecosystem is evident as the area currently remains a hotspot for birding. Due to the San Antonio River Channel Improvement Project (SACIP), migratory birds are now able to utilize areas along the San Antonio River within city limits that were previously unsuitable. The Selected Plan would contribute to the success of the other projects constructed on the river; thereby, synergistically improving the ecological output of the project due to connectivity between other migratory bird habitats.

The proposed River Road Aquatic ER Feasibility Study makes a significant contribution to a larger migratory bird conservation and restoration effort being implemented by Bexar County, City of San Antonio, the San Antonio River Authority, and USACE. The above entities have

made commitments to improving habitat across the San Antonio River watershed, approximately 1-3 miles from River Road.

3.6.2.1.2 Aquatic Habitat and the San Antonio River

The River Road study area is a prime example of the adverse effects caused by inadequate culvert systems. There are significant differences between culvert channel flow and open stream flow. The proposed NER Plan institutes an open channel flow that requires the removal of the low water crossings and subsequent replacement with bridges that will reduce the environmental complications caused by culvert interference in the natural stream flow. An open stream bed is the preferred environmental alternative to culvert-style low water crossings in the San Antonio River. A major contributing factor to the degradation of the River Road study area is the amount of sedimentation and erosion caused by human alterations to aquatic and riparian habitat. The comparison of an open stream bed and modified low water crossing can be separated into geometry, sediment and debris loading, bed integrity, and impacts on aquatic life (Singley and Hotchkiss, 2012). The main feature of a low water crossing on channel flow is its culvert. The culverts create unnatural conditions in high discharge events due to the geometry of the structure. Flow into the entrance of a culvert can lead to increased pressure and sheer stress. In addition, culverts can constrict stream flows; thereby, creating a wide array of other issues on aquatic habitat. Constricted flows can lead to increased rates of submerged inlets and unsubmerged outlets, which can increase erosion rates, sediment deposition, and debris at the entrance of the culvert.

This adverse effect of an unsuitable culvert has already occurred within the River Road study area. In an open stream bed scenario, high flows are more likely to transport sediment and debris downstream. Open stream beds have the beneficial aspect of maintaining vegetation along the channel. Natural vegetation can allow stream flows to have more flexibility compared to a concrete structure as shown in the Manning's N value and can provide additional habitat for a wide array of aquatic life. Additionally, the presence of culverts would require water to pool until it is high enough to pass through. In the absence of culverts and due to SARA's low-flow requirement, the natural streambed would ensure constant free-flowing water with no pooling.

Stream conditions cannot be easily replicated by manmade structures. Natural stream beds have varying sizes and structure of sediment (Singley and Hotchkiss, 2012). Artificial beds in culverts are more likely to scour than a natural stream bed and can alter natural fish passage and adversely affect aquatic habitat connectivity. In addition, natural stream beds have a continuous light source due to their open structure and can promote vegetative growth through sunlight. Increased vegetation due to available sunlight promotes habitat connectivity and protection for aquatic species from predators.

3.7 Description of the Recommended Plan

This plan incorporates all of the habitat benefits and measures described by the previous plans. Instream Modification Scale 1A; however, removes LWC 1, 2 and 3 and replaces those structures with a pedestrian bridge. The removal of LWCs 2 and 3 significantly improves stream flow and habitat connectivity. The lack of an immovable structure will address the problems of erosion and poor sediment transport within the study area. The section of river impacted by LWCs 2 and 3 has been channelized and allows an equal distribution of water. This plan will support the ecosystem restoration objectives of the project by addressing the

lack of aquatic shading, reduced allochthonous material inputs, lack of stratification of vertical structure, lack of terrestrial shading, and lack of soft and hard mast diversity.

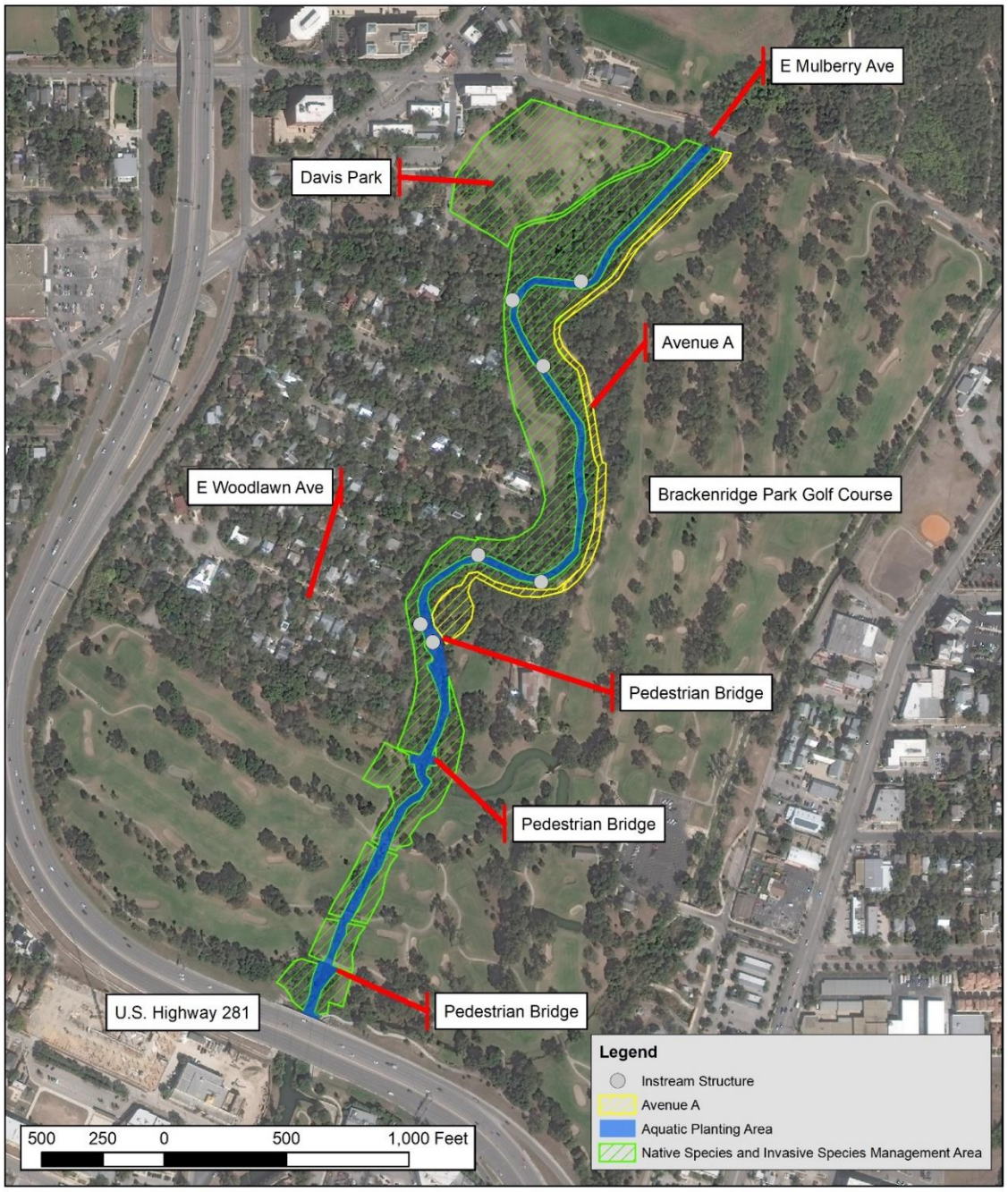


Figure 18: River Road Recommended Plan

3.7.1 Monitoring and Adaptive Management

To ensure the success of the Selected Plan, the restoration measures will be periodically surveyed to provide feedback on the response of the ecosystem and its resources to the management measures taken. By connecting the ecosystem response to the restoration as well as the management measures, potential beneficial adaptations and adjustments to the project or management plan can be identified to ensure continued success of the project. The Monitoring and Adaptive Management Plan is in Appendix C4 – Monitoring and Adaptive Management.

3.7.2 Real Estate

All project areas fall within lands already owned by the City of San Antonio and will transfer the project identified land to the Non- Federal Sponsor, SARA. All the project LERRD is within the 100-year floodplain, and as such, all the project areas are vacant, floodplain, open space properties. Information on LERRD requirements for the Recommended Plan can be found in Appendix F.

3.7.3 Hazardous and Toxic Materials

A records search was conducted in accordance with the rules and guidance of ER 1165-2-132: HTRW Guidance for Civil Works Projects, and ASTM E1527-13: Standard Practice for Environmental Site Assessment: Phase 1 Environmental Site Assessment Process. The search was conducted with a 1 mile radius from the proposed project footprint, with the following sites being identified:

- 1 archived Superfund site
- 7 Underground Storage Tank sites
- 3 past Voluntary Cleanup Sites
- 1 leaking storage tank which impacted groundwater in the past as well as
- 17 other leaking storage tank listings
- Over 700 wells

The San Antonio River in the project area has the potential to disturb soils and receive discharge from surrounding sites. It was determined that the sites identified would not impact the proposed project. Although underground wells are not classified as HTRW, they play an important role in the existing conditions in the River Road study area. Consideration has been given to the disturbance of sediments and soils that may cause an unintentional release. Refer to the HTRW appendix for a map of HTRW sites and well locations in the study area vicinity.

3.7.4 Cost

The Recommended Plan (River Road Scale 3B + Avenue A Scale 2A + Instream Modification Scale 1A) incorporates all the habitat benefits and measures described in Plans 1-5 (Section 3.5). This plan creates 8.7 AAHUs over the No Action Plan.

The economic cost summary is presented in **Table 16**. The table displays, project first cost (including costs for recreation features), interest during construction based on a 12-month construction period, and total average annual equivalent (AAEQ) costs. AAEQ OMRR&R is annualized over the 50-year period of analysis and includes estimated maintenance of plantings for years 1 through 10 and in-stream structures for years 1 through 3.

Table 17 displays the Federal and NFS cost breakdown for the Recommended Plan using the fully funded cost.

Table 16: Economic Cost Summary

Project First Cost	**$6,442,000**
Fish & Wildlife and Floodway/Diversion Structures	**$2,416,000**
Relocations	**$1,723,000**
Recreation Construction	**$328,000**
Lands & Damages	**$198,000**
Planning, Engineering & Design	**$1,264,000**
Construction Management	**$513,000**
Interest During Construction	**$53,300**
Total Investment	**$6,495,300**
AAEQ Total Investment	**$229,000**
AAEQ OMRR&R*	**$12,300**
Total AAEQ Cost	**$241,300**
FY 2021 Price Level and 2.5% discount rate; OMRR&R annualized over 50 year period of analysis using 2.5% discount rate; IDC is based on a construction period of 8 months and does not include adaptive management	

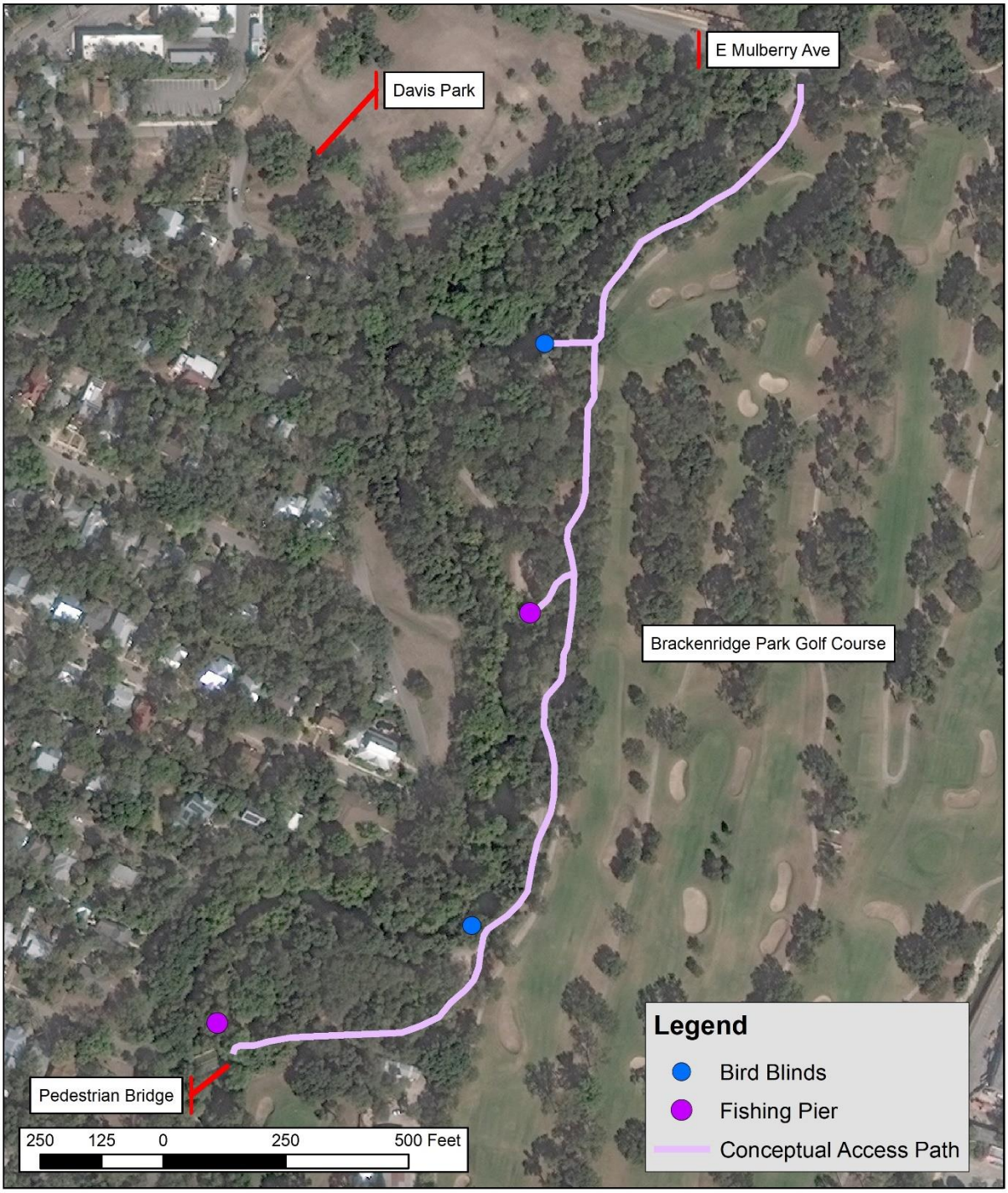
Table 17: River Road Implementation Cost Share Breakdown (FY21 Price Levels)

Feature	Non-Federal Cost	Federal Cost	Total Cost
Demo LWC	$114,450	$212,550	$327,000
Complete Removal of Avenue A	$117,250	$217,750	$335,000
Widen Golf Course Path	$15,750	$29,250	$45,000
Recreation Facilities (50/50 cost share)	$164,000	$164,000	$328,000
Instream Structure	$325,500	$604,500	$930,000
Roads, Railroads, & Bridges	$603,050	$1,119,950	$1,723,000
Boulder Barrier	$63,700	$118,300	$182,000
Planting	$208,250	$386,750	$595,000
Lands and Damages	$198,000		$198,000
Planning, Engineering, and Design	$427,000	$793,100	$1,220,000
Construction Management	$168,000	$313,000	$481,000
Total	**$2,432,250**	**$4,008,750**	**$6,442,000**
Cash	$2,234,250		
35% Maximum NFS Contribution	2,234,250	4,008,750	

3.7.5 Recreation

There is an opportunity to incorporate recreation alongside the River Road ecosystem restoration project. The project area is located within San Antonio's Brackenridge Park. The park provides opportunity for walking/jogging, picnicking, and fishing, including within the project area. The purpose of these recreation features is to allow the public to continue to access the area while preserving the ecosystem recreation features. The additions to the existing recreation are compatible with the ecosystem restoration project and would enhance the experience for visitors of Brackenridge Park by providing ease of access to the ecosystem restoration areas and additional wildlife viewing opportunities. The proposed recreation features are described below and shown in **Figure 19**, and the costs of these features are summarized in **Table 18**. Note that the asphalt path will likely be upgraded to a concrete path by the City of San Antonio.

- **Access Path** – A 2,450' by 8' Americans with Disabilities Act compliant asphalt path would be constructed along the original path of Avenue A if it were to be partially or completely removed. Currently, LWC 1 and Avenue A provide public access to both sides of the channel. Removal of Avenue A or LWC 1 would result in a loss of public access to the river. The Access Path would mitigate for this loss as an additional measure to an alternative that partially or fully removes Avenue A.
- **Fishing Access** – This measure would include the installation of recreational fishing piers along the perimeter of the San Antonio River.
- **Signage** – Installation of signage to include restoration information, recreation information, and general rules and regulations.
- **Trash Cans** – Installation of single or clustered trash cans to focus litter disposal within a specified area.
- **Bird Blinds** - This measure would include the installation of bird blinds in the public access areas of the project



Recreation Features

The U.S. Army Corps of Engineers provides this spatial data as a representation of the various geographic information gathered from multiple sources. This data should be viewed only as a representation of the provided information and should not be used for any other purpose. No guarantee is made by the U.S. Army Corps of Engineers regarding the accuracy or completeness of the data or their suitability for a particular use.

US Army Corps of Engineers® Fort Worth District

Figure 19: Recreation Features

The justification for federal participation in project recreational features as is defined in Policy Guidance Letter No.59, Recreation Development at Ecosystem Restoration Projects. The formulation of recreational feature was conducted within the following framework:

- are totally ancillary (i.e., project was not formulated solely for recreation)
- take advantage of the project's recreation potential
- are not vendible
- could not stand alone, without losing any of its utility or value, in absence of the project

The cost of recreational features would be shared equally, up to 10% of the total federal restoration project costs, between the Federal Government and the NFS. The costs of the recreational features considered are summarized in **Table 18**.

Table 18: Recreation Feature Costs

Proposed Recreation Features and Costs (FY2021 Price Level)	
Recreation Facilities including: • ADA Compliant Asphalt Path (2,450 LF) • Misc Amenities • Bird Blinds	$328,000
PED & CM	$75,000
Total	$403,000

The National Economic Development (NED) benefit evaluation procedures contained in ER 1105-2-100 (22 Apr 2000), Appendix E, Section VII, include three methods of evaluating the beneficial and adverse NED effects of project recreation: travel costs method (TCM), contingent valuation method (CVM), and unit day value method. The UDV method was selected for estimating recreation benefits for River Road ecosystem restoration study. The UDV method was assessed for both the FWOP and FWP conditions. A detail description of the UDV evaluation method for the project is included in **Appendix B - Economics**.

To calculate the BCR for the recreation features, the recreation first cost, $403,340, was annualized over the 50-year period of analysis at the FY 2021 interest rate of 2.5%. The recreation BCR is presented in **Table 19** below.

Table 19: Recreation Benefit-Cost Ratio

Estimated First Cost (Recreation)	**$403,340**
Annual Interest Rate	2.5%
Period of Analysis (years)	50
Construction Period (months)	2
Annual Recreation Benefits	$134,550
Recreation AAEQ Cost	$14,250
Recreation BCR	9.44
Note: Based on FY 2021 price level and interest rate	

4 Cumulative Effects

Potentially, the most severe environmental degradation does not result from the direct effects of any particular action, but from the combination of effects of multiple, independent actions over time. As defined in the CFR, 40 CFR 1508.7 (CEQ Regulations), a cumulative effect is the "impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions." Some authorities contend that most environmental effects can be seen as cumulative because almost all systems have already been modified. Principles of cumulative effects analysis, as described in the CEQ guide Considering Cumulative Effects under NEPA, are:

- Cumulative effects are caused by the aggregate of past, present, and reasonably foreseeable future actions.
- Cumulative effects are the total effects, including both direct and indirect effects, on a given resource, ecosystem, and human community of all actions taken, no matter who (Federal, non-Federal, or private) has taken the actions.
- Cumulative effects need to be analyzed in terms of the specific resource, ecosystem, and human community being affected.
- It is not practical to analyze the cumulative effects of an action on the universe; the list of environmental effects must focus on those that are truly meaningful.
- Cumulative effects on a given resource, ecosystem, and human community are rarely aligned with political or administrative boundaries.
- Cumulative effects may result from the accumulation of similar effects or the synergistic interaction of different effects.
- Cumulative effects may last for many years beyond the life of the action that caused the effects.
- Each affected resource, ecosystem, and human community must be analyzed in terms of the capacity to accommodate additional effects, based on its own time and space parameters.

The Recommended Plan has the potential for cumulative effects (with past, present, and reasonably foreseeable future projects) on air quality, water resources, visual aesthetics, recreation, cultural resources, and biological resources such as: vegetation, wildlife, migratory birds, and invasive species. The cumulative effects assessment is limited to projects reasonably foreseeable through 2025 within the study areas for various resources described in Chapter 5. The geographical boundaries for cumulative effects analysis are limited to San Antonio city limits. There are various upcoming construction projects including the construction of new hospitals, parks, camps, and the expansion of US Highway 281. The most significant construction project will occur immediately north of the study area in Brackenridge Park in the next five to ten years. The focus of this project will be similar to the Recommended Plan; however, this project includes the restoration of historic structures, implementation of demonstration projects to kickoff ecological restoration and the possible construction of stormwater Best Management Practices (BMPs) to protect the San Antonio River and associated historical structures.

Air Quality

Bexar County has been designated as a Marginal Nonattainment area by the EPA for the 2015 Eight-Hour Ozone NAAQS on July 25, 2018 with an attainment deadline of September 24, 2021. Bexar County is in attainment for all other NAAQS pollutants. There will be minor adverse impacts from implementation of the Recommended Plan due to the use of heavy machinery; however, these impacts will be temporary. There should not be long-term or permanent impacts to air quality within the city of San Antonio, but USACE will remain cognizant of impacts within city limits due to the existing constraints of Bexar County's Marginal Nonattainment status.

Water Resources

Past impacts to River Road habitats are documented in Section 2.2.9, Water Resources. Riverine habitats in Texas have been lost due to demand for agriculture, water, and urbanization. The conservation of water resources in Bexar County continues to be a priority and initiatives by the City, SARA, SAWS, Bexar County, TPWD, and non-profit organizations such as the National Audubon Society are making progress in increasing the extent of restored and protected aquatic habitats, including riverine habitat. Although future restoration and conservation initiatives will undoubtedly continue, the City and Bexar County are one of the top ten growth centers in the U.S. As a result, urban pressures would continue to encroach on the county's suburban and rural aquatic ecosystems. Because of projected future population growth and subsequent urbanization, the sustainability and ecological viability of aquatic habitats for fish and wildlife as well as human uses, highlights one of the greatest ecological needs of the country.

Visual Aesthetics

Areas under construction or areas that are being considered for restoration activity are ecologically impoverished; however, some still perceive the area as aesthetically pleasing. Restoration activities that improve the heterogeneity and complexity of the natural environment would have beneficial impacts to the aesthetics of the River Road study area. Any impacts caused by the demolition of the low water crossings, removal of Avenue A, and removal of invasive species will have minor adverse impacts to aesthetics within the City of San Antonio but will be temporary.

The cumulative impacts to aesthetics of past, present, or reasonably foreseeable projects when considered with the impacts of the Recommended Plan would be moderately beneficial because of the restored native vegetation and removal of manmade structures.

Recreation

Recreation is a vital component to the sustainability of any urban restoration project. The study area has the potential for beneficial recreation features. Removal of Avenue A, the low water crossings, and non-native invasive species within the River Road study area will cause temporary impacts to birding opportunities within the immediate study area during construction. This would have minor adverse impacts to recreational resources within the area. However, the plethora of recreation opportunities within the City leads to negligible effects during this short timeframe.

The cumulative impacts to recreation after completion of construction to recreation of past, present, or reasonably foreseeable projects when considered with the impacts of the Recommended Plan would be moderately beneficial in the long-term.

Biological Resources including Vegetation, Wildlife, Migratory Birds, and Invasive Species

Fish and wildlife inhabiting the San Antonio River and the surrounding areas would have consisted of a diverse community of native invertebrate, fish, amphibian, reptile, mammal, and bird species. As the habitat within the study area degraded, wildlife species intolerant of such impacts such as the Texas tortoise, indigo snakes, bobcat, and black bear migrated out of the area over time and tolerant species such as raccoons, opossums, and great-tailed grackles now thrive. The aquatic habitat that supported a diverse community of amphibians and aquatic invertebrates disappeared, further reducing wildlife diversity in this area of the City. Finally, the introduction of non-native wildlife species such as feral cats, and vegetative species such as Johnsongrass, Bermudagrass, and giant cane that have reduced habitat values, placed increased demands on scarce wildlife resources, and resulted in the non-native species out-competing native species.

In the earlier discussion of direct impacts of the Recommended Plan, significant beneficial effects were recognized that improve habitat not only for migratory birds and other upper tier trophic species, but more importantly for lower trophic level organisms that support the more visible and mobile species.
As further discussed, these beneficial impacts are not limited to the River Road study area but expand further into the San Antonio River Basin. For migratory birds, the benefits of the proposed River Road habitats might be realized several thousand miles away after the successful breeding and fledging of young on the arctic tundra.

The Recommended Plan alone cannot ensure the continued survival and existence of migratory birds and other organisms depending on riverine and riparian resources in the southwest. However, the Recommended Plan can contribute to the cumulative conservation, preservation, and restoration efforts underway both locally, regionally, nationally, and internationally. Locally, previous and ongoing restoration efforts on the San Antonio River at Eagleland, Mission Reach, and Westside Creeks will improve migratory bird habitats in the City. Additional conservation efforts in the region, including the implementation of the Southern Edwards Plateau Habitat Conservation Plan, conservation easements initiated by non-governmental conservation organizations, and international initiatives such as the PIF and Joint Ventures, will continue to provide pieces of the migratory bird habitat puzzle that will ensure migratory birds have the resources to complete migration and successfully breed and fledge young.

The cumulative habitat incorporated into these migratory bird conservation efforts are predicated on the establishment of the lower trophic levels by ensuring that aquatic and riparian habitats properly function ecologically.

4.1 Indirect Effects

Indirect effects, as defined by the CEQ's regulations, are "caused by the proposed action and occur later in time or farther removed in distance but are still reasonably foreseeable. Indirect effects may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems" (40 CFR 1508.8). Indirect effects differ from direct impacts associated with the construction and operation of the proposed project and are caused by an action or actions that have an established relationship or connection to the proposed project. However, indirect effects can be linked to direct effects in a causal chain, which can be extended as indirect effects that produce further consequences.

As previously discussed, implementation of the Recommended Plan would directly result in a net beneficial impact to the River Road study area and the associated vegetation and wildlife. In addition, the proposed River Road ecosystem restoration measures would result in benefits that extend further outside the study area for several notable environmental resources. These benefits would increase over time as the riverine and riparian habitats develop and mature.

As discussed above, even though portions of the indirect effects study area are located outside the proposed project restoration limits, these areas would receive ecological benefits resulting from restoration activities.

The establishment of native plant species in the study area and the removal and control of nonnative, invasive species provides significant indirect benefits. The seed production of the vegetation in the study area can be transported downstream, during high water events, and deposited in the San Antonio River banks. Under the No Action Alternative, these seeds would generally be comprised of non-native invasive species resulting in the further spread of these species. With implementation of the Recommended Plan, the seed source would generally be comprised of native species adapted to the conditions of the surrounding landscape. The improved aquatic habitats of the San Antonio River would improve water quality downstream as the wetland vegetation would filter pollutants and sediments.

In addition to the cumulative effects of the project, habitat connectivity for wildlife and migratory birds will be improved throughout the San Antonio area. Past projects, as described in Section 1.5 Prior Reports and Existing Water Projects, have an indirect effect on the riverine and riparian habitat in the region. Native species plantings and non-native invasive species management for prior ecosystem restoration projects on the San Antonio River will accumulate and contribute to restored areas throughout San Antonio.

4.2 Irreversible and Irretrievable Commitment of Resources

NEPA 40 CFR 1502.16 requires that environmental analysis include identification of “any irreversible and irretrievable commitments of resources which would be involved in the Recommended Plan should it be implemented.” Irreversible and irretrievable resource commitments are related to the use of nonrenewable resources and the effects that the use of these resources have on future generations. Irreversible effects primarily result from use or destruction of a specific resource (e.g. energy and minerals) that cannot be replaced within a reasonable period. Irretrievable resource commitments involve the loss in value of an affected resource that cannot be restored because of the action (e.g. extinction of a threatened or endangered species or the disturbance of a cultural site).

The Recommended Plan would result in the direct and indirect commitment of resources. These would be related mainly to construction components. Energy typically associated with construction activities would be expended and irretrievably lost under the Recommended Plan. Fuels used during the construction and operation of dredging equipment, barges, placement equipment (e.g. bulldozers, backhoes, etc.) and support vehicles would constitute an irretrievable commitment of fuel resources. Capital and labor resources, as well as, stone material would also be considered an irretrievable and irreversible commitment of resources. The use of such resources would not adversely affect the availability of such resources for other projects both now and in the future.

For the Recommended Plan, most resource commitments are neither irreversible nor irretrievable. Benthic communities would be removed and lost along with sediment during demolition and placement operations. Benthic communities would also take several years to recover. Slow moving or non-motile fish, wildlife, invertebrates, and plant (aquatic and terrestrial) species would be entrained in the materials during demolition or smothered during placement of geologic materials for pool, riffle, run features. These losses would be irretrievable as well. However, most impacts to the species' population, as a whole would be insignificant. These impacts would only occur during construction.

No other impacts, such as water resources, existing land uses, or visual resources, have been identified which could result in irreversible or irretrievable commitments of resources which would preclude implementation of the Recommended Plan.

5 Expected Future With-Project Condition for the Recommended Plan

This section describes the likely future conditions in the study area over the 50-year period of analysis. Because this is an ecosystem restoration project, the FWP is assumed to provide habitat benefits to all areas. Habitat benefits will be gained by native riparian and aquatic plantings, invasive species management, and open flow of the riverine system.

Alternative impacts were assessed primarily through habitat surveys of existing conditions, alongside expected improvements or degradations projections developed by USACE, the NFS, and state and Federal resources agencies. Details of the habitat analysis and expected future conditions regarding AAHUs are described in detail in Appendix C2 – Habitat Modeling.

Under NEPA, the significance of project impacts is a function of context and intensity. For biological resources, context refers to the importance (ecological, commercial, scientific, recreational, etc.) or regulatory (i.e., legally protected) status of the resource, and intensity refers to the magnitude – scale and duration – of the impact. Both beneficial and adverse impacts are recognized; either can be significant. In the project area, the habitats of greatest importance are riverine and riparian habitat. Substantial long-term net changes in the acreage and/or value of these habitats would likely result in significant impacts.

Losses or gains of population and habitat for special status species may also be significant, depending on the magnitude of the impact relative to the population size and distribution of the species in the region.
Finally, an impact that led to new introductions or the expansion of invasive species in the study area would also be considered significant in terms of potential far-reaching effects on the ecosystem as a whole.

Direct vs. Indirect Impacts

The terms “effect” and “impact” are synonymous as used in this analysis. Both short- and long-term effects are relevant in considering the significance of an impact. Effects are also expressed in terms of duration. The duration of short-term impacts is considered to be one year or less. Long-term impacts are described as lasting beyond 1 year. They can potentially continue in perpetuity; in which case they would also be described as permanent. Effects may be beneficial or adverse and may apply to the full range of natural, aesthetic, historic, cultural, and economic resources of the project area and the surrounding area. Definitions and examples of direct and indirect impacts as used in this document are as follows:

- Direct Impact - A direct impact is one that would be caused directly by implementing one of the two plans and that would occur at the same time and place.

- Indirect Impact - An indirect impact is one that would be caused by implementing a plan that would occur later in time or farther removed in distance but would still be a reasonably foreseeable outcome of the action. Indirect impacts may include induced changes in the pattern of land use, population density, growth rate, air, water, and other natural resources and social systems.

Significance Criteria and Impact Characterization Scale

In accordance with CEQ regulations and implementation guidance, impacts are evaluated in terms of their significance. The term "significant," as defined in 40 CFR 1508.27, part of the CEQ regulations for implementing NEPA, requires consideration of both context and intensity. Context means that the significance of an action must be analyzed in several settings, such as society as a whole (human, national); the affected region; the affected interests; and the locality. Significance varies with the setting of the Proposed Action. For instance, in the case of a site-specific action, significance would usually depend on the effects on the locale rather than on the world as a whole.

Impacts are characterized by their relative magnitude. Significant adverse or beneficial impacts are the highest levels of impacts. Conversely, negligible adverse or negligible beneficial effects are the lowest level of impacts. In this document, nine descriptions are used to characterize the level of impacts. In order of degree of increasing impact, they are:

- Significant Adverse Impact
- Moderate Adverse Impact
- Minor Adverse Impact
- Negligible Adverse Impact
- No Measurable Impact
- Negligible Beneficial Impact
- Minor Beneficial Impact
- Moderate Beneficial Impact
- Significant Beneficial Impact

Intensity refers to the severity of impact with regard to the above ratings (minor through significant). Factors contributing to the evaluation of the intensity of an impact include, but are not limited to, the following:

- The balance of beneficial and adverse impacts, in a situation where an action has both;

- The degree to which the action affects public health or safety;

- The unique characteristics of the geographic area where the action is proposed, such as proximity to parklands, historic or cultural resources, wetlands, prime farmlands, wild and scenic rivers, and ecologically critical areas;

- The degree to which the effects on the quality of the human environment are likely to be controversial;

- The degree to which the effects of the action on the quality of the human environment are likely to be highly uncertain or involve unique or unknown risks;

- The degree to which the action might establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration;

- Whether the action is related to other actions with individually insignificant but cumulatively significant impacts. Significance exists if it is reasonable to anticipate a cumulatively significant impact on the environment. Significance cannot be avoided by terming an action "temporary" or by breaking it down into small component parts;

- The degree to which the action might adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the NRHP or might cause loss or destruction of significant scientific, cultural, or historic resources;

- The degree to which the action might adversely affect an endangered or threatened species or habitat that has been determined to be critical under the ESA; and;

- Whether the action threatens a violation of Federal, state, or local law or requirements imposed for the protection of the environment.

No Action Alternative Comparison

The No Action Alternative can be interchanged with the FWOP conditions for the NEPA analysis in this section. See Section 2 Existing Conditions and FWOP conditions for a full description of the expected impacts to the study area over a 50-year period without the implementation of a project.

5.1 Hydrology, Hydraulics, and Sedimentation

No Action Alternative

The previous discussion of the Future-Without Project would be applicable. Continued urbanization over the next 50 years could lead to decreases in native vegetation along the San Antonio River. The agreement between SAWS and SARA would ensure a minimum flow of 10 cubic feet per second would be maintained. The No Action alternative would not address streambank restoration.

Proposed Action

The proposed project would restore riparian vegetation. However simply placing vegetation along the streambank would cause the floodplain in and around the project area to rise. Therefore, the measure to replace three low water crossings with single span bridges through the project area was taken as the replacement of the low water crossings would lower the floodplain. The combination of these two measures would mostly counteract each other. Three bridges/roads exist upstream of the project area (Hildebrand Avenue, Brackenridge Way, and E. Mulberry Avenue). In the 100 year flood event, it is expected that the project will either have no change in the WSE, or a decrease in WSE. **Table 20** shows the change in WSE at each bridge/road. **Table 21** presents the channel velocities at the bridges/roadways. At E. Mulberry Avenue, there is a slight increase in channel velocity in the with-project condition. It is not expected that this would have a significant erosional impact on E. Mulberry Avenue.

Table 20: 100-Year Flood Change in WSE

Road/Bridge	100-Year Flood Elevation (ft)		
	Without Project	With Project	Change in Elevation
Hildebrand Avenue	678.76	678.76	0
Brackenridge Way	675.49	675.49	0
E. Mulberry Avenue	668.01	667.77	-0.24

Table 21: 100-Year Flood Change in Channel Velocities

Road/Bridge	100-Year Flood Channel Velocities (ft/s)		
	Without Project	With Project	Change in Velocity
Hildebrand Avenue	5.61	5.61	0
Brackenridge Way	3.81	3.81	0
E. Mulberry Avenue	4.07	4.22	0.15

The proposed project includes native species plantings in the study area. Channel velocities are expected to decrease in the native species planting locations. **Table 22** presents the 100-year flood channel velocities at project planting locations.

Table 22: 100-Year Flood Change in Plantings Velocities

Planting Stations	100-Year Flood Channel Velocities (ft/s)		
	Without Project	With Project	Change in Velocity
234969	11.68	10.15	-1.53
234909	8.98	8.14	-0.84
234783	5.27	5.21	-0.06
234730	6.98	5.86	-1.12
234691	7.73	6.5	-1.23
234635	7.16	6.1	-1.06
234577	5.61	4.81	-0.8

The proposed project does include a minimal increase in WSE in some areas. In order to maintain local regulations, the NFS is pursuing a variance to all slight rises in WSE due to the proposed project. The local floodplain administrator has been included as a stakeholder in the feasibility study and has advised that the City of San Antonio Unified Development Code provides a process for the project to be permitted with an increase in the water surface elevations provided the impacts do not occur on private property or endanger a roadway and if the appropriate Conditional Letter of Map Revision (CLOMR) be submitted to the community and FEMA. If a variance is not granted for the project, slight excavations would be needed to counteract the increases in WSE for the proposed project. Appendix A provides information on project options with an excavation that would reduce the WSE in the sensitivity analysis.

Although a risk exists that the variance will not be granted, current coordination with the local floodplain administrator has been positive since the project will not increase WSE on private property or endanger a roadway. An increase in cost would occur with the additional excavation to counteract the increase in WSE, however, the excavation would be minimal, and the team agrees that this is not a likely outcome.

Details are provided in the Appendix A which includes a detailed modeling description, an account of the sensitivity analysis and details pertaining to the replacement of the low water crossings and excavation.

The Proposed Action would not address urbanization or sedimentation.

5.2 Environmental Resources

5.2.1 Climate and Climate Change

No Action Alternative

The previous discussion of the FWOP over a 50-year period of analysis would be applicable. The No Action alternative would not address Climate and Climate Change; however, it is expected that temperatures will rise and conditions will become wetter.

Proposed Action

The proposed project would utilize site-specific native plant species that have evolved to cyclical drought patterns. Construction measures would utilize management and irrigation strategies to ensure the successful establishment of vegetation in the project area. The composition of the native vegetative community would be better adapted to weather extremes anticipated as the result of climate change. The effects of climate change on stream flows are similarly uncertain, but the NFS has a contract to maintain a flow of 10 cfs within the River Road reach of the San Antonio River. This level of water should maintain and ensure the survival of aquatic native plant species within the river, avoiding adverse impacts from climate change. The Recommended Plan will also incorporate the removal of Avenue A, reducing the amount of impervious surface in the study area. Impervious surfaces can increase the impacts from the "Urban Heat Island Effect," leading to increased temperatures. By removing some of the impervious surfaces and implementing 22 acres of native species plantings, it is assumed that the overall temperature of the study area would decrease, thereby, improving the effects of Climate and Climate Change.

Features that could be impacted by climate change are the native species plantings. The aquatic species planted will be dependent on a steady supply of water. Water should be in ready supply due to regular rainfall. However, in the case of drought the river will be supplemented with 10 cfs of reuse water contributed from SAWS. Because the river has a steady supply of water, there should not be an issue with the aquatic species receiving enough water. The riparian species planted may have a slight chance of being impacted by climate change. The species selected for project implementation will be site specific and more likely to survive along the San Antonio River in any condition.

There will be short-term minor adverse impacts from emissions due to the use of heavy machinery such as back hoes and bulldozers within the study area during construction. Increased emission of Greenhouse Gases can cause temperature increases, which in turn have an adverse impact on the study area. However, the adverse impacts caused by the Proposed Action will expire once the project has been completed (expected to be less than two years). Long-term minor beneficial impacts from the Proposed Action will occur through the restoration of approximately 22 acres of riparian and riverine habitat, contributing to the collective sequestration of carbon.

5.2.2 Geology, Topography, and Soils

No Action Alternative

Development is likely to continue to transform natural areas into pockets of residential developments and other urban and agriculture uses. These actions can have adverse impact on soils through placement of non-permeable surfaces like roads and concrete for buildings. Adverse impacts to geology and topography could occur from development as well but would be expected to occur less frequently and at lower intensity due to the existing adjacent residential areas and historical Brackenridge Park Golf Course.

Proposed Action

The removal of the low water crossings would have negligible to minor, long-term, beneficial impacts on topography, geology, and soils within the San Antonio area. The beneficial impacts come from the restoration of a more natural sediment and water regime in the San Antonio River. The lower water surface profile may cause temporary bank sloughing that would naturally stabilize and re-vegetate, further stabilizing river banks from future floods. However, the planting of approximately 22 acres of native riparian species will negate some of these effects and provide stabilization of soils from larger storm events or flooding. In addition to bank sloughing, there will be some temporary minor adverse impacts to soils as a result of bank sculpting. However, bank sculpting through the use of heavy equipment will be utilized to improve the success of native vegetation that is planted along the banks as well as improving future erosion and sedimentation conditions.

Erosion is a concern with shoreline stabilization due to woody invasive species and the effects of invasive species removal. The only invasive species that this may apply to is the non-native woody, riparian privet species. Other graminoid and/or herbaceous invasive species, including elephant ear and giant cane, do somewhat stabilize shorelines in various locations throughout the project area, but are scattered.

To ameliorate potential shoreline destabilization due to invasive species removal the following general methods will be employed:

- Clearing is to consist of hand-felling all non-native vegetation and removal within the clearing limits. Native species will be preserved.
- Trees, stumps, roots, brush, and other vegetation will be cut off flush with or slightly below the original ground surface.
- All non-natives will then be treated with the appropriate herbicide ratio mixed with water with the designed timeframe of cut, completely covering the cut-stump, especially the vascular cambium area.
- Clearing operations are to be conducted to prevent damage by falling trees and herbicide application to trees indicated to be preserved.
- Blasting trees and other large-scale mechanical removal will not be permitted
- Treated cut stumps or other below-ground vegetation will remain in the sediment at ground-level to decompose naturally as removal/grading will potential increase unnecessary erosive effects. Larger stumps away from the riparian area, such as chinaberry, can be ground.
- Treated vegetation will be monitored for a specified period to direct any additional

invasive species retreatments necessary

- All cleared areas will immediately receive temporary erosion control procedures including sowing seed appropriate for the season for temporary stabilization. Additionally, after prescribed retreatment period or immediately depending on time of year or environmental conditions, cleared areas will receive permanent native seeding turf by broadcast, drill-seeding, and/or hydroseeding. These areas will be protected by barricades and signage to minimize traffic.
- Cleared areas will also be planted immediately after invasive species treatment with containerized herbaceous and woody vegetation for additional habitat development as well as streambank and shoreline stabilization efforts.
- Utilize native plants with higher "root stability ratings" where appropriate (invasive clearings).

Additional shoreline stabilization methods to be considered for incorporation with native vegetation installation include:

I. Encourage "soft" or natural shoreline protection over "hard" structural methods
   a. Easier on the environment, imitate natural systems
   b. Saves a significant amount of money (short and long term)

II. Basic Principles of Shoreline Protection
   a. Imitate nature
      i. Native vegetation
   b. Keep slopes gentle
   c. Employ "soft armoring" whenever possible
      i. Live plants, logs, vegetative mats
      ii. Alternative to hard armoring
         1. Stone blocks, sheet-pile

III. Recommended Shoreline Protection Methods
   a. Soft approach
   b. Re-vegetation
   c. Live staking
      i. For slopes with high erosion – good in conjunction with other methods
      ii. Drive woody plant cuttings deep into substrate – sprouts roots and grows
   d. Live fascines (bundles)
      i. For slopes with light erosion
      ii. Similar to staking. Plant live stems and branches in trenches, cover with soil and vegetation
   e. Brush layering
      i. For badly eroded slopes
      ii. Plant cuttings inserted at an angle into holes dug into side of slope
   f. Brush matting
      i. For badly eroded slopes
      ii. Full layer or mat of live plant cuttings that will root and grow
   g. Erosion control matting
      i. For moderate slopes along roadways or waterways
      ii. Biodegradable mat planted with grass and covered with soil

There will be short-term, minor, adverse impacts on the soil conditions where Avenue A exists.

There will be scraping and grading of the area to remove the road and its base. Areas that road has been removed will be replaced with native soil and vegetated with native riparian species. This will cause long-term minor beneficial impacts within the study area. The Farmland Protection Policy Act is not applicable because the entire study area falls within San Antonio city limits and is therefore, exempt from the Act.

5.2.3 Land Use

No Action Alternative

It is expected that recreational use of the study area would continue. There are future plans by the City of San Antonio to improve recreation features within Brackenridge Park, which would increase the use of the study area. However, if impacts from existing land use is left unchecked the river will continue to degrade through increasing erosion, sedimentation, and invasive species.

Proposed Action

The removal of the low water crossings would have minor beneficial impacts on land use within the San Antonio River. Current users and uses of the river would continue into the future as mandated 10 cfs flows would allow recreation to continue. The removal of Avenue A on the eastern portion of the San Antonio River would change how the general public accesses the area but would not permanently restrict recreation. The ADA compliant access path beginning at E Mulberry Avenue and ending at Woodlawn Avenue will promote the healthy use of the project area by restricting vehicular access, but still allow pedestrian and biking access.

5.2.4 Air Quality

No Action Alternative

Air quality across the study area is not anticipated to change from the existing condition to the No Action Alternative. While urban sprawl within San Antonio will continue to contribute to adverse air quality, these impacts are expected to be limited by advances in construction methods and materials, more fuel-efficient cars, as well as local, state, and Federal air quality management measures.

Proposed Action

The demolition of the low water crossings and Avenue A and the building of pedestrian bridges, an ADA compliant path, instream structures, and associated restoration measures would have short-term, minor, adverse impacts on air quality for the River Road study area. The increase of construction activity would result in a temporary increase of air pollution in the immediate surrounding area as total construction time is expected to be less than two years. However, there will be a reduction of idling vehicles within the study area due to the removal of vehicular access along the eastern boundary of the San Antonio River. This will result in negligible beneficial impacts on air quality.

The planting of up to approximately 22 acres of riparian species and approximately 3 acres of aquatic vegetation along the San Antonio River would have minor long-term benefits to air quality as the trees would absorb atmospheric carbon.

The operation of heavy equipment, support vehicles, and other motorized machinery for construction would result in combustion of fossil fuels and the release of volatile organic compounds (VOCs), nitrogen oxides (NOx), carbon monoxide (CO), ozone (O_3), sulfur dioxide (SO_2), and particulates(PM_{10} and $PM_{2.5}$). Additionally, fugitive dust emitted to the atmosphere by heavy equipment and support vehicles moving across unpaved, non-vegetated roadways or staging areas, wind blowing dust from disturbed areas and storage piles into the atmosphere could create a haze over the project area and increase ambient concentrations of particulate matter. Fugitive dust emissions would be greatest during the initial site preparation activities and would vary from day to day depending on the construction phase, level of activity, and prevailing weather conditions. The quantity of uncontrolled fugitive dust emissions from a construction site is proportional to the area of land being worked and the level of construction activity. Emissions would be temporary in nature. The use of BMPs during construction would minimize these emissions, including the use of cleaner burning fuels and energy efficient equipment.

Air quality impacts from project implementation would be similar in scope but varying in scale and duration. In general, each area plan would have minor and temporary direct impacts to ambient air quality from construction activities. Air emissions would be mobile in nature, temporary, and localized to the restoration unit(s) being worked at that time. Implementation of the following BMPs would further reduce air quality impacts and should be incorporated when developing contract specifications:

Mobile Source Controls:

- The use of heavy machinery should be fitted with approved muffling devices that reduce emissions;
- Plan construction scheduling to minimize vehicle trips;
- Limit idling of heavy equipment;
- Maintain and tune engines per manufacturer's specifications to perform at EPA certification levels, prevent tampering, and conduct inspections to ensure these measures are followed; and
- Consider alternative fuel and energy sources (e.g. natural gas, electricity, etc.) when and where appropriate.

Fugitive Dust Source Controls:

- Stabilize open storage piles and disturbed areas by covering and / or applying water or chemical/organic dust palliative where appropriate at active and inactive sites; and
- Install wind fencing and phase grading operations where appropriate and operate water trucks for stabilization of surfaces under windy conditions.

The temporary increase of construction activity is not anticipated to impact San Antonio air quality attainment status.

5.2.5 Noise

No Action Alternative

The No Action Alternative does not involve any activities that would contribute to changes in

existing conditions; therefore, no short- or long-term, major, moderate, or minor, beneficial, or adverse impacts on noise within the San Antonio River.

Proposed Action

The removal of the low water crossings and Avenue A would have short-term, adverse impacts on noise within the area. Heavy equipment, including excavators and dump trucks would be used to remove and haul away material, which will increase noise. Long-term, there would be no change from the No Action Alternative in regard to construction noise. Construction will comply with Section 4(b) of the Noise Control Act of 1972 (42 USC §§ 4901-4918), which directs federal agencies to comply with applicable federal, state, and local noise requirements with respect to the control and abatement of environmental noise.

Noise levels created by construction equipment would vary greatly depending on factors such as the type of equipment, the specific model, the operation being performed, and the condition of the equipment. The equivalent sound level of the construction activity also depends on the fraction of time that equipment is operated over the period of time of the construction. Construction would occur during daylight hours, thus reducing the day-night average sound levels and the chances of causing annoyances. Construction would also be in accordance with migratory bird nesting periods. The use of BMPs such as keeping equipment in good operating condition, proper training, and providing appropriate health and safety equipment would minimize the potential noise impacts associated with the Proposed Action. Construction would be conducted in accordance with Chapter 21 of the San Antonio City Ordinances.

The instream features placed along the river will produce minor long-term beneficial effects within the study area. The features will imitate a “bubbling” sound while water runs through and over the rocks, gravel, and boulders utilizing for the structures. This noise will supplement other natural sounds, including the songs and call of birds and other wildlife. Restriction of vehicular access along the eastern boundary of the study area will result in a negligible benefit in noise due to the reduction of traveling vehicles and their mechanical equipment.

5.2.6 Transportation

No Action Alternative

River Road is susceptible to damage from floods, swift flows, and erosional forces due to its location within the floodplain. There is a possibility that River Road will sustain permanent adverse impacts with the No Action Alternative. The other roads mentioned in Chapter 2 are not expected to be impacted over a period of 50 years.

Proposed Action

The implementation of the proposed low water crossing removals would have minor, long-term, beneficial impacts on transportation within the pre-project floodplain of the San Antonio River. River Road would have a higher degree of protection from being damaged by flooding, as well as the erosion caused by the low water crossings due to significant pooling.

There would be minor, long-term adverse impacts to transportation due to the removal of Avenue A from the study area. However, this road does not lead to residential or commercial areas and is not a necessary feature for public use. The constraints mentioned earlier in this

document required that vehicular access to the Brackenridge Park Golf Course maintenance building be ensured, regardless of the alternatives implemented. Due to this constraint, the measure regarding the expansion of the golf cart path on the eastern boundary of the study area will be expanded to accommodate the fee property owner. Although this expansion will not be available for public use, as it is not for recreational purposes, it will assist in transportation features within the study area.

Under the Proposed Action, construction equipment and workers would travel along regionally significant arterials and surface streets within and surrounding the study area to arrive to the work sites along the San Antonio River. Project-related trips would include construction worker commuting trips and truck trips for the delivery of construction related equipment and materials. These trips may contribute incrementally to existing and projected future queues and delays on nearby roadways. However, the traffic increase would be temporary and, where possible, construction travel to the site would be scheduled to occur outside of the peak commuting hours. Therefore, the contribution to peak hour congestion is expected to be relatively minor.

As project-related trips along the roadways in the study area would be sporadic throughout the construction period and involve only an incremental increase to existing traffic volumes during off-peak hours, the Proposed Action would not significantly impact recreational access to the San Antonio River.

5.2.7 Light

No Action Alternative

The No Action Alternative does not involve any activities that would contribute to changes in existing conditions; therefore, no short- or long-term, major, moderate, or minor, beneficial, or adverse impacts on light within the San Antonio area are expected.

Proposed Action

There will be negligible beneficial impacts on light due to the Proposed Action. Restrictions on vehicular access to the eastern boundary of the project area will diminish the amount of people entering the area at night, thereby, reducing headlight use.

5.2.8 Water Resources

No Action Alternative

Under the No Action Alternative, the continued presence of the low water crossings would: impede river flow and maintain an unnatural lake environment upstream; reduce downstream continuous hydrology connectivity as LWC 1 is unpassable for aquatic organisms, and; would allow the temporary pooling of contaminants and/or nutrients upstream until flooding flushes the area. The excessive pooling caused by LWC 1 had led to increased levels of erosion, which reduce water quality within the study area. In addition to the excessive pooling, the river lacks an adequate riparian buffer which would protect it from warmed and polluted runoff. Areas of disproportionate sediment buildup may be more susceptible to flooding if not routinely maintained, which can affect nearby properties and roads.

Proposed Action

The change in landscape due to the Proposed Action will assist in water conservation in addition to water quality improvement. Native species can increase soil's capacity to store water and can conserve water resources more efficiently than non-native plants. Site-specific species will also be more sustainable and require less maintenance compared to non-native species in the long-term.

Surface Water and Wetlands

Once constructed and the low water crossings are removed the upstream portion of the river will have a lower water elevation, however, any loss of open water habitat resulting from the removal of the low water crossings will be accomplished to compensate a natural stream channel. The loss of open water resulting in excessive pooling is marginal considering the benefits that historic riverine instream structures will provide for aquatic wildlife.

Groundwater

The River Road study area is located outside of the Edwards, Edwards Balcones Fault Zone, and Carrizo Wilcox Aquifer Recharge Zones; therefore, no measurable impacts on groundwater are anticipated from the Proposed Plan.

Water Quality

Implementation of any of the Proposed Action would directly impact surface waters in the study area through construction activities associated with demolition of low water crossings and grading associated with preparation for the pedestrian bridges; the placement of instream structures; the grading and sculpting of the river bank; and the use of geolifts to stabilize planting materials. During the construction period, these impacts are expected to temporarily degrade water quality as a result of ground disturbing activities. Temporary increases in suspended debris may also occur as the instream structures are placed within the river and the bank is graded to improve slop. Erosion and sedimentation controls, such as silt fencing and sediment traps, the application of water sprays, and the prompt re-vegetation of disturbed areas would be required during construction to reduce and control siltation or erosion impacts. In addition, every construction project poses a potential contamination risk from petroleum or chemical spills. The contractor would be required to prepare and follow a site-specific Spill Prevention Plan during construction, which would include use of BMPs such as proper storage, handling, and emergency preparedness, reducing the risk of such contamination.

Impacts to surface waters following implementation of the Proposed Action would have major beneficial impacts on water quality. The restoration of approximately 22 acres of riparian habitat and 3 acres of aquatic habitat associated with the project increase the natural nutrient and pollutant filtering functions of the river and riparian zone. Although the scale of the benefits may be relatively small, the proposed plan would be compatible with other FWOP water quality treatment methods in an integrated water quality program in San Antonio. The conditions of the San Antonio River will be improved after removing all three of the low water crossings due to reduced sedimentation from improved erosion conditions. Reduced sedimentation will improve water temperatures, water clarity, and dissolved oxygen levels over time. The construction of instream structures will also contribute to the effect above, adding to natural oxygenation and providing habitat for aquatic wildlife. The features will assist with energy dissipation, reducing the effects of flooding and erosion along the riverbanks.

5.2.9 Visual Aesthetics

No Action Alternative

It is expected that urbanization will continue, further degrading the natural resources within the study area. Under the No Action Alternative, the low water crossings will continue to artificially alter the River Road reach of the San Antonio River. In addition to the unnatural setting of the river, Avenue A will continue to accommodate vehicular access, thereby increasing the effects of human disturbance. The No Action Alternative will have major adverse effects to the study area.

Proposed Action

Short-term impacts may occur where construction-related equipment, activities, and dust could be visible to observers. Impacts would be anticipated in the years in which construction is implemented. Plans that do not include construction of structures, would realize only temporary aesthetic degradation until the disturbed area blends in with the surrounding environment, at which time, it would be anticipated that the aesthetic value of the area would be improved over the existing condition.

Construction activities can introduce differing elements of form, line, color, and texture into the landscape through construction or placement of constructed features such as roads, structures, equipment, or manipulation of vegetation. Effects can also result when actions change scenic integrity or result in conditions that produce unattractive landscapes.

Impacts associated with the proposed plans regarding aesthetics include visibility of construction disturbances, constructed structures, and temporary roads. Vegetation clearing and/or placement of excavated material on upland sites before relocation would present an obvious contrast in color with the surrounding vegetation. There will be temporary minor adverse impacts to aesthetics as a result of bank sculpting and grading. This measure will leave some bare ground that will not be aesthetically pleasing. However, this impact will improve once construction has been completed. New vegetation will begin to flourish, reducing bare ground areas.

Temporary placement of staging areas, access roads and floating docks would be visually obvious until use of these is discontinued and the area naturally restores, or the structure is removed. Natural restoration would be expected to occur over a period of 1-5 years. Aesthetic degradation would decrease as the disturbed surface begins to blend in color, form, and texture. In general, restoration measures would have minor beneficial impacts to the aesthetic value of the area and pleasing to recreationists.

The removal of LWC 1 would have mixed adverse and beneficial impacts based on an individual's perception. The flat calm water immediately upstream of LWC 1, along with the bare riverbank provide a picturesque scene for some of the public. The removal of the low water crossings would have permanent, major, adverse impacts to this aesthetic value.

However, those who prefer natural landscapes sans anthropogenic influences would find the return of flowing river and riffle complexes a permanent, major, and beneficial impact on aesthetic value. The trade-off would likely result in minor, beneficial impacts on aesthetics in the area. The removal of monocultures through invasive species management and the planting of native aquatic and riparian species will bring about an attractive change that can

produce a variety of striking colors and variation. Bare ground reduction through plantings will also increase the aesthetic value of the study area, along with the conversion of Avenue A into a space filled with an assortment of native riparian species.

5.2.10 Recreation

No Action Alternative

Under the No Action Alternative, there will be improvements to other areas of Brackenridge Park conducted by the City of San Antonio. It is expected that these improvements will enhance the park for the general public, thereby increasing recreation opportunities throughout San Antonio.

Proposed Action

The removal of the low water crossings would have minor long-term beneficial impacts on recreation within the San Antonio area. An impact trade off would occur based on the user group. For those who prefer slow, calm waters the removal would adversely impact their fishing or other recreation experience. However, fishing piers will be installed for individuals that still wish to utilize the area for that purpose. For those who prefer recreating in and around free-flowing water, they would perceive the removal of the LWC 1 as a beneficial impact. With the low water crossings removed, both user groups can still recreate in the project area. Overall, a minor beneficial impact would be realized as the increased ease and safety across the river within the area would result from project implementation.

The removal of Avenue A would also have an impact trade off depending on the use group. Those that prefer to access the area via vehicle would be adversely impacted through the removal of the road. However, those that prefer a more natural setting with pedestrian access will perceive the removal and management of vegetation in the area as a beneficial impact.

The conversion of Davis Park from an open non-native invasive grassland into a riparian area will have moderate permanent adverse impacts on recreation within the northwestern portion of the study area. The features that are included in other parts of the project and the accessibility of Brackenridge Park will increase recreational use of the project area, thereby making these effects minor. There is an opportunity for environmental outreach within Davis Park as it is easily accessible from all boundaries. It is important to note that wood bollards currently border this area, so vehicle access will continue to be restricted. Signage will be placed to inform the public of the importance of the restoration efforts for wildlife and migratory birds. This information will be essential in mitigating the public's need for open-space recreation areas.

Continued pedestrian access throughout the study area is essential. As noted in Appendix C5 – National Environmental Policy Act Compliance and Public Review, the public has commented on the need to maintain access for everyone. Existing trails throughout Brackenridge Park will provide connectivity to the trails introduced by the project. By maintaining access throughout the study area, the project will provide a wider connection to other recreational opportunities in San Antonio.

Although the proposed plans may have a temporary adverse impact during construction by restricting pedestrian access to active construction sites, the overall recreation experience

after construction would be improved as the improved habitat will support increased diversity and population sizes of birds and other wildlife. Any recreation features such as: fishing piers, trails, picnic areas, and bird blinds will encourage the recreational use of the River Road project areas. The enhancement of 22 acres of riparian habitat will attract migratory birds and the addition of bird blinds will attract additional birders to the area, increasing overall recreation use of the project area.

5.2.11 Vegetation

No Action Alternative

Under the No Action Alternative, there would be no direct impacts, but the vegetation would continue to be routinely driven over and maintained by the general public. The existing non-native invasive species would continue to provide a seed source for dispersal downstream, contributing to the spread of non-native invasive species and adversely impacting downstream restoration efforts.

Proposed Action

There will be some temporary minor adverse impacts to vegetation as a result of construction. It is expected that the equipment utilized for construction and general human disturbance will cause the loss of some native vegetation in the project area. Mortality of species will be avoided as best as possible.

As part of ecosystem restoration, all action alternatives include the reestablishment of site-specific, native plant species. The river and its banks would be planted with hydrophytic (water loving) vegetation making these areas highly productive environments for many species of fish, reptiles, amphibians, birds, and small mammals. There would be significant beneficial effects from planting approximately 22 acres of native riparian vegetation, and establishing hydrophilic vegetation in the wetter areas. Appropriate native vegetation would improve water quality by filtering out sediments and chemical constituents. Additionally, it would provide forage, cover, and organic inputs to the riverine ecosystem, developing the lower trophic levels utilized by fish and wildlife species. For each of the action alternatives, the proposed aquatic and woody vegetation would further increase the organic allochthonous material to the aquatic system and provide the energy to the lower level trophic organisms that drive and support the River Road ecosystem. Planting of appropriate vegetation within the study area would also provide connectivity of the aquatic and riparian habitats, more closely mimicking historical conditions.

The appropriate use of BMPs such as erosion control practices and tree protection devices at construction sites would protect existing trees and large blocks of vegetation/habitat adjacent to the construction areas. Temporary construction impacts to vegetation within staging areas are anticipated, since staging areas would be located on hardened surfaced (i.e. concreted) areas. Some non-native invasive species are acting in an erosion control capacity. Care should be taken to ensure the management of invasive species will not increase erosion or sedimentation impacts.

5.2.12 Wildlife

No Action Alternative

Under the No Action Alternative, the wildlife habitat conditions in the River Road study area would remain unchanged. Although, the adjacent habitats support a diverse ecosystem, including many warbler, vireo, and other neotropical migrant songbirds, the fragmented and heavily modified habitats associated with the study area significantly limit the diversity and populations of lower trophic level organisms in the river, thereby limiting diversity of the wildlife community.

Proposed Action

Where construction or disposal is proposed, there would be an increased level of human disturbance, such as noise, vehicular traffic, and construction equipment, which could lead to temporary localized displacement of affected existing fish and wildlife populations. Mortality of fish or wildlife individuals is possible during the construction phase, but would be rare, as most species would avoid the areas of disturbance.

There would be major long-term beneficial impacts on fish and wildlife populations from the implementation of the proposed alternatives through geographic expansion and improved quality of their respective habitats. By removing the existing low water crossings and restoring the San Antonio River to a more natural condition, native fish populations could repopulate areas that have not been favorable for their existence or survival. Water quality improvements (resulting from planting riparian and hydrophilic vegetation) would improve habitat conditions for intolerant native species, and would restore balance to the native tolerant/native intolerant aquatic species over time.

Increased connectivity within the river will provide better habitat conditions for native fish, such as channel catfish (*Ictalurus punctatus*), yellow bullhead (*Ameiurus natalis*), and largemouth bass (*Micropterus salmoides*) through increased aquatic plant diversity and improved habitat structure. Pool/riffle/run features acting in a more natural capacity assist ecosystem restoration in a variety of ways. Pools can protect smaller fish or provide shelter during dry conditions and also allow sediment and organic materials to settle within the streambed because the river moves more slowly. Riffles also assist in the protection of smaller species from predators while also acting as a unique food source. Riffles are a good source of habitat for caddisflies, stoneflies, and mayflies; indicator species for river health. Smaller fish, unable to adequately compete in pools, are more likely to utilize runs because of the quick moving water over shallower areas. Due to the complexity of pool/riffle/run features, each segment acts as its own micro habitat providing protection and forage for a variety of species.

The restoration of approximately 22 acres of riparian and 3 acres of aquatic vegetative structure would provide additional wildlife habitat (food, shelter, and reproductive resources) for small mammals, amphibians, reptiles, and birds. Inclusion of habitat structures, such as bird nesting and bat boxes will also have minor beneficial impacts on local wildlife. The restoration measures would also connect adjacent park areas and downstream habitats by reducing the existing fragmentation. The proposed study area, which is located in the Central Flyway for migratory waterfowl and Neotropical bird species, would increase the amount of scarce riparian habitat and water resources along this migratory bird corridor. The ability of these species to find adequate resources along their migration route ultimately determines their ability to arrive at their breeding grounds in a healthy condition to establish territories, find mates, reproduce, and fledge young. For birds breeding in the riparian zones of the southwest, the improvement of the habitat increases the breeding bird’s ability to successfully breed and fledge young.

5.2.13 Federally Listed Threatened and Endangered Species

No Action Alternative

The No Action Alternative does not involve any activities that would contribute to changes in existing conditions; therefore, there would not be any short- or long-term, major, moderate, or minor, beneficial, or adverse impacts on Federally threatened and endangered species within the River Road study area.

Proposed Action

The Proposed Action will restore approximately 22 acres of riparian habitat and 3 acres of riverine habitat. The restoration measures enacted will benefit aquatic and riparian habitat species through reduction of non-native invasive species and increased native species. Federally listed threatened and endangered species can be sensitive to human and outside disturbances. The removal of Avenue A will greatly reduce the influence of the general public on the San Antonio River and riparian zone by reducing erosion and improving sedimentation and water quality. The reduced surface area of an impervious surface will assist in reducing flood impacts that would likely cause scouring and damage to the stream bed. Improved water quality can increase the abundance and diversity of aquatic species. The removal of all three low water crossings will improve water quality through reduced erosion and sedimentation while also opening the stream bed for aquatic species to move freely within the study area. The pool/riffle/run features will be especially significant for the species Texas pimpleback (*Cyclonaias petrina*) and Texas fatmucket (*Lampsilis bracteata*). Mussels are an important indicator to stream health because they are unlikely to survive in deep and non-flowing water. They are able to filter pollution from water, as long as they are not overwhelmed, and are an effective food source for fish, birds, and other wildlife species.

The Proposed Action would cause minor beneficial impacts to threatened or endangered species within the study area. Although core habitat for the threatened and endangered species listed in **Appendix C1 – Environmental Resources** is not available within the study area, the Proposed Action has the potential to create the habitat conditions necessary for federally listed species. Should federally listed species change in the future, associated requirements will be reflected in construction efforts in coordination with the USFWS. The Proposed Action will not have “no effect” on Federally listed threatened and endangered species.

5.2.14 Migratory Birds

No Action Alternative

The No Action Alternative does not involve any activities that would contribute to changes in existing conditions; therefore, there would not be any short- or long-term, major, moderate, or minor, beneficial, or adverse impacts on migratory birds within the River Road study area.

Proposed Action

Many important habitats in the focused study area provide migratory bird shelter, nesting, feeding, and roosting habitat. Short-term, minor, and adverse impacts to migratory birds would

occur during construction and cease post-construction. Some long-term major impacts to migratory birds could occur through the beginning stages of invasive species management and the early stages of native riparian and aquatic species planting. Because a majority of the project area is either not vegetated or vegetated with invasive species, there will be a lack of site-specific vegetation until establishment can occur. However, it will be necessary to eradicate non-native invasive species early in project implementation to ensure establishment of healthy native vegetation. Significant beneficial impacts to migratory birds would be expected from ecosystem restoration measures. Restoration of riparian and riverine areas would result in an overall net increase in functional value and ultimately support larger populations of species and potentially increase species diversity. There will be major beneficial impacts to migratory birds as a result of the Recommended Plan. The project area will provide crucial stopover habitat for migratory birds during migration. By enhancing the quality and quantity of habitat within the Central Flyway, the Recommended Plan incorporates measures that ensure the success of migration by providing food and nourishment to sustain birds during their migration and will offer vegetation as a safe place to rest.

During construction, there is a potential for harm and/or harassment of nesting migratory birds. Attempts would be made to conduct all restoration activities outside of the nesting season; however, this may not be possible, due to the extended length of some species nesting periods. Prior to construction commencing, if during the nesting season, nest surveys conducted by biologists would be completed. Coordination with USFWS should be completed prior to construction if nests have been identified. USFWS guidelines should be followed to avoid adverse impacts to these species. By implementing these conservation measures, there should be no adverse effects to migratory birds.

Implementation of the Proposed Action would be in compliance with the Migratory Bird Treaty Act and EO 13186, Responsibility of Federal Agencies to Protect Migratory Birds.

5.2.15 Invasive Species

No Action Alternative

Under the No Action Alternative, the spread of invasive species will most likely occur without proper management and will cause significant adverse impacts to the study area. The marginal existing native vegetation will continue to provide habitat, but will not be as successful for improving wildlife diversity as compared to the Recommended Plan.

Proposed Action

EO 13112, Invasive Species, dated February 3, 1999, directs federal agencies to expand and coordinate their efforts to combat the introduction and spread of invasive species (i.e., noxious plants and animals not native to the U.S.). Implementation of BMPs such as cleaning equipment prior to entering restoration units and monitoring post construction for invasive species would prevent further spread of invasive species. Implementation of any of the action plans would be in compliance with EO 13112. A healthy ecosystem with plentiful species diversity will help deter the spread and establishment of invasive species.

As with any ground-disturbance activity, the probability of introducing, spreading, and/or establishing new populations of invasive, non-native species, particularly plant species, exists. Contractors would be required to clean all equipment prior to entering the construction area to

avoid the spread of invasive species into the project area.

Areas that are expected to have high rates of erosion, are susceptible to invasive species establishment, or where recruitment of a monoculture is anticipated, would be vegetated with native species. Post-construction and plantings, if needed, each restoration unit would be monitored for invasive species and action taken to prevent establishment of any species.

In addition, analyses have also documented shear stresses in some sections of the river that may not be exhibiting erosion at present but are candidates for erosion. In some of these areas, existing invasive species vegetation is helping to stabilize the bank. Careful consideration should be taken to balance the goals of reduced sedimentation through reduced erosion (bank stabilization), removal of invasive species, and habitat restoration.

5.3 Cultural Resources

No Action Alternative

Under the No Action Alternative, cultural resources would not be impacted by the USACE undertaking. Overall, no known significant impact to cultural resources under the No Action alternative would occur, aside from the natural formation processes that occur over time.

Proposed Action

Potential impacts to cultural resources at the River Road Aquatic Ecosystem Restoration Study site include disturbance of archeological material associated with the removal of the low water crossings, the removal of Avenue A, the installation of pool/riffle/run features, the mechanical management of invasive species, the installation/creation of habitat structures, as well as the construction and/or use of access routes, and the construction of any laydown areas. If it is determined that any of the low water crossings themselves are eligible for listing in the National Register of Historic Places, or are contributing elements of a National Register of Historic Places Historic District, removal of the structure(s) would constitute an adverse effect under Section 106 of the National Historic Preservation Act. Brackenridge Park itself is a listed Historic District in the National Register of Historic Places (NRHP), and there are several other Historic Districts surrounding the park. The park is also a State Archeological Antiquities Landmark under the Antiquities Code of Texas. Any impacts to an archeological site, historic structure, or historic resource must be evaluated in the context of the Historic District(s) as a whole, including changes to the viewshed(s).

There are four previously recorded terrestrial archeological sites, and three historic resources (three low-water crossings), within the study area. The San Antonio River Authority developed a Scope of Work to conduct cultural resources investigations at the Area of Potential Effect. The State Historic Preservation Office (SHPO) concurred with this scope, which details the various methods that will be utilized to further delineate the known cultural resources and for documenting any new cultural resources. A programmatic agreement (PA) has been drafted and submitted to all interested parties, including the State Historic Preservation Office and the appropriate Native American Tribes, for review. When completing the Section 106 process prior to making a final decision on a particular undertaking may not be practical, the regulations allow an agency to pursue a "project PA" [36 CFR § 800.14(b)(3)], rather than a memorandum of agreement under certain circumstances. The most common situation where a project PA may be appropriate is when the agency cannot fully determine how a particular undertaking may affect historic

properties or the location of historic properties and their significance and character prior to approving a project.

5.4 Environmental Engineering

No Action Alternative

There will be no changes under the No Action Alternative for Environmental Engineering or HTRW from the FWOP conditions. It is expected that the use of petroleum, chemicals, and other hazardous materials will continue in the project vicinity, thought it can be expected to be remediated over time.

Proposed Action

To minimize potential impacts from hazardous and regulated materials during construction, all fuels, waste oils, and solvents would be collected and stored in tanks or drums within a secondary containment system that consists of an impervious floor and bermed sidewalls capable of containing the volume of the largest container stored therein.

The refueling of machinery would be done following accepted guidelines, and all vehicles would have drip pans, when not in use, to contain minor spills and drips. Although it would be unlikely for a major spill to occur, any spill of five gallons or more would be contained immediately within an earthen dike, and the application of an absorbent (e.g., granular, pillow, sock, etc.) would be used to absorb and contain the spill. Any major spill of a hazardous or regulated substance would be reported immediately to SARA and USACE environmental personnel who would notify appropriate Federal and State agencies.

Additionally, all construction personnel would be briefed as to the correct procedures for preventing and responding to a spill. All waste oil and solvents would be recycled if practicable. All non-recyclable hazardous and regulated wastes would be collected, characterized, labeled, stored, transported, and disposed of in accordance with all Federal, State, and local regulations, including proper waste manifesting procedures. A Spill Prevention Plan would be in place prior to the start of construction, and all personnel shall be briefed on the implementation and responsibilities of this plan. Adoption and full implementation of the construction measures described above would reduce adverse hazardous/regulated substances impacts to insignificant levels.

5.5 Socioeconomic and Environmental Justice

No Action Alternative

Under the No Action Alternative, no changes would be made to the socioeconomic environment of the River Road neighborhoods.

Proposed Action

One of the constraints of the study is the need to maintain water surface elevations, so that there would be no increase in adverse flood risk to neighboring populations. An ancillary benefit of the ecosystem restoration of the Proposed Action is the reestablishment of vegetation that has been

aesthetically and physically divided from Avenue A. With recreation also being considered, benefits would not only accrue to the local neighborhoods, but to the city as a whole.

Given these expectations, no economic justice concerns are anticipated and the proposed project would be consistent with EO 12898 (see Environmental Compliance section of this Chapter). Since the project area is located near residential areas where children may be present, EO 13045 is considered in this EA (see Environmental Compliance section of this Chapter). The construction area would be flagged or otherwise fenced. Therefore, issues regarding Protection of Children are not anticipated.

6 Plan Implementation

6.1 Design and Construction Considerations

An abbreviated Cost Risk Analysis was completed on 04 May 2020. The risk analysis was based on the individual features of the alternatives and then modified for the Recommended Plan. It was broken down by the individual areas with a combined contingency of 15% for the construction pieces and 10% for the PED and 12% for Construction Management. Recreation features were not included at time of Risk Analysis but based on the content, utilizing the 15% average established for the other elements appears reasonable. A detailed account of the abbreviated Cost Risk Analysis can be found in **Appendix H**.

6.2 LERRD Considerations

River Road Aquatic Ecosystem Restoration Project focuses on increasing the diversity of habitat which will increase the diversity of wildlife including birds, amphibians, reptiles, and mammals benefiting from the restoration, improved stream connectivity, improved sediment distribution, decreased erosion impacts, improved water quality, and the ability of the project to address all of the problems associated with the study area. All of the project areas fall within lands owned by the City of San Antonio. The Non-Federal Sponsor, SARA, has coordinated with the City of San Antonio. The Assistant Manager of Park Planning with the City of San Antonio stated in email that they are committed to collaborating with the San Antonio River Authority for the purpose of restoring the San Antonio River in the River Road Reach of Brackenridge Park. City of San Antonio and SARA are exploring options, similar to what was executed for the Mission Reach project, such as transferring the property via donation utilizing deed without warranty. All of the project LERRD is within the 100-year floodplain. As such, all of the project areas are vacant, floodplain, open space properties. LERRD crediting will be applied for all project identified real estate needs.

Proposed project features include: Instream Modification (Scale 1A), Avenue A Modification (Scale 2A), and River Road Modification (Scale 3B). Table 24 quantifies the LERRD requirements of the proposed project. Instream modification (Scale 2A) includes the removal of all 3 LWC and the replacement with pedestrian bridges to allow for improved sediment transport, decreased erosion, and improved aquatic connectivity of the San Antonio River. A 50-foot riparian zone will be established on both banks of the river with native herbaceous, shrub, and tree species. The proposed project area for Instream Modification (Scale 1A) will enhance the aquatic ecosystem that encompasses 15.99 acres. The Avenue A Modification (Scale 2A) includes the removal of Avenue A road and the replacement with appropriate soils. The area and adjacent area will be planted with native riparian species, assisting in run off filtration, improving sedimentation through erosion, increasing shade, and providing a diverse habitat. The Avenue A Modification (Scale 2A) will enhance the aquatic ecosystem that encompasses 4.60 acres. The proposed project area for River Road Modification (Scale 3B) includes the planting of native vegetation and invasive species management within Davis Park, expanding the riparian zone 600 feet on the western bank of the river. The proposed project area for River Road Modification (Scale 3B) will enhance the aquatic ecosystem that encompasses 4.91 acres.

Table 23: Proposed Project LERRD Requirements

LANDS, EASEMENTS AND RIGHTS OF WAY REQUIRED RIVER ROAD ACQUATIC ECOSYSTEM RESTORATION PROJECT		
ESTATE	ACRES	TRACTS
INSTREAM MODIFICATION (Scale 1A)		
Fee	15.99	5
AVENUE A MODIFICATION (Scale 2A)		
Fee	4.60	2
RIVER ROAD MODIFICATION (Scale 3B)		
Fee	4.91	1
Grand Total	**25.50**	**8**

An informal consultation with the Office of Council was obtained concerning the classification of the bridge measure as a project cost, as opposed to a relocation/replacement cost. It was agreed upon by the team that the mitigation of public access, previously provided by the LWCs, would classify the bridge measure as a project cost.

6.3 Operations and Maintenance Considerations

The NFS, SARA, would ultimately be responsible for all Operations, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R). Prior to the final project completion, the USACE team will transfer responsibility of the functional elements of the project to SARA as they are completed. Per Implementation Guidance for Section 1161 of the WRDA 2016, Completion of Ecosystem Restoration Projects, “Ten years after ecological success has been determined pursuant to paragraph 7.c, the responsibility of a non-federal sponsor to conduct O&M activities on nonstructural and non-mechanical elements of an ecosystem restoration project (or component of a project) will cease. Operation, maintenance, repair, replacement, and rehabilitation of structural and mechanical elements of an ecosystem restoration project (or component of a project) will continue as outlined in the operations manual for the project.” A detailed description of the Monitoring and Adaptive Management Plan can be found in **Appendix - C4.**

The OMRR&R schedule for the features in the selected plan are displayed in Table 25, below. The non-structural O&M costs pertain to the plantings. These costs are required for years 1 through 10, and account for invasive species management (i.e., mowing, herbicide, and replanting).

Table 24: OMRR&R Costs

Year	Annual OMRR&R Cost		
	Non-Structural	**Structural**	**Total**
Years 1 - 3	$53,295	$10,000	$63,295
Years 4 - 5	$53,295	-	$53,295
Years 6 - 10	$15,045	-	$15,045

The structural OMRR&R costs include maintenance on the in-stream structures, which is projected to be necessary during the first three years following construction and is estimated to cost $10,000 annually. There are no other structural OMRR&R costs listed, but incidental maintenance (e.g., painting of bridges) may be required occasionally.

When annualized over the 50-year period of analysis using a discount rate of 2.5%, the average annual equivalent (AAEQ) OMRR&R cost is $12,337.

6.4 Institutional Requirements

6.4.1 The USACE Campaign Plan

The USACE has developed a campaign plan with a mission to "deliver vital engineering solutions, in collaboration with our partners, to secure our Nation, energize our economy, and reduce risk from disaster". This Campaign Plan shapes the USACE command priorities, focuses transformation initiatives, measures and guides progress, and helps the USACE adapt to the needs of the future by improving the current practices and decision-making processes of USACE. The USACE Campaign Plan is available at the following address: http://www.usace.army.mil/about/campaignplan.aspx. The goals and objectives outlined in the latest USACE Campaign Plan (FY18-22) include:

1. Support National Security
2. Deliver Integrated Water Resource Solutions
3. Reduce Disaster Risk
4. Prepare for Tomorrow

This project supports Goals 2 and 4 of the USACE Campaign Plan by addressing:

- Campaign Plan Goal 2: Deliver enduring and essential water resource solutions using effective transformation strategies
    - Objective 2c: Deliver quality solutions and services
    - Objective 2d: Deliver reliable, resilient, and sustainable infrastructure systems
- Campaign Plan Goal 4: Build resilient people, teams, systems, and processes to sustain a diverse culture of collaboration, innovation, and participation to shape and deliver strategic solutions
    - Objective 4b: Restore trust and understanding with customers, stakeholders, teammates, and the public through strategic engagement and communication

6.4.2 Environmental Operation Principles

In 2002 and again in 2012, the USACE formalized a set of Environmental Operating Principles (EOP) applicable to decision-making in all programs. The seven EOPs are:

- Foster sustainability as a way of life throughout the organization
- Proactively consider environmental consequences of all the USACE activities and act accordingly
- Create mutually supporting economic and environmentally sustainable solutions
- Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the USACE, which may affect human and natural environments
- Consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs
- Leverage scientific, economic, and social knowledge to understand the environmental context and effects of the USACE actions in a collaborative manner
- Employ an open, transparent process that respects the views of individuals and groups who are interested in the USACE activities

These principles are available at the following address: http://www.usace.army.mil/Missions/Environmental/Environmental-Operating-Principles/.

The principles are consistent with the NEPA, the Army Strategy for the Environment, other environmental statutes, and the WRDA of 2007. The EOPs are considered at all stages of the study process at the same level as economic issues. Environmental consequences, sustainability, risk management, and stakeholder involvement were integral parts of the study process.

7 Environmental Compliance

This EA has been prepared to satisfy the requirements of all applicable environmental laws and regulations and has been prepared in accordance with the CEQ's implementing regulations for NEPA, 40 CFR Parts 1500 – 1508, and the USACE ER 200-2-2, Environmental Quality: Procedures for Implementing NEPA.

7.1 Migratory Bird Treaty Act

The MBTA makes it illegal to take, possess, import, export, transport, sell, purchase, barter, or offer for sale, purchase, or barter, any migratory bird, or the parts, nests, or eggs of such a bird except under the terms of a valid Federal permit.

The Recommended Plan will enact measures that remove non-native invasive species, which can also include trees that may house migratory bird nests. However, clearing and/or control of vegetation will be conducted outside of bird migration periods. Any and all trees that have been found to contain migratory bird nests will be avoided and appropriate methods will be enacted to move forward with the study, such as implementing timing limitations based on the species affected or intensity of breeding activity, average nesting dates are May 15th to July 15th; inspect and clear an area for migratory bird nesting (should be performed by qualified personnel); and prioritize opportunities to habitat changes based on significant species needs.

7.2 Section 404 of the Clean Water Act

The USACE under direction of Congress regulates the discharge of dredged and fill material into all waters of the US, including wetlands. Although the USACE does not issue itself permits for construction activities that would affect waters of the U.S., the USACE must meet the legal requirement of the Act. A Clean Water Act Section 404(b)(1) analysis has been prepared for this study, as well as a TCEQ Water Quality Certification dated March 1, 2021 (first two pages of document); the Final documents are located **in Appendix C3 – Clean Water Act Section 404(b)1 Analysis**.

Although this is an aquatic ecosystem restoration project, there will be permanent and temporary impacts to the San Antonio River. However, the discharge of fill materials into the river will be limited to temporary impacts after the demolition of LWCs 1, 2, and 3 has been completed. The Section 404(b)(1) analysis will describe all impacts associated with the Recommended Plan, complying with the Clean Water Act.

7.3 Section 176(c) Clean Air Act

The General Conformity Rule (GCR) was promulgated by the EPA. The GCR rule mandates that the Federal government does not engage in, support, or provide financial assistance for licensing or permitting, or approving any activity not conforming to an approved State Implementation Plan. In Texas, the applicable plan is the Texas State Implementation Plan (SIP), an EPA-approved plan for the regulation and enforcement of the National Ambient Air Quality Standards (NAAQS) in each air quality region within the state. The General Conformity Rule is applicable only to non-attainment and maintenance areas as described in 40 CFR Part 93.153.

The proposed project site is located within the Bexar County. Bexar County has been designated as a Marginal Nonattainment area by the EPA for the 2015 Eight-Hour Ozone NAAQS on July 25, 2018 with an attainment deadline of September 24, 2021. Bexar County is in attainment for all other NAAQS pollutants. For federal projects in this area General Conformity Determinations are required for projects where indirect and or direct emissions exceed the de minimis threshold of 100 tons per year (tpy) of the Ozone precursors, either NOx or VOC.

The proposed project construction effort has been reviewed included the construction equipment types, size and hours running. Based on the size of the project and resulting construction effort emissions the project is expected to have direct emissions far below the de minimis threshold of 100 tpy (40 CFR Part 93.153(b)) and does not require a General Conformity Determination.

7.4 Executive Order 11312, Invasive Species

The Recommended Plan would comply with EO 13112 by restoring native aquatic and riparian vegetation species to the riverine system. The River Road study area is dominated by non-native invasive plant species. The measures included in the Recommended Plan would improve conditions for native plant species, while enacting mechanical and chemical controls for non-native invasive. Required operation and maintenance of the project area by the NFS after ecological success is determined will deter the influence of non-native invasive plants.

7.5 Executive Order 13751, Invasive Species

This order amends EO 13112 and directs actions to continue coordinated Federal prevention and control efforts related to invasive species. This order maintains the National Invasive Species Council (Council) and the Invasive Species Advisory Committee; expands the membership of the Council; clarifies the operations of the Council; incorporates considerations of human and environmental health, climate change, technological innovation, and other emerging priorities into Federal efforts to address invasive species; and strengthens coordinated, cost-efficient Federal action.

7.6 Executive Order 11990, Protection of Wetlands

The purpose of EO 11990 is to "minimize the destruction, loss or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands". To meet these objectives, the Order requires federal agencies, in planning their actions, to consider alternatives to wetland sites and limit potential damage if an activity affecting a wetland cannot be avoided.

The purpose of the River Road Aquatic Ecosystem Restoration Feasibility Study is to restore the aquatic ecosystem of the San Antonio River within the study area. The Recommended Plan will have beneficial impacts to wetlands through the restoration of the river with native species plantings, invasive species management, removal of low water crossings, and placement of instream structures for aquatic habitat. Any adverse impacts to wetlands will be temporary and mitigated as best as possible.

7.7 Executive Order 11988, Floodplain Management

EO 11988 was enacted May 24, 1977, in furtherance of the National Environment Policy Act of 1969, as amended (42 USC. 4321 et seq.), the National Flood Insurance Act of 1968, as amended (42 USC. 4001 et seq.), and the Flood Disaster Protection Act of 1973 (PL 93-234, 87 Star. 975). The purpose of the EO was to avoid to the extent possible the long- and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct or indirect support of floodplain development wherever there is a practicable alternative.

The order states that each agency shall provide and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by floodplains in carrying out its responsibilities for:

- Acquiring, managing, and disposing of Federal lands and facilities;
- Providing Federally undertaken, financed, or assisted construction and improvements; and
- Conducting Federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating, and licensing activities.

All alternatives were designed to ensure that the combination of all ecosystem restoration measures proposed would not result in a decrease in the floodplain capacity and an increase in flood risk to the study area. The Proposed Action is located in the floodplain due to its intent: aquatic ecosystem restoration. The aquatic ecosystem that has been evaluated is located within the floodplain, thus the goals of the project cannot be achieved without implementing the project within the floodplain. All of the practicable alternatives would have occurred within the base flood plain and would have been unavoidable regardless of the selected plan. The agencies and organizations involved with this project include: USFWS, TPWD, TCEQ, SARA, and the CoSA.

The Hydraulic modeling process was completed to demonstrate the impacts of the Atlas 14 1% ACE with various options. Although some of the options do show increases in water surface elevation, they are minimal and will not impact existing infrastructure, human safety, health, and welfare. In order to maintain local regulations, a variance may be required to allow the slight rise in water surface elevation due to the proposed action. The local floodplain administrator has been included as a stakeholder in the feasibility study and has advised that the City of San Antonio Unified Development Code provides a process for the project to be permitted with an increase in the water surface elevations provided the impacts do not occur on private property or endanger a roadway and the appropriate Conditional Letter of Map Revision be submitted to the community and FEMA.

The proposed action does not negatively impact the natural and beneficial values of the floodplain and will designed in a way to avoid potential harm to the floodplain through specific consideration of planting regimes. The Recommended Plan has the potential to reduce the hazard and risk associated with floods on existing infrastructure and minimize the impact of floods on human safety, health and welfare. The reduction and minimization of flood risk will occur as a result of the low water crossing removal included as part of the Recommended Plan as well as the reduction of Avenue A as an impervious surface. The low water crossings have acted as small-scale dams within the river while Avenue A has deflected appropriate water absorption leading to increased erosion and sedimentation. By removing these manmade features, the Recommended Plan will restore the natural and beneficial uses of the base flood plain.

The Recommended Plan would remain in compliance with EO 11988 by protecting the values of the River Road study area floodplains.

7.8 Executive Order 13186, Migratory Birds

The proposed ecosystem restoration would contribute directly to the USFWS Migratory Bird Program goals to protect, conserve, and restore migratory bird habitats to ensure long-term sustainability of all migratory bird populations through the ecosystem restoration measures described for the Recommended Plan.

7.9 Executive Order 12898, Environmental Justice

EO 12898 “Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations” dated February 11, 1994, requires all Federal agencies to identify and address disproportionately high and adverse effect of its programs, policies, and activities on minority and low-income populations. Data were compiled to assess the potential impacts to minority and low-income populations within the study area. Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Minorities account for a large portion of the local population and the low-income population is above the national and local averages, construction of the proposed alternatives would not have a disproportionately high or adverse impact on these populations. No environmental justice concerns are anticipated, and the Recommended Plan would be consistent with EO 12898.

7.10 Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks

EO 13045 “Protection of Children from Environmental Health Risks” dated April 21, 1997 requires Federal agencies to identify and address the potential to generate disproportionately high environmental health and safety risks to children. This EO was prompted by the recognition that children, still undergoing physiological growth and development, are more sensitive to adverse environmental health and safety risks than adults.

Numerous types of construction equipment such as backhoes, bulldozers, graders, and dump trucks, and other large construction equipment would be used throughout the duration of construction of the Recommended Plan. Because construction sites and equipment can be enticing to children, construction activity could create an increased safety risk. During construction, safety measures would be followed to protect the health and safety of residents as well as construction workers. Barriers and “No Trespassing” signs would be placed around construction sites to deter children from playing in these areas, and construction vehicles and equipment would be secured when not in use. Since the construction area would be flagged or otherwise fenced, issues regarding Protection of Children are not anticipated.

7.11 Endangered Species Act of 1973

Current lists of Federally listed threatened or endangered species were compiled for the River Road Feasibility Study. There will be no adverse impacts on Federally threatened or endangered species resulting from the Recommended Plan. However, continued long-term beneficial impacts, such as habitat enhancement, could occur because of the Recommended Plan. The

purpose of the assessment is to coordinate with the USFWS about the likelihood if impacting threatened and endangered species. A rating of "no effect" is assumed for the Recommended Plan and has been verified by the USFWS in a letter dated February 24, 2021 (**Appendix C1 – Environmental Resources in Attachment A**.).

7.12 Fish and Wildlife Coordination Act

In accordance with the Fish and Wildlife Coordination Act of 1934, as amended, from the initial stages of this study the USFWS and TPWD have been involved in the planning process. All agencies have had an opportunity to provide comments throughout the planning process. The USFWS and the TPWD biologists provided input on the model selection, participated in fieldwork, and participated in the habitat benefit projection meetings for the FWP and FWOP conditions. The USACE initiated public involvement and agency scoping meetings to solicit input on the River Road Feasibility Study process, as well as identify prospective measures, and identify significant issues related to the Recommended Plan. Information provided by the USFWS and the TPWD on fish and wildlife resources has been utilized in the development of the Recommended Plan.

A Final Fish and Wildlife Coordination Act Report and Concurrence Letter (dated February 24, 2021) has been prepared and signed and can be found in **Appendix C1 – Environmental Resources in Attachment A.**

7.13 Advisory Circular 150/5200-33A - Hazardous Wildlife Attractants on Near Airports

The advisory circular provides guidance on locating certain land uses having the potential to attract hazardous wildlife to or near public-use airports. The circular provides guidance on ecosystem restoration projects in and around airports and establishes notification procedures if reasonably foreseeable projects either attract or may attract wildlife.

In response to the Advisory Circular, the U.S. Army as well as other Federal agencies, signed a Memorandum of Agreement with the Federal Aviation Administration (FAA) to address aircraft-wildlife strikes. The MOA establishes procedures necessary to coordinate their missions to address existing and future environmental conditions contributing more effectively to aircraft-wildlife strikes throughout the US.

In accordance with the Advisory Circular, USACE has coordinated with the FAA to address potential hazardous wildlife attractants near airports within the CoSA with respect to the Recommended Plan. Appendix C5 – National Environmental Policy Act Compliance and Public Review includes the FAA's decision of "No Impact."

7.14 National Historic Preservation Act of 1966, as amended

Compliance with the NHPA of 1966, as amended, requires identification of all properties in the project area listed in, or eligible for listing in, the NRHP. All previous surveys and site salvages were coordinated with the Texas State Historic Preservation Office. Known sites are mapped and have been avoided. Areas that have not undergone cultural resources surveys or evaluations would need to do so prior to any earthmoving or other potentially adverse activities. Any sites

that are impacted through the proposed action will be mitigated. A Programmatic Agreement was signed by the SHPO on June 1, 2021 and can be found in **Appendix D – Cultural Resources**.

7.15 National Environmental Policy Act of 1969

The National Environmental Policy Act (NEPA) was signed into law on January 1, 1970. NEPA requires federal agencies to assess the environmental effects of their proposed actions prior to making decisions. Section 102 in Title I of the Act requires federal agencies to incorporate environmental considerations in their planning and decision-making through a systematic interdisciplinary approach. Specifically, all federal agencies are to prepare detailed statements assessing the environmental impact of and alternatives to major federal actions significantly affecting the environment.

Environmental information on the proposed action has been compiled and the IFR-EA has been prepared and coordinated for public, state, and Federal agency review. The Proposed Action is in compliance with NEPA through the analysis of environmental impacts proposed by USACE.

7.16 Additional Acts Considered

See below for all Acts that were considered, but not applicable to this study:

- Native American Graves Protection and Repatriation Act, 1990- Native American burial sites are not located within the study area
- Wild and Scenic Rivers Act, as amended – the San Antonio River is not included under this Act
- Magnuson Fisheries Conservation and Management Act – the project area is not located with a fishery.
- Coastal Zone Management Act 1972, as amended – the project area is not located within a coastal environment.
- Farmland Protection Policy Act – The project area is located within the city limits of San Antonio, TX and is therefore invalid.
- Archaeological and Historic Preservation Act 1974, as amended – superseded by the NHPA.
- Archaeological Resources Protection Act 1979, as amended – only applicable on Federal and Tribal lands.
- Rivers and Harbors Act, 1899 – not applicable because of the study area's proximity to the San Antonio River headwaters and its location within downtown San Antonio
- Marine Mammal Protection Act of 1972
- Estuary Protection Act of 1968
- Federal Water Project Recreation Act of 1965, as amended
- Fishery Conservation and Management Act of 1976
- Submerged Lands Act of 1953
- Coastal Barrier Resources Act and Coastal Barrier Improvement Act of 1990
- Resource Conservation and Recovery Act (RCRA), As Amended by the Hazardous and Solid

- Waste Amendments (HSWA) of 1984,
- Comprehensive Environmental Response Compensation and Liability Act (CERCLA), Toxic Substances Control Act (TSCA) of 1976
- Safe Drinking Water Act of 1974, As Amended, Marine Protection, Research and Sanctuaries Act
- Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646)
- Anadromous Fish Conservation Act
- Marine Protection, Research and Sanctuaries Act

8 Summary of Coordination, Public Views, and Comments

8.1 Participating and Cooperative Agencies

Copies of agency coordination letters are presented in Appendix C5 – National Environmental Policy Act and Public Review. Formal and informal coordination has been and will continue to be conducted with the following resource agencies:

- EPA
- FAA
- USFWS
- USDA NRCS
- TPWD
- TCEQ
- Texas SHPO

The TPWD, USFWS, NRCS, and TCEQ have been involved throughout the study process. These organizations participated in initial brainstorming and problem identification and provided comments throughout the River Road Feasibility Study process. The TPWD, USFWS, and the TCEQ also participated in the data collection, field surveys, and contributed in the projections of FWP and FWOP benefits.

8.2 Public Review

In accordance with 40 CFR §§1501.7, 1503, and 1506.6, the USACE initiated public involvement and agency scoping activities to solicit input on the River Road Aquatic Ecosystem Restoration Feasibility, as well as identify appropriate measures, and identify significant issues related to the project. The USACE began its public involvement process with a public scoping meeting to provide an avenue for public and agency stakeholders to ask questions and provide comments. This public scoping meeting was held on 13 August 2019 at the Lion's Field Adult and Senior Center, 2809 Broadway Street, San Antonio, TX 78209. The USACE, Fort Worth District, placed advertisements on the USACE webpage and social media prior to the public scoping meeting. A

second public meeting was held on 3 December 2019 at the Lion's Field Adult and Senior Center, 2809 Broadway Street, San Antonio, TX 78209. The USACE, Fort Worth District, placed advertisements on the USACE webpage and social media, as well as providing the public notice to email addresses provided during the first public meeting prior to the public meeting. A third public meeting was held on 19 November 2020 via webinar due to COVID-19 restrictions. The USACE, Fort Worth District, placed advertisements on the USACE webpage and social media, and provided a Notice of Availability to interested parties prior to the third public meeting occurrence. A summary of public comments and USACE responses can be found in Appendix C5 – National Environmental Policy Act Compliance and Public Review.

The public provided a variety of comments, with specific importance related to public access, flood risk, and use of environmentally sensitive methods. USACE has given special consideration to all applicable comments and concerns by the public, local, state, and federal organizations.

A vast majority of written comments opposed the removal of pedestrian access across the San Antonio River at East Woodlawn Avenue. However; the existing structure (LWC 1) is a significant factor in the degradation of the study area. The PDT formulated for pedestrian bridges to mitigate adverse impacts to recreation. Although the removal of the low water crossing may be controversial, it will effectively address components of the aquatic ecosystem restoration and will be mitigated through new infrastructure.

8.3 List of Preparers

Name	Technical Specialty
Andrew Johnston	Project Management
Zia Burns	Project Management
Zachary Rogers	Plan Formulation Lead
Natalie Garrett	Plan Formulation
Simeon Benson	Hydrology and Hydraulic Engineering
Jennifer Purcell	Economics
Justyss Watson	Environmental Resources
Daniel Allen	Environmental Resources
Christopher Davies	Cultural Resources
Ramanujachari Kannan	Geotechnical Engineering
Eugenia Barnes	HTRW
Anthony Mendolia	Real Estate
David Brown	Civil Engineering
Ninfa Taggart	Cost Engineering

9 Conclusions

The findings of this study indicate that there is a need for aquatic ecosystem restoration in the River Road segment of the San Antonio River. A failure to do so would result in a further degraded

aquatic ecosystem and riparian corridor adjacent to the channel banks. The recommended plan would restore help restore the river toward a more natural state while reducing the risk to the public infrastructure in the project area. This report with integrated EA discloses the potential environmental and cultural impacts associated with the proposed Continuing Authority Program Section 206 Aquatic Ecosystem Restoration project along the River Road segment of the San Antonio River in San Antonio, Texas.

The Recommended plan, Alternative Plan 6, would result in minimal temporary adverse impacts to the natural environmental. The project would incorporate the removal of low water crossings, the removal of invasive species, and the planting of native species to restore the degraded environmental conditions and improve water quality. It is the finding of this assessment that implementation of the recommended plan would not constitute a major Federal action requiring the preparation of an Environmental Impact Statement.

10 District Engineer's Recommendation

I recommend that the restoration plan as generally described in the FINAL Feasibility Report and Integrated Environmental Assessment, be implemented under the authority of Section 206 of the WRDA of 1996, Public Law 104-303, with such modifications as in the discretion of the appropriate authority may be deemed advisable. The total project first cost is currently estimated to be $6,442,000.

Prior to the commencement of construction, local interest must agree to meet the requirements of Local Sponsor responsibilities as outlined in this report and future legal documents. The San Antonio River Authority has demonstrated that they have the authority and financial capability to provide all Local Sponsor requirements for the implementation, operation, and maintenance of the project. The recommendations contained herein reflect the information available at the time and current Department of the Army policies governing formulation, evaluation and development of individual projects under the US Army Corps of Engineers Continuing Authorities Program.

Jonathan Stover

25 August 2021

DATE

Jonathan S. Stover, P.E., PMP
Colonel, U.S. Army
Commanding

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10 Quality Control

DISTRICT QUALITY CONTROL TEAM		
DQC TEAM MEMBER	DISCIPLINE	DISTRICT
Hollie Eljizi	CESWF-PEC	HTRW
Manus Chaiprasert	CESWF-EC-H	Hydraulics & Hydrology
Tracy Ng	CESWF-ECA-C	Cost Engineer
Seth Sampson	CESWF-PEE-T	Cultural Resources
Cody Bowden	CESWF-REI	Real Estate
Bob Singleton	CESWF-PEC-CI	Environmental
Christy Sorrels	CESWF-PEC-PE	Economics
Natalie Garrett	CESWF-PER-P	Plan Formulation

AGENCY TECHNICAL REVIEW TEAM		
ATR MEMBER	DISCIPLINE	DISTRICT
Angela Dunn	ATR Lead/Environmental & Cultural Resources	CESAJ-PD-E
Kevin Wittmann	Economics	CESAM-PD-D
Melissa Nasuti	Environmental Resources	CESAJ-PD-ES
Keith Duffy	H&H / Climate Preparedness and Resilience	CENWP-ENC-HY
Rachel Mesko	Planning	CEMVP-PD
Christine Moss	Civil Design	CEMVP-EC-D
Charles Rairdan	Real Estate	CESPD-PDR
Derek Nelson	Cost Engineering	CENWW-ECE

11 Acronyms and Abbreviations

~	Approximate or Approximately
°	Degree or Degrees
$	US Dollars
‘	Foot or Feet
>	Greater Than
≥	Greater Than or Equal To
“	Inch or Inches
<	Less Than
#	Number
AAHU	Average Annual Habitat Unit
AO	Administrative Order
AOI	Area of Interest
APE	Area of Potential Effect
ATR	Agency Technical Review
BCC	Birds of Conservation Concern
BMP	Best Management Practice
CE/ICA	Cost Effective–Incremental Cost Analysis
CEM	Conceptual Ecological Model
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cfs	Cubic Feet per Second
City	City of San Antonio, Texas
Cm	Centimeter
CN	Curve Number
CNM	Curve Number Method
CO	Carbon Monoxide
CO2	Carbon Dioxide
cy	Cubic Yards267
dbh	Diameter at Breast Height
DQC	District Quality Control Review
DO	Dissolved Oxygen
DoD	Department of Defense
EA	Environmental Assessment
EC	Engineering Circular
ECO-PCX	Ecosystem Restoration Planning Center of Expertise
e.g.	For example
EO	Executive Order
EOP	Environmental Operating Principle
EP	Engineering Pamphlet
EPA	Environmental Protection Agency
ER	Engineering Regulation
ERDC	Engineer Research and Development Center
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FPPA	Farmland Protection Policy Act
FWOP	Future Without-Project
FWP	Future With-Project

Gpm	Gallons per Minute
GRR	General Re-evaluation Report
HEC	Hydrologic Engineering Center
HEP	Habitat Evaluation Procedure
HMS	Hydrologic Modeling System
HsB	Houston Black Clay
HSI	Habitat Suitability Index
HTRW	Hazardous, Toxic, and Radioactive Waste
HU	Habitat Unit
HuB	Houston Black Gravelly Clay
IBI	Index of Biological Integrity
i.e.	Id Est or That Is
IFR-EA	Integrated Feasibility Report and Environmental Assessment
L	Liter
LRSI	Life Requisite Suitability Index
m	Meter
MBTA	Migratory Bird Treaty Act
Measures	Management Measures
PL	Public Law
n	Number of Observations or Measurements
NAAQS	National Ambient Air Quality Standards
NABCI	North American Bird Conservation Initiative
NAWCP	North American Waterbird Conservation Plan
NAWMP	North American Waterfowl Management Plan
NED	National Economic Development
NEPA	National Environmental Policy Act
NER	National Ecosystem Restoration
NO2	Nitrogen Dioxide
NOAA	National Oceanic and Atmospheric Administration
O3	Ozone
OMRR&R	Operation and Maintenance, Repair, Replacement and Rehabilitation
OSE	Other Social Effects
Pb	Lead
PIF	Partners in Flight
PL	Public Law
PM10	Particulate Matter Less Than 10 Microns
PM2.5	Particulate Matter Less Than 2.5 Microns
PMF	Probable Maximum Flood
QHEI	Qualitative Habitat Evaluation Index
RPEC	Regional Planning and Environmental Center
RR	Railroad Commission
s	Second
SACIP	San Antonio Channel Improvement Project269
SARA	San Antonio River Authority
SAWS	San Antonio Water System
SO2	Sulfur Dioxide
SPA	Albuquerque District
SPD	South Pacific Division
SPK	Sacramento District
SWF	Fort Worth District
SWT	Tulsa District

TCEQ	Texas Commission on Environmental Quality
TDS	Total Dissolved Solids
TPDES	Texas Pollutant Discharge Elimination System
TPWD	Texas Parks and Wildlife Department
TSP	Tentatively Selected Plan
TSS	Total Suspended Solids
TWDB	Texas Water Development Board
TWQB	Texas Water Quality Board
TY	Target Year
USC	US Code
UDC	Unified Developed Code
US	United States
USACE	US Army Corps of Engineers
USFWS	US Fish and Wildlife Service
WeC2	Floresville Fine Sandy Loam
WRDA	Water Resources Development Act
WSC	Westside Creeks
WWTP	Wastewater Treatment Plan