



APPENDIX E

Task 12: Flood Mitigation Evaluation Memorandums

Flood Management Evaluation Memorandum

TO: Lower Colorado-Lavaca Regional Flood Planning Group
Lower Colorado River Authority
P.O. Box 220
Austin, TX 78767

DATE: May 9, 2023

FROM: Mark Lewis, P.E., CFM
Halff Associates, Inc.
13620 Briarwick Drive, Suite 100
Austin, TX 78729

PROJECT: LCRA Contract No. 5809
Halff AVO 43796.001

SUBJECT: **FME ID: 101000027**
Project Sponsor: Bastrop County
Project Name: FM 812 at Little Alum Creek



Mark Lewis
May 9, 2023

On September 15, 2022, the Lower Colorado-Lavaca Regional Flood Planning Group (RFPG) approved the evaluation of this Flood Management Evaluation (FME) to identify, evaluate and recommend additional potentially feasible Flood Mitigation Projects (FMP).

Introduction

Bastrop County identified FM 812 crossing Little Alum Creek as high importance to increase the level of service and provide safe access to residential areas to use as their primary ingress and egress. To advance the project from an FME to an FMP additional work is required to meet the Texas Water Development Board (TWDB) FMP requirements. Items needed to advance the project to an FMP include updating the H&H analysis to incorporate Atlas 14 rainfall data, a no adverse impact evaluation, and updating the cost estimate. This memorandum provides an updated analysis for the FM 812 crossing Little Alum Creek and includes all required items to advance the project to an FMP.

Project Location and History

FM 812 is located in western Bastrop County between Red Rock, TX and State Highway 21 as shown in **Figure 1**. FM 812 is a major collector roadway. Little Alum Creek crosses FM 812 through 2 – 7' x 7' box culverts. The Walnut Creek Flood Protection Planning (FPP) study, dated March 2018, identified FM 812 crossing Little Alum Creek as a potential flood mitigation project. The proposed solution from the Walnut Creek FPP watershed study was to replace the existing culverts with a bridge and channel benching to lower water surface elevations and provide a higher level of service for the road.

Shortly after the Walnut Creek FPP watershed study was completed the TWDB advanced six (6) watershed studies through the Federal Emergency Management Agency's (FEMA's) Cooperating Technical Partner (CTP) Risk Mapping, Assessment, and Planning (Risk MAP) Project for Fiscal Year 2017 (FY17). The FY 17 CTP Risk MAP Project included all watersheds within the Lower Colorado-Cummins (LCC) watershed, of which the Walnut Creek watershed is included. This CTP Risk MAP Project was completed in April 2020 and will hereafter be referred as the LCC watershed study. The LCC watershed study updated the Walnut Creek FPP watershed study using NOAA

Atlas 14 rainfall data and 2017 LiDAR terrain data. The existing FM 812 crossing Little Alum Creek was updated in the LCC watershed study, but no flood mitigation project was proposed in the LCC watershed study. However, the LCC watershed study is considered the best available data and considered existing conditions for this analysis.

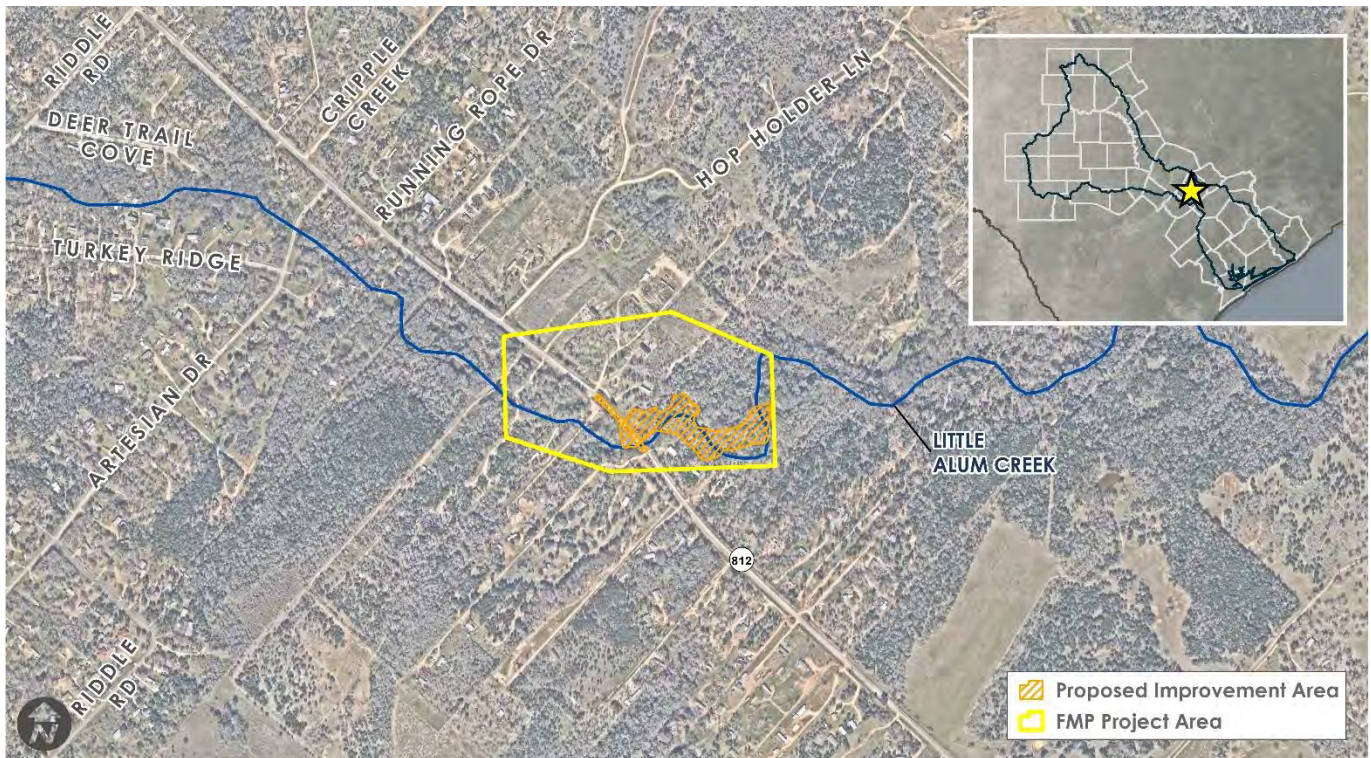


Figure 1: Study Area Location

Modeling Analysis

The following sections provide an overview of the data, hydrologic analysis, and hydraulic analysis used to identify the existing condition flood risk.

Data Collection and Site Visits

Half obtained and reviewed, or performed the following items:

- Bastrop County Flood Protection Planning Study for the Walnut Creek watershed dated March 2018
- TWDB CTP Flood Risk Project Mapping Activity Statement No. 14 for the Lower Colorado-Cummins Watershed dated April 2020
- Site visit on February 9, 2023
- Ground survey completed in February 2023
- Subsurface Utility Engineering (SUE) desktop analysis conducted in February 2023
- Environmental desktop analysis conducted in March 2023

The LCC watershed study was the foundation of this updated analysis. It used the following items for its analysis:

- Terrain Data: StratMap 2017 Central Texas LiDAR
- Soils Data: 2019 Natural Resource Conservation Service (NRCS) Web Soil Survey
- Land Use Data: 2011 National Land Cover Database
- Rainfall: NOAA Atlas 14

Hydrology

Below outlines the methodologies used for the hydrologic analysis:

- Modeling Software: HEC-HMS version 4.2
- Rainfall Data: NOAA Atlas 14, 24-hour duration, frequency storm temporal distribution
- Initial Losses: Initial and Constant loss method
- Hydrograph Approach: Snyder’s Unit Hydrograph method
- Routing: Modified Puls
- Areal Reduction: Depth-area computations using TP-40

Table 1 below provides peak flows of Little Alum Creek at FM 812 from both the Walnut Creek FPP watershed study and LCC watershed study. The change in peak flows between the 2 watershed studies is due to the change in rainfall data from USGS rainfall to Atlas 14 rainfall.

Table 1: Peak Flows Comparison

River Sta	Model	2-yr	10-yr	25-yr	50-yr	100-yr
27004	FPP	840	1770	2200	2500	2900
	LCC	1050	1790	2100	2400	2700
22725	FPP	920	2600	3200	3900	4600
	LCC	1150	2600	3200	3700	4300
16099	FPP	860	2600	3300	4000	4800
	LCC	1150	2600	3300	3800	4400
15955	FM 812					
13603	FPP	880	2700	3500	4200	5100
	LCC	1150	2700	3500	4000	4700
12790	FPP	930	2800	3600	4400	5300
	LCC	1150	2800	3600	4200	4900
9059	FPP	990	3000	3900	4800	5900
	LCC	1270	3100	4000	4700	5500
2426	FPP	1000	3000	4000	5000	6100
	LCC	1290	3200	4200	5000	5800

Hydraulics

Below outlines the methodologies used for the hydraulic analysis:

- Modeling Software: HEC-RAS version 5.0.3, 1D steady-state simulation
- Boundary Conditions: Downstream normal depth

Existing Condition Flood Risk

FEMA Floodplain

Little Alum Creek is a FEMA regulated stream with Zone A designated floodplain on the Flood Insurance Rate Map (FIRM) Map Number 48021C0325E, dated January 19, 2006. FEMA is currently in the process of updating the Flood Insurance Study (FIS) for Bastrop County, Texas and Incorporated Areas. The preliminary FIS study, Number 48021CV000C, will become effective May 9, 2023. The preliminary FEMA FIS for Little Alum Creek is based on the LCC watershed study.

Existing Conditions

The existing structure is 2 – 7' x 7' box culverts. Little Alum Creek is heavily wooded resulting in lower velocities and conveyance which cause higher water surface elevations. As a result, the crossing does not have a 5-year level of service. **Table 2** summarizes the existing roadway flood risk for FM 812. In addition to the road overtopping, there are three (3) residential structures located near FM 812 in the preliminary FEMA 100-year floodplain.

Figure 2 below shows the Little Alum Creek effective FEMA 100-year floodplain and the preliminary FEMA 100-year floodplain (effective May 9, 2023) at FM 812. Also seen in the figure are the residential structures within the preliminary FEMA 100-year floodplain.

Table 2: FM 812 Existing Flood Risk

Roadway	Existing Overtopping Depth (ft)						Level of Service
	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
FM 812	0.00	1.45	1.81	2.16	2.42	2.64	< 5-year

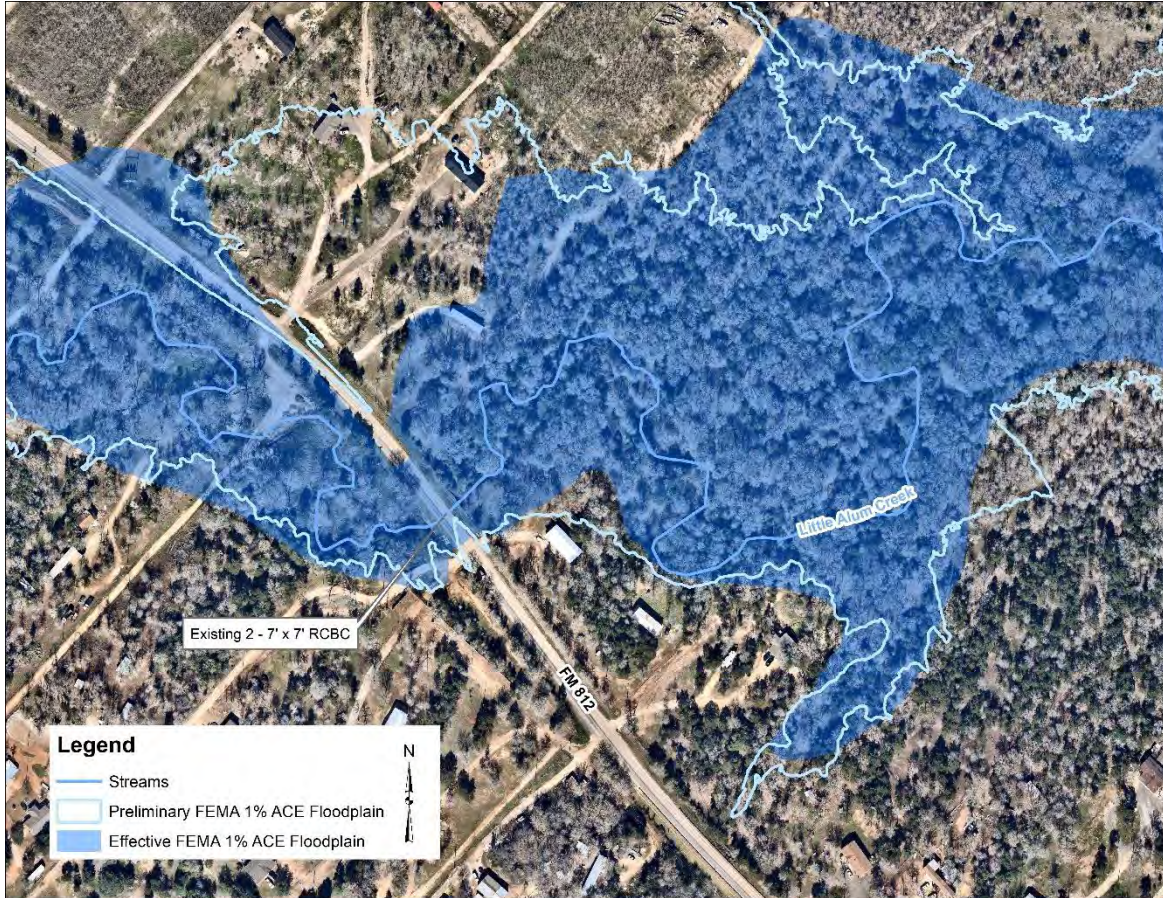


Figure 2: Existing Condition Flood Risk

Proposed Improvements

To provide a higher level of service, changes to FM 812 and Little Alum Creek are proposed. Proposed changes for FM 812 include raising the road approximately 2.4 feet and replacing the existing 2 – 7' x 7' box culverts with a bridge. The proposed bridge is a double span bridge with each span measuring 70' feet for a total bridge length of 140' feet.

Proposed changes for Little Alum Creek include benching into the channel banks approximately 1,930 feet downstream of the road, through the proposed bridge, and approximately 70 feet upstream of the road. An ordinary high-water mark was assumed approximately 2 feet above the channel thalweg because a Waters of the United States (WOTUS) delineation has not occurred yet. The bench section has a maximum cut of 300 feet and a minimum slope of 1%. To get back to existing grade, a 3:1 slope is proposed at the end of the bench cut. As a result of the channel benching there will be a larger flow area and the heavily wooded areas will be thinned resulting in lower water surface elevations downstream of the bridge to help offset losses through the bridge.

Figure 3 shows the proposed changes for FM 812 and the channel benching extents and **Figure 4** shows a cross section of the proposed bridge with the proposed channel benching. A summary fact sheet for the project is provided in **Attachment 1**.

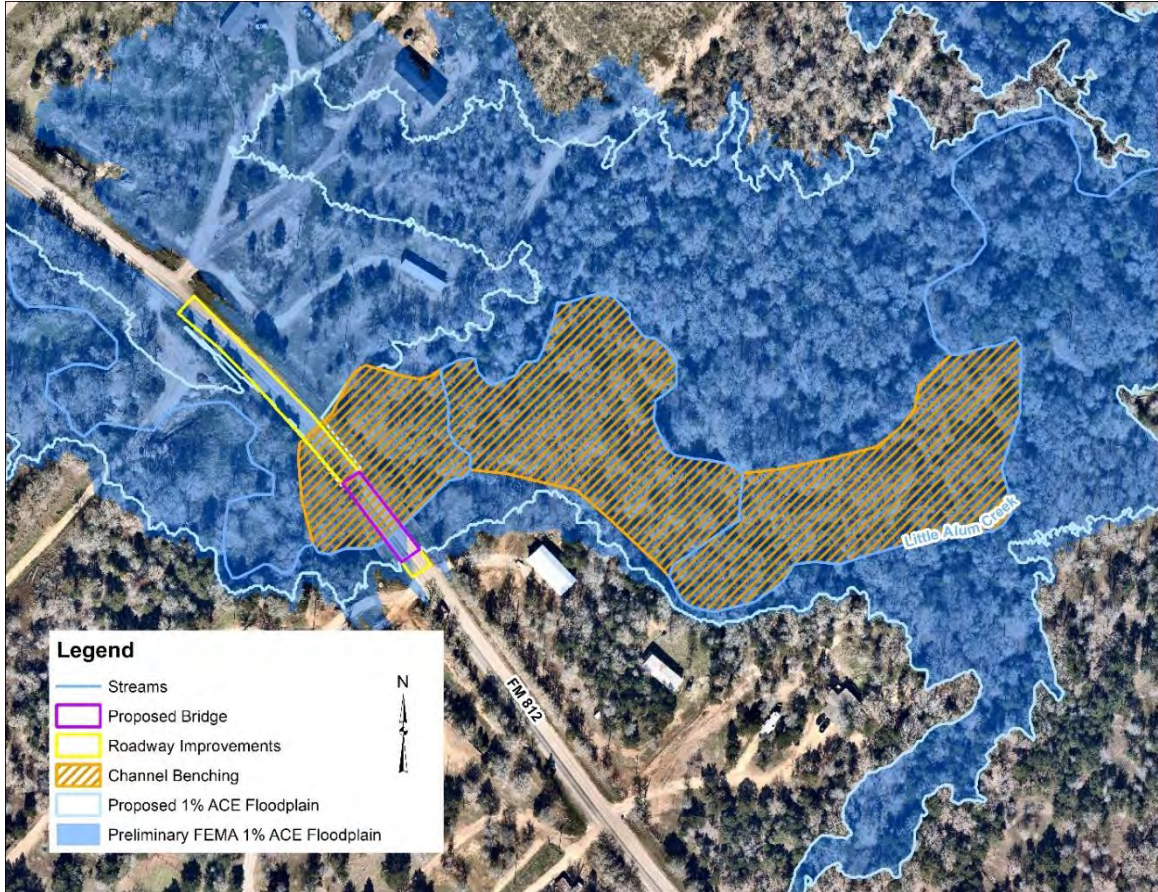


Figure 3: Proposed Improvements

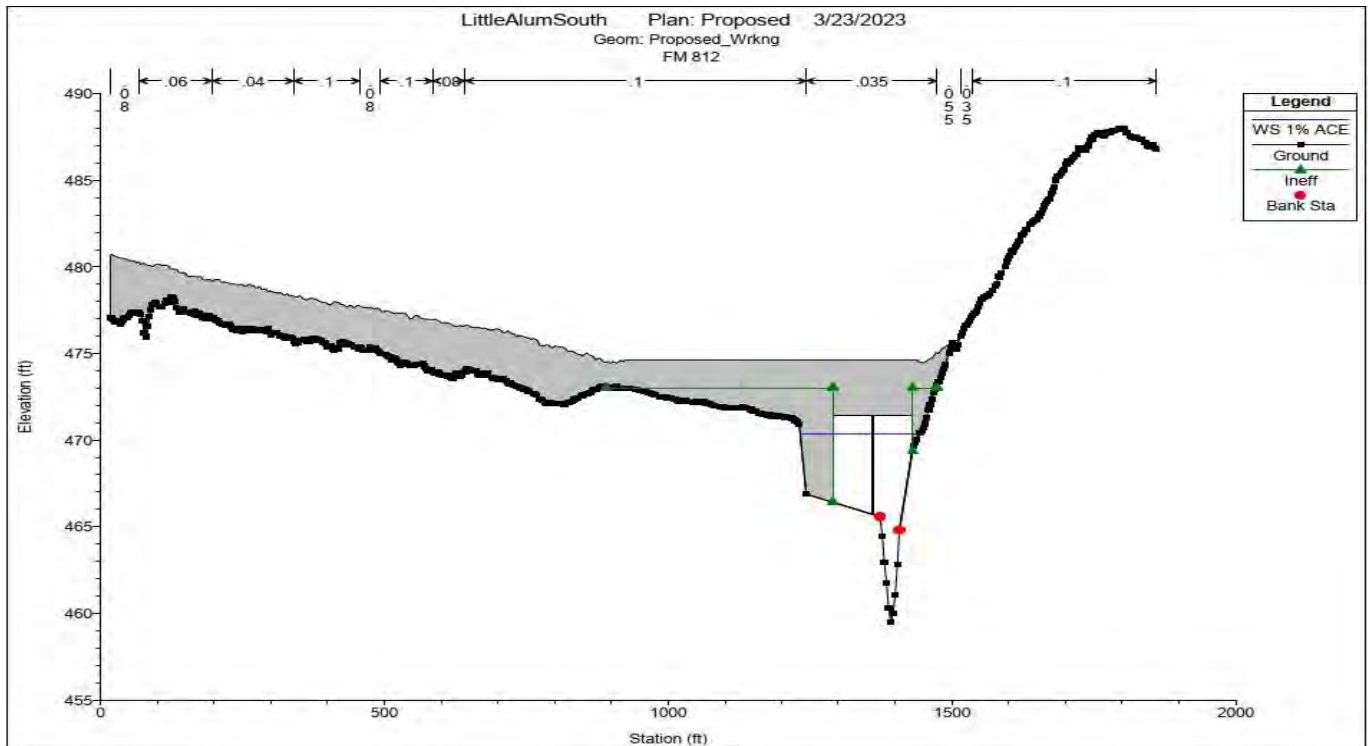


Figure 4: Bridge Cross Section

Project Benefits

FM 812 provides residents their primary ingress/egress. During large storm events the road is impassible for vehicle traffic. With the road impassible during large storm events residents are unable to move to safer locations and emergency vehicles must make detours, delaying response times for emergency needs. **Table 3** provides a water surface elevation (WSEL) comparison for existing and proposed conditions during the 100-year storm event. The proposed mitigation solution will reduce flood elevations at FM 812 and provide a 100-year level of service. Providing a higher level of service for the roadway will allow residents and emergency vehicles a safe travel route during large storm events. Additionally, the residential structures located within the preliminary FEMA 100-year floodplain near FM 812 are not in the proposed 100-year floodplain. **Table 4** provides a summary of the risk reduction benefits.

Table 3: Risk Reduction Benefits

Cross Section	Existing WSEL (ft)	Proposed WSEL (ft)	Δ WSEL (ft)
18047	478.20	478.20	0.00
17661	476.72	476.65	-0.07
17210	475.83	475.57	-0.26
16733	475.10	474.28	-0.82
16099	474.89	470.50	-4.39
15992	474.83	470.26	-4.57
15955	Bridge		
15928	471.40	468.93	-2.47
15853	471.49	469.10	-2.39
15815	471.36	469.06	-2.30
15660	471.13	469.08	-2.05
15503	470.99	468.79	-2.20
15377	470.90	468.94	-1.96
14661	470.31	468.70	-1.61
14463	468.72	468.58	-0.14
14375	469.20	468.67	-0.53
13603	468.31	468.31	0.00

Table 4: Risk Reduction Benefits

Flood Risk Condition	Number of At-Risk Buildings	Number of At-Risk Critical Facilities	Number of At-Risk Roadway Crossings (low water crossings)	Estimated At-Risk Daytime Population (based on building populations)	Impacted Agricultural Land (square miles of at-risk land cover)
Existing Condition 1% Annual Chance (100-year)	3	N/A	1	N/A	N/A
Post-Project Condition 1% Annual Chance (100-year)	0	N/A	0	N/A	N/A

Estimate of Probable Cost

An opinion of probable cost was prepared for the proposed project. The cost estimate includes construction and soft costs (engineering, permitting, O&M, etc.). Local and regional Texas Department of Transportation (TxDOT) average bid unit costs provided a basis for estimating unit costs for construction items. A percentage of the construction costs was applied for each soft cost item. A 30% contingency was applied to the project subtotal to account for uncertainties in the conceptual design development. The total project cost is estimated at \$8,288,617. The cost estimate is provided in **Attachment 1**.

Project Constraints

Potential constraints including environmental constraints, utility conflicts, and drainage easements for the proposed project were evaluated.

Environmental Constraints

A desktop level environmental constraints analysis was performed for the proposed project. The analysis included water resources, biological resources, and cultural resources assessments. A report was prepared discussing the findings of the analysis and is included as **Attachment 2**. Below summarizes the environmental constraints.

Water Resources

The proposed project is located within a regulated FEMA Zone A, 100-year floodplain. FEMA CLOMR and LOMR permits are required for changes to the channel or structures crossing the channel. In addition to coordinating with FEMA, coordination with the local floodplain administrator is required to comply with local floodplain ordinances.

The United States Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) and the United States Geological Survey (USGS) National Hydrology Dataset (NHD) show surface waters features within the study area including one freshwater forested/shrub wetland and one riverine feature (Little Alum Creek). A site survey by a qualified environmental scientist is required to delineate WOTUS and comply with US Army Corps of Engineers (USACE) permitting. USACE permitting procedures fall under Section 404 of the Clean Water Act (CWA). A site survey is required to determine impacts to WOTUS and if the project qualifies for a nationwide permit or if an individual 404 permit is required.

The Texas Commission on Environmental Quality (TCEQ) 2022 Texas Integrated Report of Surface Water Quality for Clean Water Sections 305(b) and 303(d) was also reviewed. Little Alum Creek is not identified as an impaired water body; therefore, no permit with TCEQ for impaired water bodies is required.

Biological Resources

The USFWS Information for Planning and Consultation (IPaC) report includes eleven (11) federally listed threatened or endangered species that should be considered in a Threatened and Endangered (T&E) species effects analysis. There were no USFWS designated critical habitats located within the study area.

The Texas Parks and Wildlife (TPWD) Rare, Threatened, and Endangered Species of Texas (RTEST) list for Bastrop County includes sixty-five (65) state listed species or species of greatest conservation need. A Texas Natural Diversity Database (TXNDD) search did not identify records of sightings of rare or endangered species within two (2) miles of the project area.

A biological resources on-site evaluation conducted by a qualified biologist is recommended to field verify any potential effects and impacts to federal or state protected species.

The proposed project is not located within any TPWDs Wildlife Management Areas (WMAs). Therefore, no further permitting is required for TPWD WMAs.

A review of the US Department of Agriculture (USDA) National Resource Conservation Services (NRCS) Web Soil Survey revealed the proposed project is not within prime farmland or farmland of statewide importance. Therefore, no further permitting is required with the USDA.

Cultural Resources

The project falls under purview of the Antiquities Code of Texas (ACT) (Title 9, Chapter 191 of the Texas Natural Resources Code) requiring the Texas Historical Commission (THC) to review actions that have the potential to impact archeological historic properties within the public domain. A review of the THC Atlas records indicated no archeological historic properties, National Register of Historic Places (NRHP) properties/districts, State Antiquities Landmarks (SALs), cemeteries, or Official Texas Historical Markers (OTHMs) within the vicinity of the proposed project. Additionally, there are no known cultural resource surveys previously done in the area and no archeological historic properties that have been documented within the vicinity of the proposed project. Although there are no known cultural resources near the proposed project, an ACT permit application and coordination with THC are required.

Utility Conflicts

A QL D level subsurface utility analysis was conducted to determine utilities in the project area. Only one utility, AT&T, was identified within the proposed project boundaries. AT&T shows a buried cable running along the FM 812 and downstream of the road. During the design process coordination with AT&T is required to determine if protecting or relocating the cable is required. Although no other utilities were discovered during this preliminary phase, during design confirmation of additional utilities is recommended.

Drainage Easement

To maintain the proposed channel benching, a drainage easement is required. A drainage easement will allow Bastrop County to perform needed maintenance to ensure the channel benching functions as designed. The easement should extend the entire limits of the benching. During design, more detailed extents of the easement

will need to be determined. A meets and bounds legal description and sketch of the easement should be prepared.

Texas Department of Transportation

FM 812 is identified as a major collector for Texas Department of Transportation (TxDOT) and considered an on-system road. Coordination with TxDOT is required for any changes to the roadway.

Benefit Cost Analysis

The TWDB Benefit Tool Kit was used to determine the Benefit Cost Analysis (BCA) for the FM 812 at Little Alum Creek project. Traffic counts were taken from the TxDOT TPP Statewide Annual Average Daily Traffic (AADT). To determine damages, the 10-, 25-, and 100-year storm events were used to estimate expected damages for residential structures and the roadway. Green infrastructure was also included to the benching areas for additional riparian areas within the project area. As the project advances, unknown data not included in this BCA can be obtained to refine the BCA. The known available data was entered into the TPWD Benefit Tool Kit to determine a preliminary benefit cost ratio of 0.5. See **Attachment 1** for the data inputs for the Benefit Cost Analysis (BCA).

No Negative Impact

In accordance with the *TWDB Technical Guidelines for Regional Flood Planning*, “No Negative Impact means that a project will not increase flood risk of surrounding properties. Using best available data, the increase in flood risk must be measured by the 1 percent annual chance event water surface elevation and peak discharge. It is recommended that no rise in water surface elevation or discharge should be permissible, and that the analysis extent must be vast enough to prove proposed project conditions are equal to or less than the existing conditions.”

The preliminary modeling confirms the following:

- Stormwater does not increase inundation in areas beyond the public right-of-way, project property, or easement.
- Stormwater does not increase inundation of storm drainage networks, channels, and roadways beyond design capacity.
- Maximum increase of 1D Water Surface Elevation rounds to 0.0 feet (< 0.05ft) measured along the hydraulic cross-section within the right-of-way.

This memorandum is prepared to serve as certification of no negative impact for the FM 812 at Little Alum Creek flood mitigation project. As the project is advanced, the impact analysis should be updated to reflect final design and confirm no negative impacts.

Recommendation

Based on the findings presented in this Technical Memorandum, it is recommended that Flood Management Evaluation No. 101000027 be reclassified as a Flood Mitigation Project. Bastrop County concurs with this recommendation and requests that it be considered by the Regional Flood Planning Group for inclusion in the amended Regional Flood Plan for the Lower Colorado-Lavaca Region.

Technical Memorandum Attachments

Attachment 1. Flood Mitigation Project

- FMP Summary Sheet
- Cost Estimate
- Benefit Cost Ratio

Attachment 2. Environmental Constraints Report

Attachment 1

Flood Mitigation Project

Flood Mitigation Project (FMP)

Title ID#
Sponsor (note if City or County) Commitment Yes No
Technical committee recommend Yes No RFPG recommend Yes No

REGION 10

Project Type

STRUCTURAL

Detention Channel modification Bridge/culvert Storm drain Levee/floodwall

Other

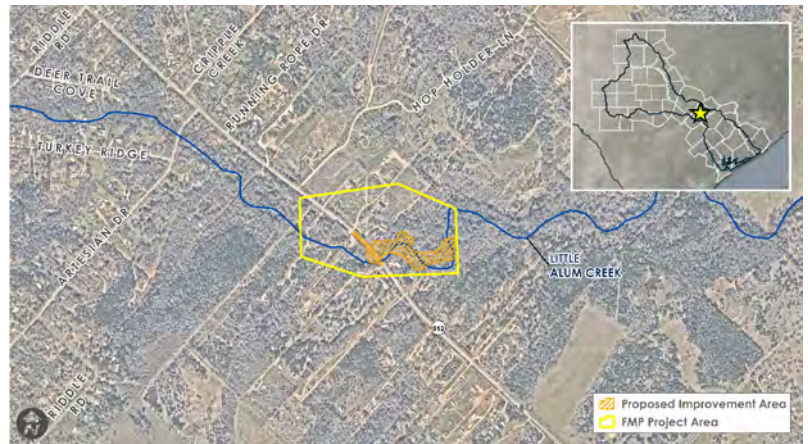
NON-STRUCTURAL

Property buyouts Floodproofing Flood readiness/resilience Flood warning system/gauges

Other

Problem Area

City County
Watershed name(s)
Tributary(ies)
HUC#(s) Stream miles (est.)
Drainage area: square miles, est or acreage, est
Social Vulnerability Index (SVI)
(SVI score 0.0 indicates least vulnerable; 1.0 indicates most vulnerable.)
Other



Flood Risk Description

Bastrop County identified FM 812 at Little Alum Creek of high importance to increase the level of service and provide safe access to residential areas to use as their primary ingress and egress. The existing structure (2 – 7' x 7' box culverts) where FM 812 crosses Little Alum Creek does not have a 5-year level of service. In addition to the road overtopping, there is one residential structure located near the crossing in the FEMA effective 100-year floodplain.

Proposed level-of-service Status Atlas 14 rainfall used

Project Description

The proposed improvements include raising FM 812 and replacing the existing 2 – 7' x 7' box culverts with a 2-span bridge with each span measuring 70 feet (for a total bridge length of 140 feet) and approximately 510 feet of roadway improvements. Proposed improvements for Little Alum Creek include benching into the channel banks approximately 1,930 feet while avoiding the ordinary high water mark.

Related Goal(s)

6.1 Reduce the number of structures and critical facilities that are at high risk through the implementation of structural flood mitigation projects. 6.2 Increase the number of entities that mitigate flood risk at vulnerable roadways or waterways.

Estimated Project Cost

Capital cost Ongoing O&M costs Cost/benefit analysis
Potential funding source(s)

Project: FM 812 at Little Alum Creek
Stream: Little Alum Creek
Engineer's Estimate of Probable Construction Cost
Date: April 7, 2023



PAY ITEM NO	DESCRIPTION	UNITS	UNIT PRICE	QTY	TOTALS
BENCHING COSTS					
1	PREPARING ROW	AC	\$40,000	10	\$400,000
2	EXCAVATION (CHANNEL)	CY	\$25	75,379	\$1,884,467
3	PERMANENT EROSION CONTROL	SY	\$20	48,400	\$968,000
BENCHING SUBTOTAL					\$3,252,467
BRIDGE COSTS					
4	EXCAVATION (ROADWAY)	CY	\$41	120	\$4,920
5	RIPRAP (STONE PROTECTION)(D ₅₀ =18 IN)	CY	\$223	435	\$97,175
6	BRIDGE (PLAN VIEW)	SF	\$150	3,900	\$585,000
7	RAIL	LF	\$180	200	\$36,000
8	REMOV STR (WINGWALL)	EA	\$2,202	2	\$4,404
9	REMOV STR (BOX CULVERT)	LF	\$200	142	\$28,400
10	EMBANKMENT (FINAL)(DENS CONT)(TY C)	CY	\$45	187	\$8,415
11	FL BS (CMP IN PLACE)(TY A GR 1-2)(8")	SY	\$20	1,490	\$29,800
12	D-GR HMA(SQ) TY-C PG64-22	TON	\$223	160	\$35,680
BRIDGE SUBTOTAL					\$829,794
Unit Total					\$4,082,261.42
13	MOBILIZATION		10%		\$408,200
14	TEMPORARY EROSION CONTROL		2%		\$81,600
15	UTILITY RELOCATION		5%		\$366,700
16	TRAFFIC CONTROL		2%		\$81,600
PROJECT SUBTOTAL					\$5,020,361
30% CONTINGENCY					\$1,506,108
BASE TOTAL					\$6,526,470
17	ENVIRONMENTAL PERMITTING		2%		\$130,529
18	ENGINEERING DESIGN & GEOTECH		15%		\$978,970
19	CONSTRUCTION SERVICES & TESTING		10%		\$652,647
PROJECT TOTAL					\$8,288,617

This statement was prepared utilizing standard cost estimate practices. It is understood and agreed that this is an estimate only, and that Engineer shall not be held liable to Owner or third party for any failure to accurately estimate the cost of the project, or any part thereof. Unit prices are in current dollars and should be adjusted as required when letting schedule for project is determined.

FM 812 at Little Alum Creek BCA

Data Compilation and Assumptions

- Flooded Streets
 - Miles of flooding: width of floodplain footprint along roadway.
 - Benefiting structures were evaluated based on an assumption of the addition of 3-ft for mobile homes from the ground elevation to determine an estimated finished floor elevation. Using this assumption, no structures were found to have flood depths within the project area.
 - Duration of flooding: HMS model data.
 - Daily traffic amounts: most recent TxDOT counts, same values for existing and proposed for all frequencies.
 - Mileage for detour: shortest distance to opposite side of Little Alum Creek without using roadways that are overtopping within model.
 - Detour time: minutes for mileage with assumption of traveling at 30 mph.
 - Normal EMS response time: closest EMS service is 17.5 miles away, google maps estimated a 22-minute driving time.
 - EMS response time during event: the closest EMS is located northeast of the project area. The detour time during storm events does not apply as the response time is the same traveling to either side of the of the Creek from the EMS location. This results in no counts for structures impacted by EMS delay and no increase in response time.
- Low Water Crossing
 - Depth of flooding: model results. The TWDB excel document contains a drop-down list for the depth of flooding in 6" intervals. Flood depths were rounded to the closest option from the drop-down list.
 - Duration of flooding: HMS model data.
 - Daily traffic: most recent TxDOT counts, same values for existing and proposed for all frequencies.
- Other Inputs- Green Infrastructure:
 - Benching extent was calculated in acres to determine addition of riparian areas.

Input Into BCA Toolkit		
Project Useful Life	30	
Event Damages	Baseline	Project
10 - year storm	\$689,024	\$0
25 - year storm	\$830,882	\$0
100 - year storm	\$1,525,075	\$0
Total Benefits from BCA Toolkit	\$1,171,649	
Other Benefits (Not Recreation)	\$1,748,438	
Recreation Benefits	-	
Total Costs	\$5,531,486	
Net Benefits	-\$2,611,399	
Net Benefits with Recreation	-\$2,611,399	
Final BCR	0.5	
Final BCR with Recreation	0.5	

This workbook has been designed to work in conjunction with FEMA's BCA Toolkit v6.0 to calculate the Benefit-Cost Ratio (BCR) of flood risk management projects for the Texas Water Development Board (TWDB).

The BCA Input Workbook is designed to help collate the necessary input data and to calculate the Baseline (Before Mitigation) and Project (After Mitigation) Damages. These damages are then input into the FEMA BCA Toolkit to calculate the Project benefits.

[Instructions on how to download and install the FEMA BCA Toolkit v6.0 can be found here.](#)

Please refer to Model Instructions for detailed instructions on how to use this workbook.

Input cells are highlighted green.

The TWDB BCA Input Workbook calculates benefits from the following benefit areas, which will be input into the BCA Toolkit:

- Structure damages & associated loss of function
- Reduction in street flooding
- Utility loss of function
- Agricultural damages
- Low water crossings replacements

The following benefit areas are calculated entirely in the BCA Toolkit:

- Critical facility loss of function

The following benefit areas are calculated entirely in the TWDB BCA Input Workbook:

- Recreation benefits
- Water supply benefits
- Environmental benefits of green infrastructure
- Residual value of investment

Project Name

[Project Region](#)

Project Type

Start Construction Year

End Construction Year

Input up to 3 Recurrence Intervals for which you have water level (H&H) data.
At least 1 Recurrence Interval must be the 100-year storm.
Recurrence Intervals must be input in decreasing order of likelihood (i.e., 50-year storm before 100-year storm).

Recurrence Interval 1

Recurrence Interval 2

Recurrence Interval 3

Types of Project Impacts

Residential Structure Damage Reduction	<input type="text" value="No"/>	
Commercial Structure Damage Reduction	<input type="text" value="No"/>	
Critical Facility (Police, Fire, Hospital) Loss of Function Reduction	<input type="text" value="No"/>	
Reduction in Street Flooding	<input type="text" value="Yes"/>	Input water levels and detour information in the 'Flooded Streets' sheet; Damage totals will be shown in 'Total Impacts'
Utility Outage Reduction	<input type="text" value="No"/>	
Agricultural Damage Reduction	<input type="text" value="No"/>	
Water Supply Benefits	<input type="text" value="No"/>	
Recreation Benefits	<input type="text" value="No"/>	
Does this project include Green Infrastructure elements?	<input type="text" value="Yes"/>	Input acreage of green infrastructure elements in 'Other Inputs' sheet; benefit totals will be shown in 'Total Impacts'
Does this project replace a low-water crossing?	<input type="text" value="Yes"/>	Input water levels in 'Low Water Crossing' sheet; Damage totals will be shown in 'Total Impacts'

Capital Cost	
Right-of-Way	
Utility Relocation	\$366,700
Construction	\$7,921,917
Total Capital Cost	\$8,288,617
Operations & Maintenance (O&M)	
Baseline Annual O&M	
Project Annual O&M	
Increased Annual O&M	\$0
Project Lifespan (years)	30

	10 - year storm		25 - year storm		100 - year storm	
	Baseline	Project	Baseline2	Project2	Baseline3	Project3
How many miles of roadway is flooded >6"?	0.079	0	0.097	0	0.11	0
How long are the roadways impassable (hours)?	1.7	0	2.05	0	2.75	0
What is the daily traffic (vehicle count) on the affected roadways?	2,265	2,265	2,265	2,265	2,265	2,265
How much mileage does the detour add to the route? (Difference between direct route and detour)	18	0	18	0	18	0
How much time (minutes) does the detour add to the route? (Difference between direct route and detour)	36	0	36	0	36	0
Normal Emergency Medical Services (EMS) response time (minutes)	22					
EMS response time during storm event	22	22	22	22	22	22
Number of households impacted by EMS delay due to flooded streets	0	0	0	0	0	0
Number of commercial buildings impacted by EMS delay due to flooded streets	0	0	0	0	0	0

Input	10 - year storm		25 - year storm		100 - year storm	
	Baseline	Project	Baseline2	Project2	Baseline3	Project3
Depth of flooding over roadway	24"		24"		30"	
Duration of flooding (hours)	1.7	0	2.05	0	2.75	0
Daily Traffic	2,265					
What is the length of the detour (minutes)?	20 to 40		20 to 40		20 to 40	

****Note:** These impacts will only be included in the Total Impacts if "Yes" is selected under "Types of Project Impacts" on the Project Information sheet.

Does the project reduce utility outages?	<input type="checkbox"/> No
Does the project increase water supply?	<input type="checkbox"/> No
Does the project impact flooding on agricultural lands?	<input type="checkbox"/> No
Does the project include any green infrastructure elements?	<input checked="" type="checkbox"/> Yes
Type of habitat	Acres
Green open space	
Riparian	4.88
Wetlands	
Forests	
Marine & Estuary	

Project Impacts by Recurrence Interval	10 - year storm		25 - year storm		100 - year storm	
	Baseline	Project	Baseline2	Project2	Baseline3	Project3
Residential Flood Damage	-	-	-	-	-	-
Commercial Flood Damage	-	-	-	-	-	-
Flooded Streets	\$5,852	\$0	\$7,057	\$0	\$9,467	\$0
Utility Impacts	-	-	-	-	-	-
Agricultural Losses	-	-	-	-	-	-
Low Water Crossing Damages	\$683,172	\$0	\$823,825	\$0	\$1,515,609	\$0

Flooded Structures by Recurrence Interval	10 - year storm		25 - year storm		100 - year storm	
	Baseline	Project	Baseline2	Project2	Baseline3	Project3
Flooded residential structures	-	-	-	-	-	-
Impacted Residents	-	-	-	-	-	-
Flooded commercial structures	-	-	-	-	-	-
Impacted Employees	-	-	-	-	-	-

Other Project Impacts	Benefits
Water Supply Benefits	-
Environmental Benefits	\$1,748,438
Residual Value of Investment	\$0
Recreational Benefits	-

Attachment 2

Environmental Constraints Report



Firm Registration No. 312

Environmental Constraints Analysis

FM 812 at Little Alum Creek Project

for

Bastrop County, Texas

Prepared by

Halff

AVO 43796

April 2023

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- 4.0 NWI/NH Map
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- 6.0 TPWD TXNDD Map
- 7.0 USGS Geologic Rock Unit Map
- 8.0 NRCS Soil Map

1. Introduction

Halff is conducting a hydrologic and hydraulic study for the proposed Farm to Market Road (FM) 812 at Little Alum Creek Project in Bastrop County, Texas. The proposed project includes a 140-foot long bridge span with 2,000 linear feet of channel benching improvements along Little Alum Creek. The study area encompasses approximately 0.4 acres, and the benching area encompasses approximately 0.2 acres (see **Appendix A - Figures 1.0 and 2.0**).

2. Summary of Environmental Constraints

Halff prepared this Environmental Constraints Analysis that summarizes the potential environmental constraints and permitting requirements associated with the proposed project. Reviewed data sources include Texas Parks and Wildlife Department (TPWD), U.S. Fish and Wildlife Service (USFWS), U.S. Geological Survey (USGS), and Natural Resource Conservation Service (NRCS). No site visit was conducted to assess environmental constraints.

2.1 AERIAL IMAGERY DESCRIPTION

Aerial imagery maps were reviewed and show undeveloped land to the east of the study area. This land may have been subject to agricultural practices. One residential neighborhood is located west of the study area adjacent to FM 812. The study area is intersected by Little Alum Creek, with undeveloped forested land along the western boundary of the study area. Land to the south of the study area is primarily residential.

2.2 TOPOGRAPHIC MAP DESCRIPTION

The USGS topographic map for 2022 depicts the study area as containing primarily undeveloped land, depicted as herbaceous landcover (indicated by no-or-sparse green shading), adjacent to Little Alum Creek (depicted by a dashed blue line) (see **Appendix A - Figure 3.0**). The study area also intersects one roadway, FM 812. No urban developments are shown in or around the study area.

2.3 WATER RESOURCES

Water resources includes surface water features (e.g., wetlands, tributaries, rivers, impoundments, and other potential waters of the United States), floodplains and groundwater features. Water resources within the study area were evaluated to identify local, state, and/or federal permitting requirements that may be associated with construction of the proposed project.

Wetlands are identified as areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Based on the review of USFWS National Wetlands Inventory (NWI) data and USGS National Hydrography Dataset (NHD) data, surface water features within the study area include one freshwater forested/shrub wetland and one riverine feature (Little Alum Creek) (see **Appendix A - Figure 4.0**).

Federal Emergency Management Agency (FEMA) floodplain data were reviewed to evaluate the location of the mapped floodplains in relation to potential aquatic resources located within the study area. According to the FEMA National Flood Hazard Layer (NFHL) dataset, a majority of the study area is located within the 1-percent annual chance flood hazard (100-year floodplain) zone. The southeastern portion of the study area is located in the area of minimal flood hazard. The FEMA NFHL Map depicts the floodplain limits within the study area (see **Appendix A - Figure 5.0**).

2.4 BIOLOGICAL RESOURCES

The USFWS Information for Planning and Consultation (IPaC) report for the study area includes eleven federally listed species that should be considered in an effects analysis for the project. Critical habitats are specific geographic areas that contain features essential for the conservation of a threatened or

endangered species and that may require special management and protection. There are no USFWS-designated critical habitats located within the study area.

The USFWS critical habitat mapper was reviewed March 9, 2023. The review did not identify mapped critical habitat within 2 miles of the study area. The closest mapped critical habitat is for the Houston toad (*Bufo houstonensis*) and is approximately 14 miles northeast of the study area.

The TPWD Rare, Threatened, and Endangered Species of Texas (RTEST) list for Bastrop County includes 65 species that are state listed or species of greatest conservation need. A Texas Natural Diversity Database (TXNDD) search was also conducted on March 6, 2023. The TXNDD search identified no element occurrence records (records of sightings of rare or endangered species) within 2 miles of the study area (see **Appendix A - Figure 6.0**).

USFWS and TPWD data cannot substitute for on-site evaluations conducted by qualified biologists. A field visit by a qualified biologist is recommended prior to construction to determine the potential effects and impacts to protected species.

2.5 GEOLOGY

Surface geology data derived from the USGS Texas Geology database were reviewed to identify rock units within the study area. One rock unit, Wilcox Group, undivided (Ewi), was identified within the study area (see **Appendix A - Figure 7.0**).

2.6 SOIL SURVEY

Soil data for the study area were obtained from the NRCS Web Soil Survey, which is derived from the U.S. Department of Agriculture (USDA) Soil Survey for Bastrop County, Texas. Soil units within the study area are shown atop an aerial imagery map in **Appendix A - Figure 8.0. Table 1** describes characteristics of these soil types.

Table 1: Soil Units within the Study Area

Soil Unit	Topography	Frequency of Flooding	Hydrologic Soil Group]
Sa – Sayers fine sandy loam	0-1% Slopes	Occasionally flooded	A
AfC2 – Edge fine sandy loam	2-5% Slopes	None	D

Note: Hydric soil groups are a classification system defined by NRCS in which soils are categorized into four runoff potential groups.

- Group A: High permeability, little to no runoff production.
- Group D: Low permeability, high runoff production.

2.7 CULTURAL RESOURCES

Because the project is being developed by the City of Bastrop, a political sub-entity of the State of Texas, the project falls under purview of the Antiquities Code of Texas (Title 9, Chapter 191 of the Texas Natural Resources Code), which requires the Texas Historical Commission (THC) to review actions that have the potential to impact archeological historic properties within the public domain.

Halff conducted desktop research to determine the potential for the project to impact archeological historic properties eligible for listing on the National Register of Historic Places (NRHP) or State Antiquities Landmark (SAL) designation. The Texas Archeological Sites Atlas (Atlas), maintained by the THC, was reviewed to determine whether any archeological historic properties, NRHP properties/districts, SALs, cemeteries, Official Texas Historical Markers (OTHMs), and previous cultural resource surveys are documented within or adjacent to the study area.

Review of THC Atlas records revealed that there are no archeological historic properties, NRHP properties/districts, SALs, cemeteries or OTHMs documented within or adjacent to the study area. In addition, the study area has not undergone previous cultural resources surveys and no archeological historic properties have been documented in the surrounding 1-kilometer vicinity.

3. Conclusions

Based on the assessment of potential environmental constraints within the study area, additional actions regarding potential environmental impacts may be required. These actions are included in **Appendix B**. The study area contains aquatic resources which may be regulated as waters of the United States (WOTUS) by the U.S. Army Corps of Engineers (USACE) under Section 404 of the Clean Water Act (Section 404). Aquatic resources within the study area may be considered WOTUS to the extent of the ordinary high water mark (OHWM), and adjacent wetlands where present. To facilitate avoidance of these resources, Halff proposes to perform an on-the-ground delineation of aquatic resources within the study area in accordance with the USACE “Wetland Delineation Manual, Technical Report Y-87-1” and the “Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Great Plains Region (Version 2.0).” Additionally, to demonstrate compliance with the Endangered Species Act (ESA), Halff proposes to conduct a threatened and endangered species and habitat (T&E) assessment, which includes an evaluation of federal and state-listed threatened and endangered species for Bastrop County.

3.1 WATER AND BIOLOGICAL RESOURCES

At a minimum, recommended additional studies include a WOTUS delineation, and a T&E assessment. The WOTUS delineation would include employing GPS surveying techniques per USACE Fort Worth District’s operating procedures to delineating the limits of potential WOTUS, including wetlands; completing necessary wetland data forms and take on-site photography for representative site features; and, preparing draft and final reports describing the methodology and results of the investigation, so that the report may satisfy the jurisdictional determination requirement for future permits, if necessary. Geographic Information System shapefiles of the field data collected will be provided with the final report. The T&E assessment would include an effects determination for species occurring within the study area. The effect determination would identify whether any listed species are likely to be present; whether the project affects or has the potential to affect federal-listed species; and Halff shall address the best management practices for avoiding impacts to other wildlife during construction, specifically migratory birds and bald and golden eagles. At this phase of project development, the preliminary cost estimate for these additional studies is \$21,000.

3.1 CULTURAL RESOURCES

Based on Halff’s evaluation of the study area, future ground disturbing activity would not impact any documented cultural resources, including those listed eligible for NRHP inclusion or SAL designation. However, given that the study area has not undergone any prior cultural resources investigations, cultural resources surveys would likely be required for any proposed ground disturbing activity within the study area to comply with the Antiquities Code of Texas (ACT). In addition, if the project includes any federal funding or permitting, compliance with Section 106 of the National Historic Preservation Act would be required.

Cultural resources services would be provided when the extent of ground disturbing activities have been identified (e.g., during the project design phases). Compliance with the ACT and Section 106 will at minimum require direct coordination with the THC and submittal of an ACT permit application and scope of work to perform the cultural resources field investigations in the study area. Upon issuance of the ACT permit number assigned to the project by the THC, Halff will conduct an intensive cultural resources survey that conforms to the standards outlined by the Council of Texas Archeologists and approved by the THC. The survey will be performed by Halff archeologists who meet the U.S. Secretary of the Interior’s (SOI) Professional Qualification Standards for Archeology and Historic Preservation under the direction of an

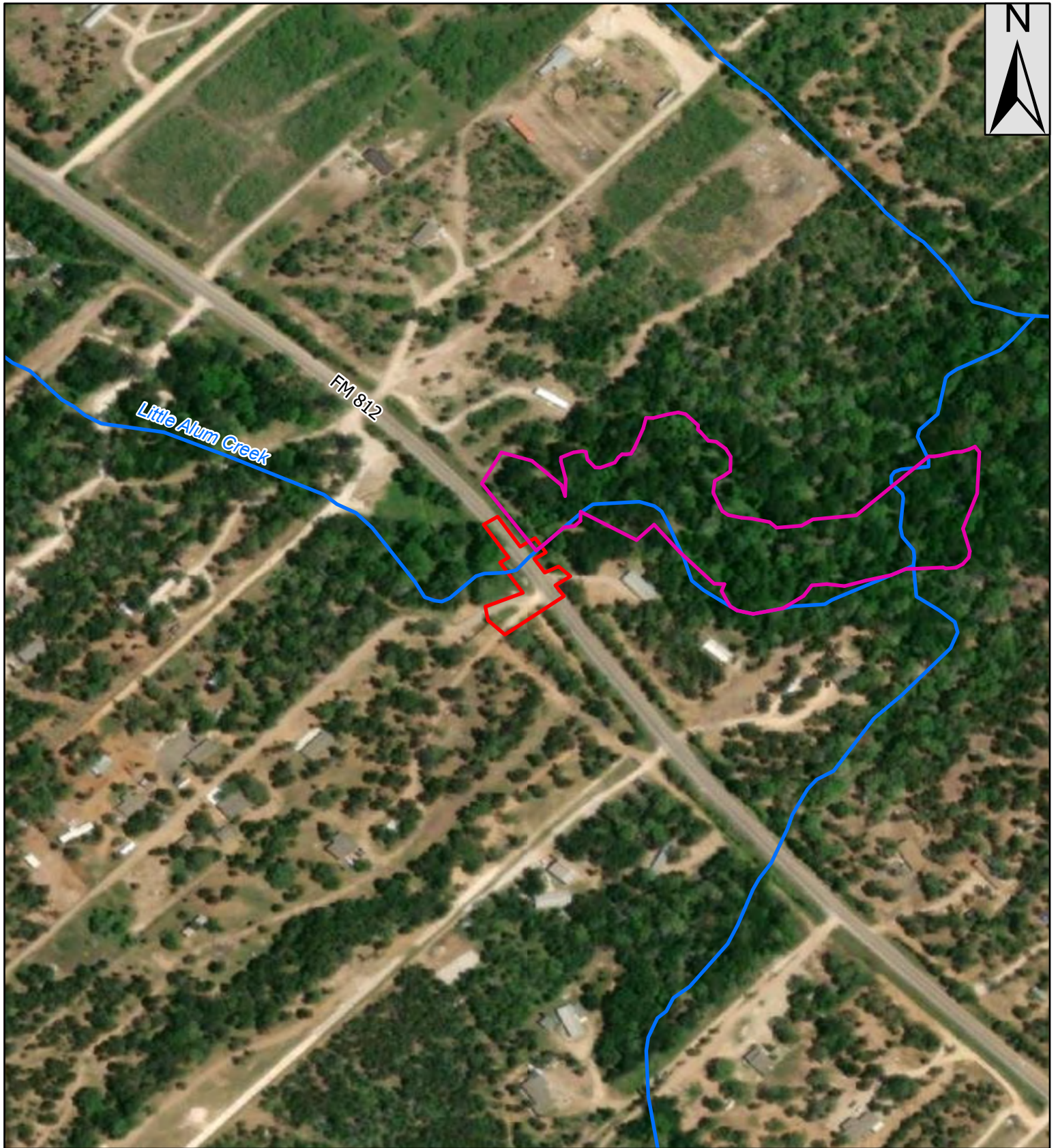
SOI-qualified Principal Investigator. The survey may include pedestrian reconnaissance, shovel testing and mechanized trenching within the proposed study area, depending on the horizontal and vertical extents of proposed ground disturbance. For example, if proposed construction activities are greater than 3 feet in depth, mechanized trenching may be required to test for deeply-buried archeological sites. If any above-ground historic resources are identified within or adjacent to the study area, an SOI qualified historian will perform an effects assessment.

At the conclusion of the field survey, Halff will prepare and submit a draft report that conforms to the SOI Guidelines for Archaeology and Historic Preservation. The report will summarize the findings of the cultural resources survey, provide recommendations regarding any effects to archeological historic properties and determine whether additional ACT or Section 106 compliance is required. Following a period of City review, the draft report will be submitted for review by THC and all other applicable state/federal agencies as needed. After acceptance of the draft report by the THC, a final report will be submitted and all field records, photographs and collected artifacts will be prepared for permanent curation at the Center for Archaeological Studies located at Texas State University in San Marcos, Texas.

The preliminary cost estimate for the cultural resources services described above is \$18,000, which is subject to change based on the project design. The cultural resources services include the ACT permit application, archeological and historic resources surveys, survey reports and curation tasks described above. Any further ACT and Section 106 requirements, including but not limited to formal NRHP/SAL eligibility evaluations of archeological historic properties discovered in the study area, and the documentation, exhumation or repatriation of human burials discovered in the study area would be scoped separately as additional services.

Appendix A – Figures

Appendix B – Environmental Constraints Table



Legend

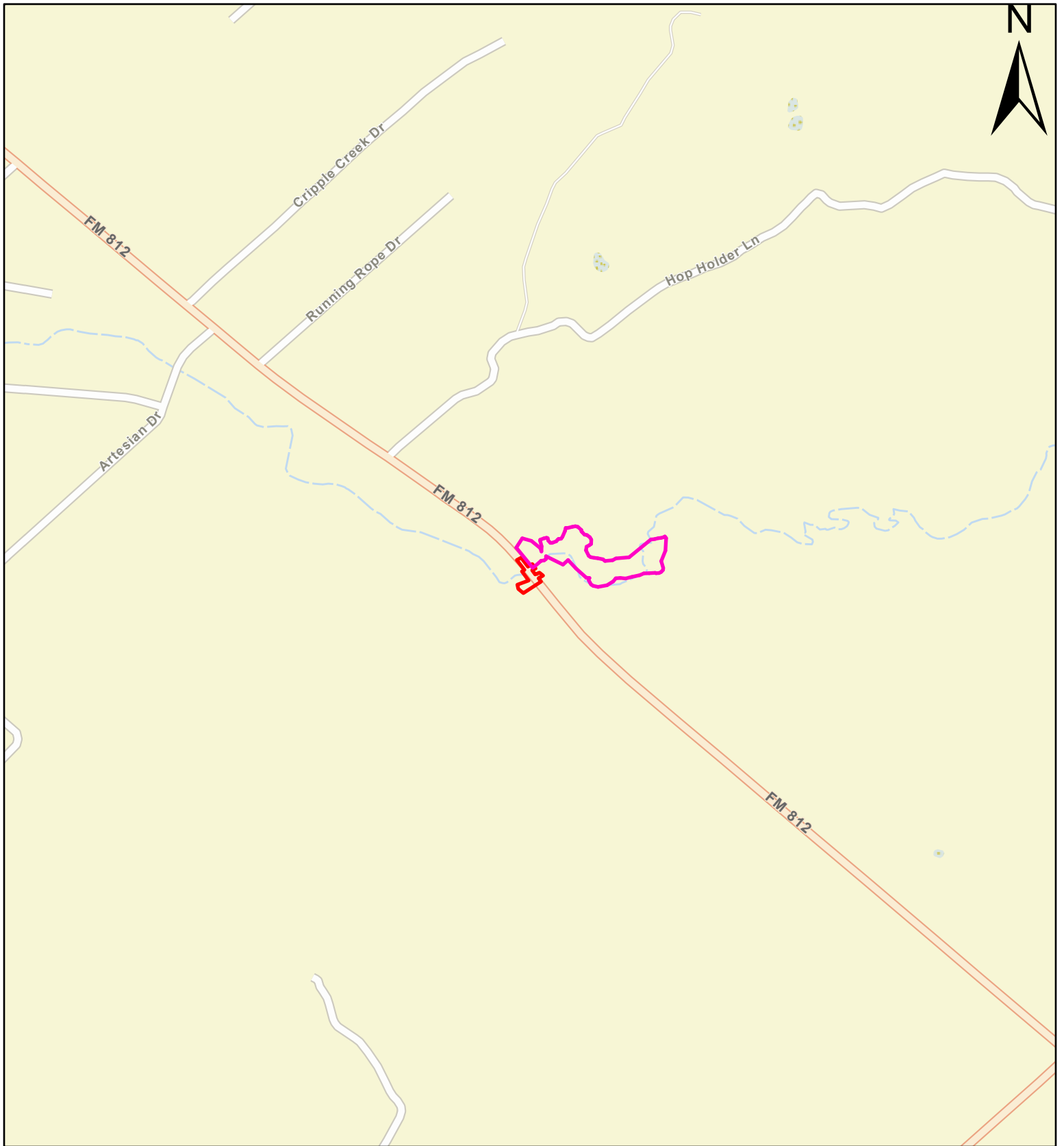
- Study Area
- Bench Area
- NHD
- Stream/River

0 150 300 600 Feet

Notes:
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 30.01169°N
 2. World Imagery: Maxar
 3. USGS National Hydrography Dataset

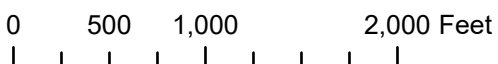
FM 812 at Little Alum Creek Project
 Bastrop County, Texas
 Figure 1.0 - Location Map
 AVO: 43796
 Date: 4/10/2023





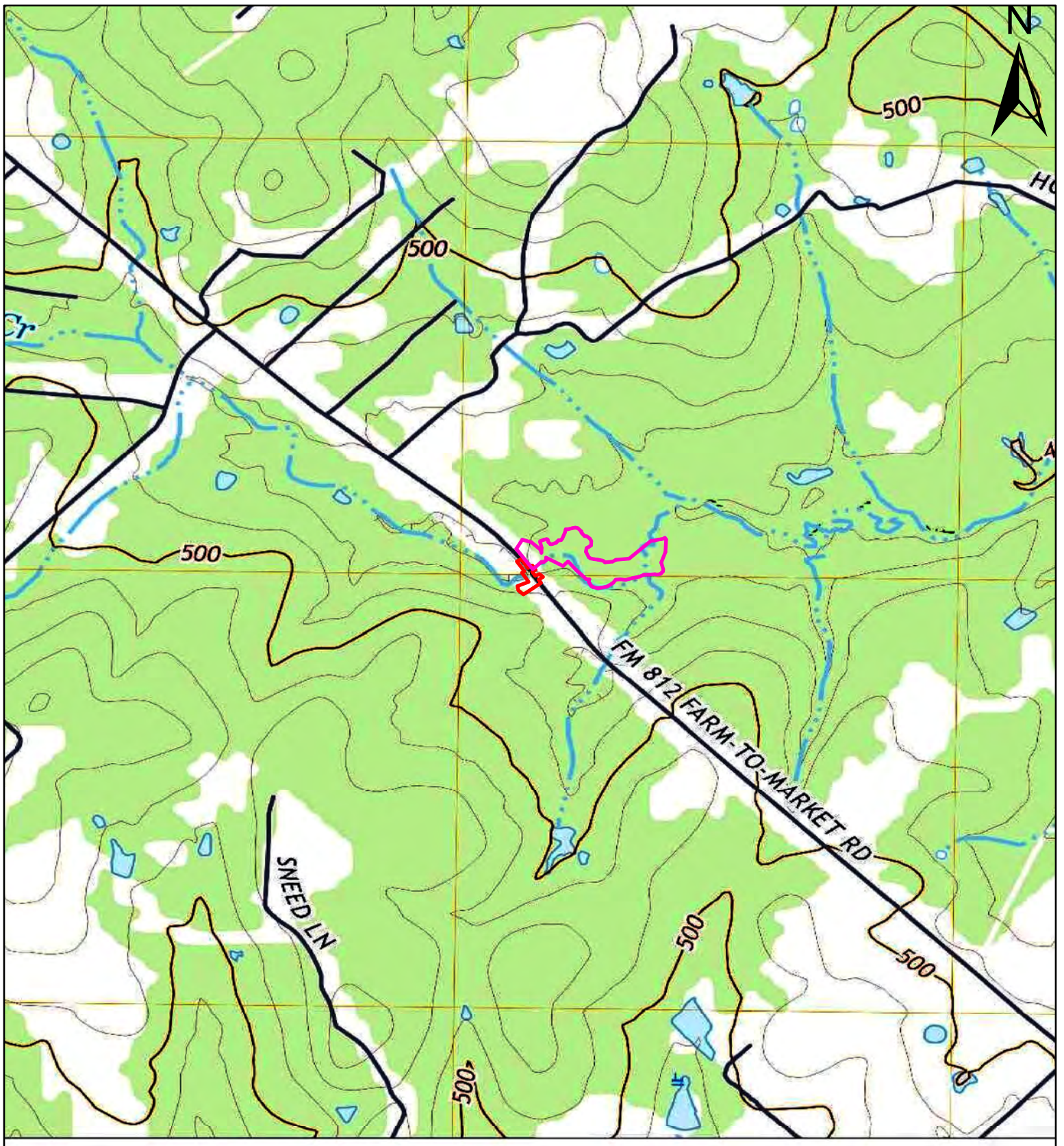
Legend

- Study Area
- Bench Area



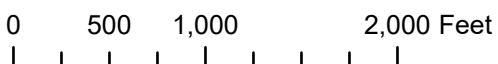
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 2. World Street Map: Esri
 Community Maps Contributors,
 Baylor University, City of Austin,
 Texas Parks & Wildlife,
 CONANP, Esri, HERE, Garmin,
 SafeGraph, GeoTechnologies,
 Inc, METI/NASA, USGS, EPA,
 NPS, US Census Bureau,
 USDA

FM 812 at Little Alum Creek Project
 Bastrop County, Texas
 Figure 2.0 - Vicinity Map
 AVO: 43796
 Date: 4/10/2023



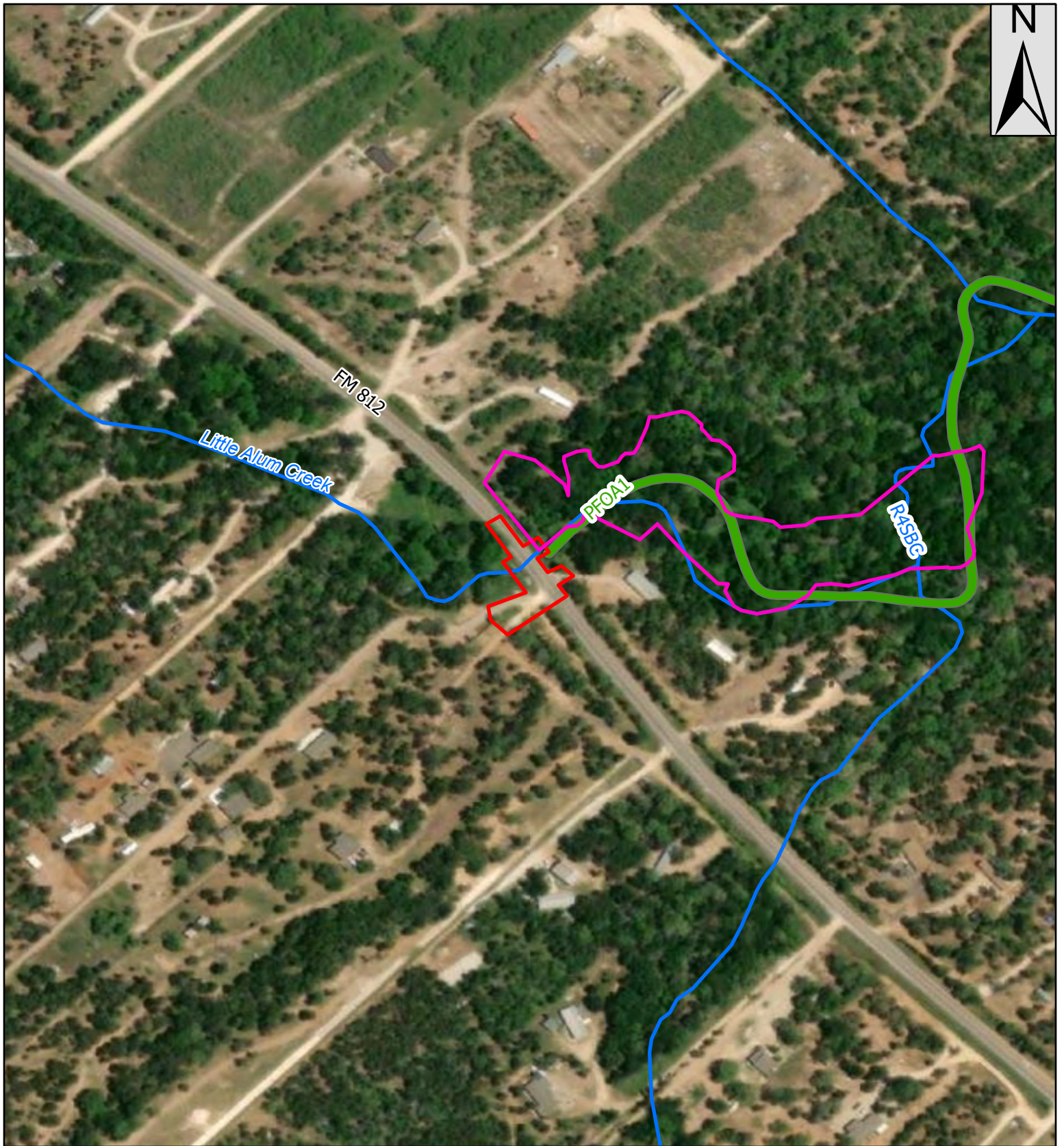
Legend

- Study Area
- Bench Area



Notes:
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 2. topoview - "Lytton Springs, Texas" USGS quadrangle, 2022

FM 812 at Little Alum Creek Project
 Bastrop County, Texas
 Figure 3.0 - 2022 USGS
 Topographic Map
 AVO: 43796
 Date: 4/10/2023

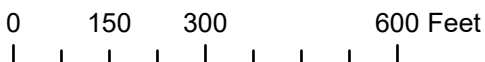
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- ▭ Study Area
- ▭ Bench Area

NWI

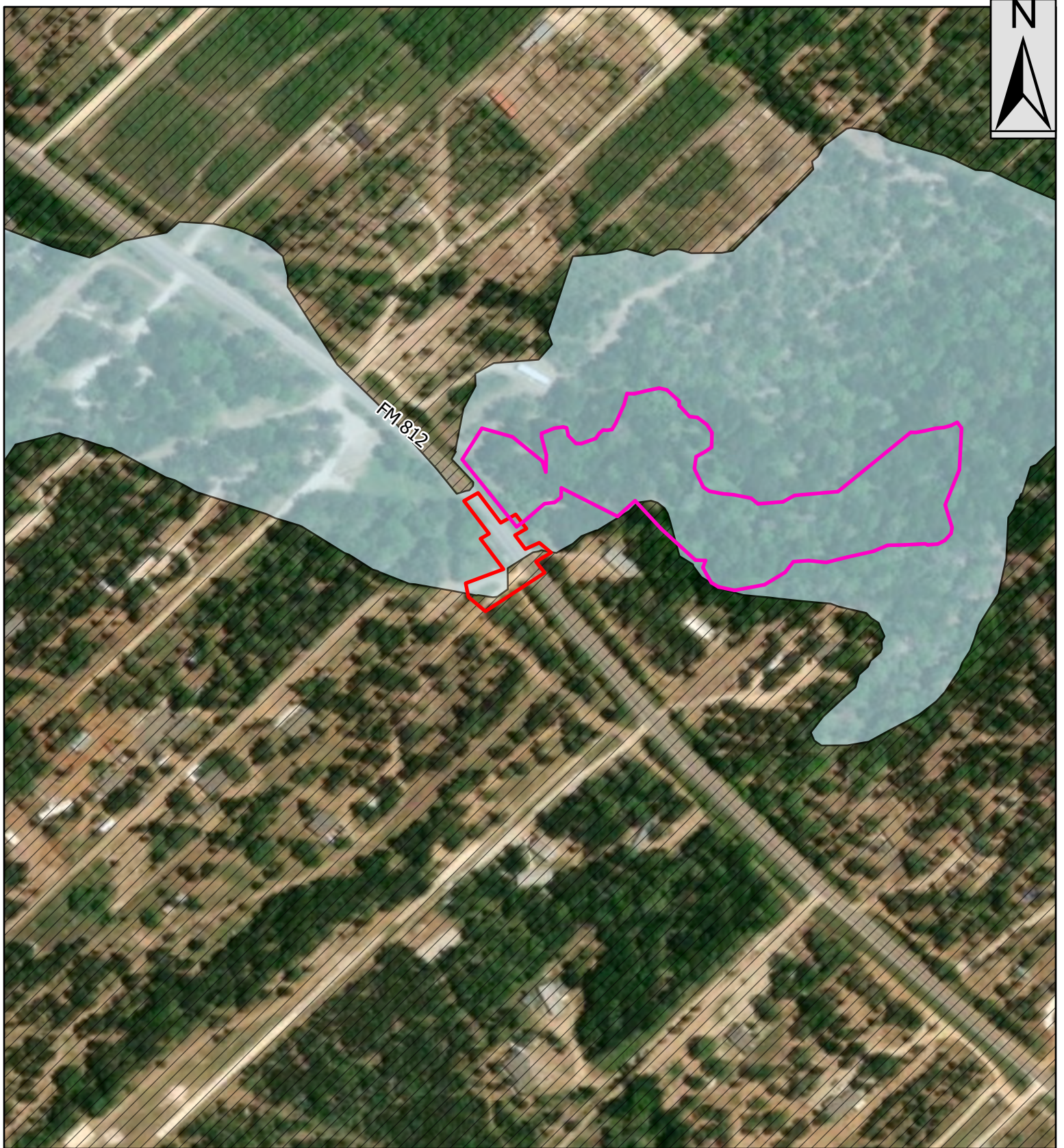
- ▭ Freshwater Forested/Shrub Wetland

- NHD**
- Stream/River



Notes:
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 30.0117°N
 2. World Imagery: Maxar
 3. USFWS National Wetlands Inventory
 4. USGS National Hydrography Dataset

FM 812 at Little Alum Creek Project
 Bastrop County, Texas
 Figure 4.0 - NWI/NHD Map
 AVO: 43796
 Date: 4/10/2023

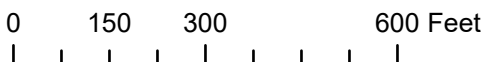


Legend

- Study Area
- Bench Area

FEMA NFHL

- 1% Annual Chance Flood Hazard
- Area of Minimal Flood Hazard






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 2. World Imagery: Maxar
 3. FEMA NHFL

FM 812 at Little Alum Creek Project
 Bastrop County, Texas
 Figure 5.0 - FEMA NFHL Map
 AVO: 43796
 Date: 4/10/2023





Legend

-  Study Area
-  2-Mile Buffer
-  Bench Area

0 2,500 5,000 10,000 Feet

- Notes:
1. Map Center: 97.52648°W
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 2. World Imagery: Earthstar
Geographics
 3. TPWD TXNDD Element
Occurrence
 4. USFWS Critical Habitat

FM 812 at Little Alum Creek Project
Bastrop County, Texas
Figure 6.0 - TPWD TXNDD Map
AVO: 43796
Date: 4/10/2023



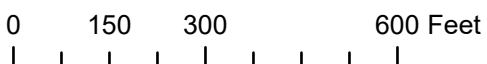


Legend


- Study Area
- Bench Area

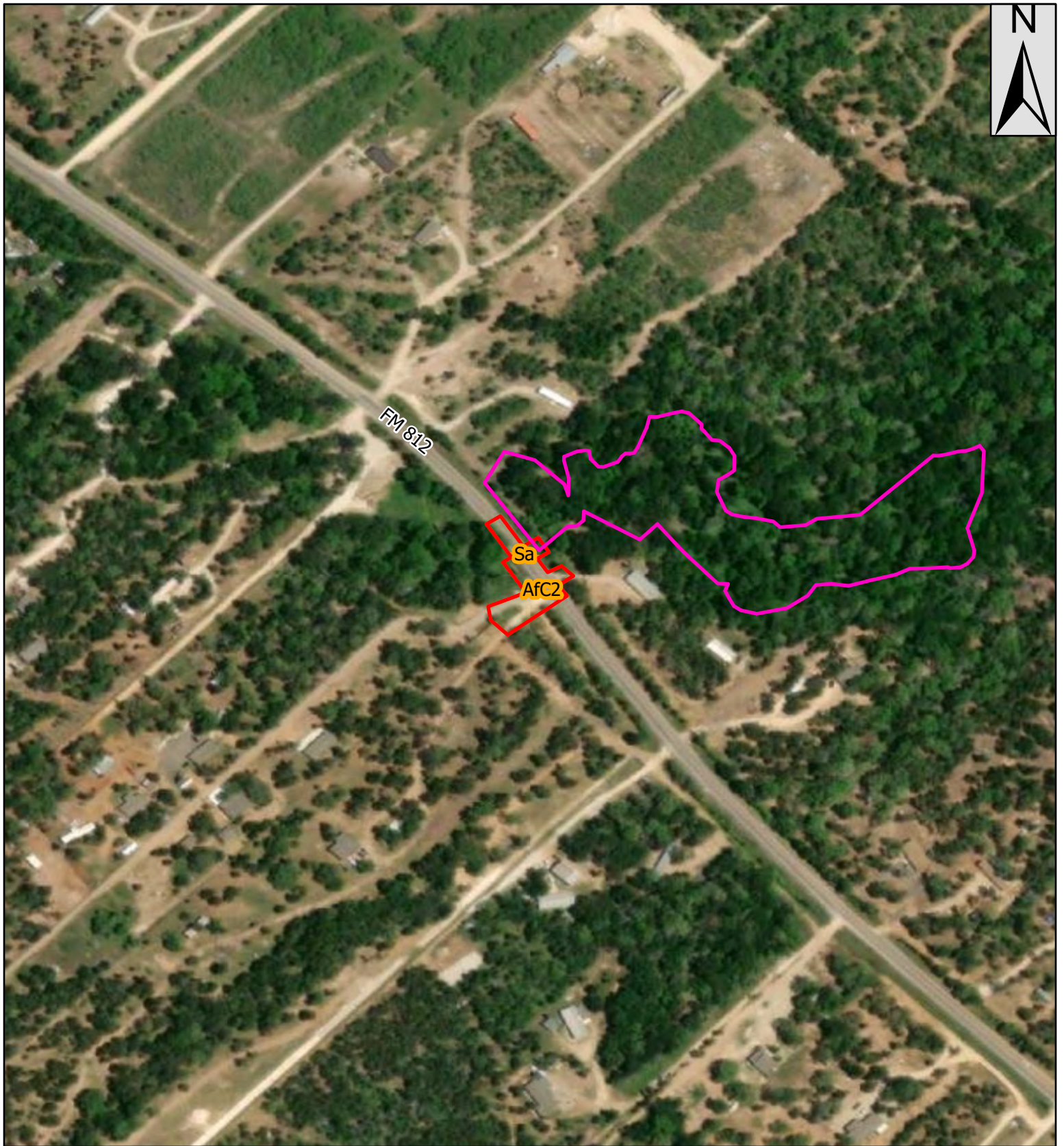
USGS Rock Unit

- Wilcox Group (Ewi)



Notes:
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 2. World Imagery: Maxar
 3. USGS Geology of Texas

FM 812 at Little Alum Creek Project
 Bastrop County, Texas
 Figure 7.0 - USGS Geologic Rock
 Unit Map
 AVO: 43796
 Date: 4/10/2023


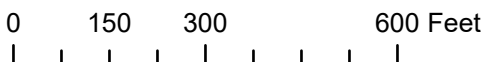


Legend

- ▭ Study Area
- ▭ BenchArea

NRCS Soils

- ▭ Edge fine sandy loam (Afc2)
- ▭ Sayers fine sandy loam (Sa)



Notes:
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 30.0117°N
 2. World Imagery: Maxar
 3. USDA Web Soil Survey
 NRCS SSURGO

FM 812 at Little Alum Creek Project
 Bastrop County, Texas
 Figure 8.0 - NRCS Soil Map
 AVO: 43796
 Date: 4/10/2023

Environmental Constraints Table

Resource / Regulating Entity (or Policy)	Database Review	Database Findings	Applicable Regulations & Following Steps
Water Resources			
Jurisdictional Waters of the U.S. / U.S. Army Corps of Engineers (USACE), Section 404 of the Clean Water Act (CWA)	Data from the National Hydrography Dataset, The USFWS National Wetland Inventory (NWI), and aerial imagery data were reviewed to identify mapped surface waters and wetlands within the study area. The database review is utilized only as a general guide to the potential location of aquatic resources and does not substitute for site surveys to identify and delineate streams and wetlands regulated under Section 404.	NHD data shows Little Alum Creek within the study area. The study area contains NWI-mapped wetlands.	<ul style="list-style-type: none"> The USACE regulates activities within jurisdictional waters, such as streams, rivers and lakes. Conduct a site survey to identify any USACE regulated water features and delineate boundaries. Follow USACE permitting procedures under Section 404 of the CWA, if applicable. Depending on the nature of activity, activities that result in the placement of fill within waters of the U.S. under ½-acre or below 300 linear feet are generally authorized under a nationwide permit. A pre-construction notification and compensatory mitigation may be required. Impacts to waters of the U.S. above these thresholds may require an individual permit.
Floodplains / Federal Emergency Management Agency (FEMA)	Digital data derived from FEMA Flood Insurance Rate Maps were reviewed.	Portions of the study area are located within the 100-year floodplain (Zones A, AE or X).	<ul style="list-style-type: none"> Comply with FEMA floodplain regulations and local ordinances, and coordinate with the local floodplain administrator. If federal funding is utilized, comply with Executive Order (EO) 11988.

Environmental Constraints Table

Resource / Regulating Entity (or Policy)	Database Review	Database Findings	Applicable Regulations & Following Steps
Impaired Assessment Units / TCEQ, Section 303(d) of the CWA	The 2022 Texas Integrated Report – Texas 303(d) List was reviewed in conjunction with TCEQ geospatial data to determine if any impaired assessment units occur within the study area.	No impaired assessment units occur within the study area.	No applicable regulations or following steps.
Biological Resources			
Protected Species / USFWS	A USFWS Information for Planning and Consultation (IPaC) was generated for Bastrop County.	According to data in the IPaC report, four bird species, two amphibian species, one insect species, three arachnid species, and one plant species are federally listed as either threatened or endangered in Bastrop County. One insect species is as a candidate for listing, and four clam species are proposed threatened or endangered.	<ul style="list-style-type: none"> The Endangered Species Act regulates for the protection of habitat and species. Based on the report findings and a review of aerial photography, the study area has the potential to contain habitat for listed species. A site visit, conducted by a qualified biologist, should occur to determine if habitat for listed species is present within the study area.
Critical Habitat / USFWS	The USFWS Critical Habitat for Threatened & Endangered Species online mapper was reviewed.	No mapped critical habitat is located within the study area.	No applicable regulations or following steps.

Environmental Constraints Table

Resource / Regulating Entity (or Policy)	Database Review	Database Findings	Applicable Regulations & Following Steps
Rare, Threatened, and Endangered Species of Texas (RTEST) / TPWD	The TPWD's RTEST by County lists were reviewed for Bastrop County. TPWD's Texas Natural Diversity Database data were obtained for the study area.	<p>There are 65 species listed on TPWD's RTEST list for Bastrop County that include the following: Amphibians (5), birds (13), crustaceans (1), fish (5), insects (7), mammals (13), mollusks (2), reptiles (9), plants (10).</p> <p>No TXNDD element occurrence records are located within 2 miles of the study area.</p>	<ul style="list-style-type: none"> • The Texas Parks and Wildlife (TPW) Code and Texas Administrative Code (TAC) protect state-listed species and prohibit take of state-listed species. Comply with TPW Code and the TAC for laws and regulations pertaining to endangered or threatened species. • Based on the report findings and a review of aerial photography, the study area has the potential to contain habitat for listed species. • A site visit, conducted by a qualified biologist, should occur to determine if habitat for listed species is present within the study area.
Wildlife Management Areas / TPWD	The TPWD's wildlife management areas (WMAs) were reviewed.	No WMAs occur within the study area.	No applicable regulations or following steps.
Farmland / Natural Resources Conservation Service (NRCS),	The U.S. Department of Agriculture (USDA) NRCS Web Soil Survey was utilized to identify prime farmland, farmland of statewide importance, farmland of local importance, or unique farmland within the study area.	Portions of the study area are not located within an urbanized area. Based on the soil survey, soils mapped as prime farmland or farmland of statewide importance are not mapped within the study area.	No applicable regulations or following steps.

Flood Management Evaluation Memorandum

TO: Lower Colorado-Lavaca Regional Flood Planning Group
Lower Colorado River Authority
P.O. Box 220
Austin, TX 78767

DATE: May 9, 2023

FROM: Paul Morales, PE, CFM, CPESC
Halff Associates, Inc.
13620 Briarwick Drive, Suite 100
Austin, TX 78729

PROJECT: LCRA Contract No. 5809
Halff AVO 43796.001

9 May 2023

SUBJECT: **FME ID: 101000102**
Project Sponsor: City of Bastrop Project
Name: Piney Creek Mitigation



On September 15, 2022, the Lower Colorado-Lavaca Regional Flood Planning Group (RFPG) approved the evaluation of this Flood Management Evaluation (FME) to identify, evaluate and recommend additional potentially feasible Flood Mitigation Projects (FMP).

Introduction

The City of Bastrop identified Piney Creek channel benching improvements as a potential flood mitigation solution to reduce the 1% ACE using USGS rainfall data. These improvements would reduce the potential overtopping of State Highway (SH) 95 and would reduce the overtopping depth at Main Street and Reids Bend. The roads that cross Piney Creek floodplain are at grade and not elevated. The City is currently working on a Drainage Master Plan and is interested in making road crossing improvements for safety ingress/egress during significant storm events from the downtown core area of the City. Additional work is needed to meet TWDB requirements as a FMP which includes updating hydrologic and hydraulic analysis to use NOAA Atlas 14 rainfall data, a no adverse impact evaluation, updated cost estimates, a benefit cost analysis (BCA), and identification of potential constraints (e.g., environmental impacts, permitting, land acquisition, utility conflicts, and constructability). This memorandum provides an updated analysis for the Piney Creek Benching improvements and includes all required items to advance the project to an FMP.

Project Location and History

Piney Creek is a tributary to the Colorado River and located on the western edge of the city limits north of State Highway (SH) 71. **Figure 1** shows the extents of the Piney Creek benching project that extends approximately two (2) miles from the Union Pacific Railroad (UPRR) at the downstream end to SH 95 at the upstream limit. The project improvements include approximately 4,150 LF of channel benching, 2,200 LF of channel clearing or vegetation thinning, and bridge improvements at UPRR bridge, Main Street and pedestrian bridge, and SH95. UPRR bridge is proposed to be widened from a 150 foot span to a 300 foot span. Main Street bridge is currently a 100 foot span and is being proposed to a 300 foot span. The pedestrian bridge at Main Street is a 50 foot span and is proposed to be a 300 foot span to match Main Street. And finally, SH 95 is currently a 60 foot span and is proposed to be a 250 foot span.

Improvements along Piney Creek were initially identified as part of the *Bastrop County Flood Protection Planning (FPP)*, completed in 2018, which focused on flood mitigation within the City of Bastrop. The models developed as part of the FPP were then utilized and updated with new LiDAR terrain and NOAA Atlas 14 rainfall as part of the *Lower Colorado Cummings Phase 2 FEMA Preliminary Models and Mapping*, completed April 2020. The Lower Colorado Cummings models are being utilized in the *Bastrop County Flood Infrastructure Fund (FIF)* of the upper watershed of Piney Creek (in the County’s jurisdiction) and is considered to be the best available data. The City of Bastrop is currently developing a city-wide Drainage Master Plan and has identified Piney Creek road crossings as flood problem areas and is utilizing the models developed as part of the FIF Piney Creek watershed study to develop flood mitigation solutions.

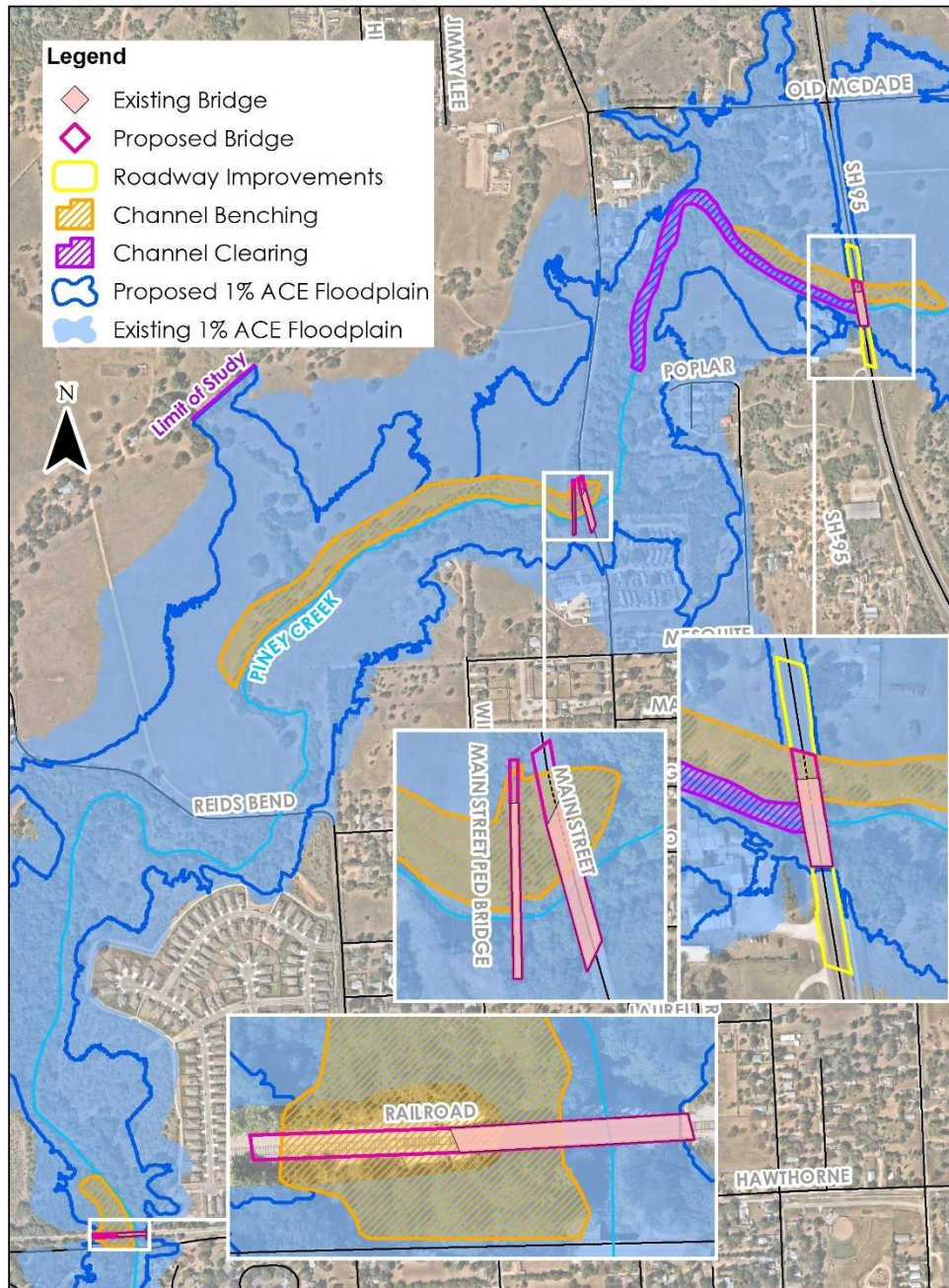


Figure 1: Study Area Location

Modeling Analysis

The following sections provide an overview of the data, hydrologic analysis, and hydraulic analysis used to identify the existing condition flood risk.

Data Collection and Site Visits

Half obtained and reviewed, or performed the following items:

- Bastrop County Flood Protection Planning (FPP) Study for the Piney Creek watershed models dated March 2018
- TWDB CTP Flood Risk Project Mapping Activity Statement No. 14 for the Lower Colorado-Cummins Watershed Study dated April 2020
- Bastrop County Flood Infrastructure Fund (FIF) Study for the Piney Creek watershed currently ongoing
- Structure survey completed as part of the Bastrop County FPP and FIF watershed study
- Subsurface Utility Engineering (SUE) desktop analysis conducted in February 2023
- Environmental constraints desktop evaluation conducted in March 2023

The Bastrop County FIF watershed study was the foundation of this preliminary analysis. It used the following items for its analysis:

- Terrain Data: StratMap 2017 Central Texas LiDAR
- Soils Data: 2019 Natural Resource Conservation Service (NRCS) Web Soil Survey
- Land Use Data: 2011 National Land Cover Database
- Rainfall: NOAA Atlas 14

Hydrology

Below outlines the methodologies used for the hydrologic analysis:

- Modeling Software: HEC-HMS version 4.2
- Rainfall Data: NOAA Atlas 14, 24-hour duration, frequency storm temporal distribution
- Initial Losses: Initial and Constant loss method
- Hydrograph Approach: Snyder’s Unit Hydrograph method
- Routing: Modified Puls
- Areal Reduction: Depth-area computations using TP-40

No changes to the Bastrop County FIF Piney Creek hydrologic models were made. **Table 1** below provides a summary of the peak flows along Piney Creek from the downstream study limit at UPRR to SH 95.

Table 1: Piney Creek Peak Flows

Location	Peak Flows (cfs)	
	50-year	100-year
State Highway 95	31,070	37,170
Main Street	31,230	37,430
Reids Bend	31,910	38,180
UPRR	31,970	38,250

Hydraulics

Below outlines the methodologies used for the hydraulic analysis:

- Modeling Software: HEC-RAS version 5.0.3, 1D steady-state simulation
- Hydrologic Data: see above
- Boundary Conditions: Downstream normal depth

Existing Condition Flood Risk

FEMA Floodplain

Piney Creek is a FEMA regulated stream with Zone AE designated floodplain as shown on Flood Insurance Rate Map (FIRM) Map Numbers 48021C0215E and 48021C0355E, dated January 19, 2006. FEMA is currently in the process of updating the Flood Insurance Study (FIS) for Bastrop County, Texas and Incorporated Areas. The preliminary FIS study, Number 48021CV000C, will become effective May 9, 2023. The preliminary FEMA FIS for Piney Creek is based on the *Lower Colorado Cummings FEMA Preliminary Modeling and Mapping*.

Existing Conditions

The existing conditions flood risk includes three road crossings that overtop and two subdivisions that flood during the 100-year storm event. **Figure 1 (above)** shows the Piney Creek the preliminary FEMA 100-year floodplain (effective May 9, 2023). The two subdivisions located in close proximity to the channel banks of Piney Creek are Bastrop Estates Mobile Home Park and Mercedes Cove subdivision, both of which are located in the FEMA regulated 100-year floodplain. **Table 2** below summarizes the roadway flood risk.

Table 2: Piney Creek Existing Roadway Flood Risk

Roadway	Existing Overtopping Depth (ft)		Approx. Level of Service
	50-year	100-year	
State Highway 95	0.6	2.3	25-year
Main Street	9.6	11.8	2-year
Reids Bend	13.7	16.7	10-year
UPRR	-	-	500-year

Proposed Improvements

The proposed improvements provide an all-weather access at SH 95 and reduces overtopping at Main Street and Reids Bend during the 100-year storm event. Below is a summary of the proposed conveyance improvements shown on **Figure 1 (above)** that incorporates bridge improvements, channel benching improvements, and vegetation thinning to remove underbrush and smaller trees within the channel. **Table 3** provides a summary of the proposed improvements. No improvements are proposed for Reids Bend due to the UPRR bridge creating significant backwater. Opening up the UPRR bottleneck is proposed to reduce the overtopping at Reids Bend and Main Street.

Table 3: Summary of Proposed Improvements

Improvements	Existing Bridge Span (ft)	Proposed Bridge Span (ft)	Channel Benching (LF)	Vegetation Thinning (LF)
SH 95 Bridge Improvement	190	250	1,200	2,200
Main Street Bridge Improvement	200	300	2,500	-
UPRR Bridge Improvement	150	300	450	-

Proposed channel benching was located approximately four feet above the Piney Creek flow line to minimize potential impacts to Waters of the US jurisdiction. Typical bench cut extends 80 feet with a 4(H):1(V) slope until the cut daylight. Channel vegetation thinning was considered to lower the roughness coefficient to promote efficient channel flow. Vegetation thinning would involve removal of underbrush vegetation while leaving trees of a selected size and native grasses to hold the soils in place to prevent erosion. See **Attachment 1** for the Piney Creek Benching FMP summary sheet for further project information.

Project Benefits

The Piney Creek Benching project includes three roadways to provide Bastrop residents ingress/egress to the city. During the 100-year storm event, SH 95, Main Street, and Reids Bend overtopping prevents safe access for residents and emergency needs. **Table 4** summarizes a water surface elevation (WSEL) comparison of existing to proposed conditions during the 100-year storm event. The table indicates the proposed mitigation solution would reduce flood elevations a maximum of approximately eight (8) feet upstream of the UPRR. Downstream of the UPRR, the Colorado River flood elevation of 353 feet controls and is approximately 4.5 feet higher than the Piney Creek flood elevation of 349.3 feet. Providing a higher level of service for the roadway creek crossing over Piney Creek will allow residents and emergency vehicles a safe travel route during large storm events. **Table 5** summarizes the post-project overtopping depths that will be reduced and the proposed level of service at each bridge crossing. Level of service at SH 95 is increased from a 25-year storm event to a 100-year storm event creating an all-weather road creek crossing. Main Street shows a reduced overtopping depth with an increase in level of service to a 10-year storm event from a 2-year storm event. Reids Bend level of service remains the same at a 10-year level of service. A summary of risk reduction benefits for the proposed flood mitigation project are shown in **Table 6**.

Table 4: Piney Creek 100-year WSEL Comparison

Cross Section	Existing WSEL (ft)	Proposed WSEL (ft)	Δ WSEL (ft)	Cross Section	Existing WSEL (ft)	Proposed WSEL (ft)	Δ WSEL (ft)
18384	379.46	379.46	0.00	8876	362.37	358.75	-3.62
17993	378.15	378.14	-0.01	8841	Main Street		
17572	376.83	376.81	-0.02	8813	362.27	358.36	-3.91
17238	377.12	377.11	-0.01	8780	362.19	358.29	-3.90
16674	376.11	376.08	-0.03	8758	362.16	358.30	-3.86
16291	374.48	374.36	-0.12	8741	Main Street Ped Bridge		
15698	374.11	374.01	-0.10	8730	362.19	358.04	-4.15
14947	373.77	373.65	-0.12	8483	362.13	357.96	-4.17
14366	373.23	373.09	-0.14	7920	360.57	356.98	-3.59
13876	372.11	371.93	-0.18	7369	360.19	356.42	-3.77
13250	369.27	368.32	-0.95	7102	360.00	355.83	-4.17
12919	368.24	366.05	-2.19	6779	359.83	355.72	-4.11
12691	368.63	365.18	-3.45	6522	359.77	355.66	-4.11
12340	368.56	366.42	-2.14	5536	359.45	354.68	-4.77
12049	368.42	365.57	-2.85	5415	359.43	354.63	-4.80
11993	SH 95			5384	Reids Bend		
11937	365.50	363.99	-1.51	5334	359.47	354.78	-4.69
11608	365.59	364.18	-1.41	5281	359.47	354.79	-4.68
11297	365.47	364.10	-1.37	3631	358.50	351.94	-6.56
11111	365.04	363.38	-1.66	2525	358.21	350.15	-8.06
10558	363.26	360.33	-2.93	1642	357.58	349.51	-8.07
10162	362.83	358.87	-3.96	1308	353.08	348.86	-4.22
9749	362.56	357.99	-4.57	1288	349.33	348.50	-0.83
8969	362.52	358.85	-3.67	1267	Railroad		

Table 5: Piney Creek Proposed Roadway Flood Risk Reduction

Roadway	Proposed Overtopping Depth (ft)		Approx. Level of Service
	50-year	100-year	
State Highway 95	-	-	100-year
Main Street	6.3	8.1	10-year
Reids Bend	9.8	12.1	10-year
UPRR	-	-	500-year

Table 6: Risk Reduction Benefits

Flood Risk Condition	Number of At-Risk Buildings	Number of At-Risk Critical Facilities	Number of At-Risk Roadway Crossings (low water crossings)	Estimated At-Risk Daytime Population (based on building populations)	Impacted Agricultural Land (square miles of at-risk land cover)
Existing Condition 1% Annual Chance (100-year)	66	1	3	20	0.54
Post-Project Condition 1% Annual Chance (100-year)	28	0	2	7	0.4

Note: Number of at-risk roadway crossing counts are based on the overtopping roadways for this project and not based on the Regional Flood Plan low water crossing database.

Estimate of Probable Cost

An opinion of probable cost was prepared for the proposed Piney Creek Benching project. The cost estimate includes construction and soft costs (engineering, permitting, construction phase services, etc.). Local and regional TxDOT average bid unit costs provided a basis for estimating unit costs for construction items. A percentage of the construction costs was applied for each soft cost item. A 30% contingency was applied to the construction cost subtotal to account for uncertainties and assumptions made in the conceptual design development. The total project cost is estimated at \$23,991,550. A detailed project cost breakdown is located in the **Attachment 1**.

Project Constraints

Potential constraints identified for this project include environmental permitting constraints, utility relocation/conflicts, and multi-jurisdictional coordination.

Environmental Constraints

A desktop level environmental constraints analysis was performed for the proposed project. The analysis included water resources, biological resources, and cultural resources assessments. A report was prepared discussing the findings of the analysis and is included as **Attachment 2. Table 7** summarizes the environmental constraints.

Table 7: Environmental Constraints Summary

Regulating Entity	Database Findings	Applicable Regulations
Waters of the US (WOTUS)/US Army Corps of Engineers (USACE)/Section 404 of the Clean Water Act (CWA)	National Wetlands Inventory (NWI) indicates mapped wetlands	Section 404 of the CWA
Federal Emergency Management Agency (FEMA)	Regulated Zone AE and A	FEMA/Local Jurisdiction FEMA Floodplain Regulations and local ordinances
Protected Species/US Fish and Wildlife Service (USFWS)	IPaC report identifies four bird species, two amphibian species, on insect species, three arachnid species, and one plant species are federally listed either threatened or endangered in Bastrop County.	Endangered Species Act (ESA)
Critical Habitat/US Fish and Wildlife Service (USFWS)	Critical habitat for the Houston toad in close proximity of project area.	Endangered Species Act (ESA)
Rare, Threatened, and Endangered Species of Texas (RTEST)/Texas Parks and Wildlife Department (TPWD)	65 species listed on TPWD's RTEST list for Bastrop County	TPWD Code and Texas Administrative Code (TAC) for protected state listed species

Utility Conflicts

A Quality Level (QL) D (records request only) subsurface utility evaluation was conducted to identify potential utility conflicts in the project area. Utilities identified are City of Bastrop water and wastewater lines, Bastrop Power and Light, AT&T aerial and buried lines, LCRA electrical transmission lines, ONCOR electric transmission lines, Bluebonnet natural gas pipeline, and Spectrum lines. Primarily, utilities were located within the public right of way at each of the roadway creek crossings. As the project advances, further evaluation and coordination of existing utilities is required to determine if protecting or relocating the utilities is required.

Drainage Easement

To allow access to maintain the proposed channel benching, a drainage easement is required. A drainage easement will allow City of Bastrop to perform needed maintenance to ensure the channel benching functions as designed. The easement should extend the entire limits of the proposed benching. During design, more detailed extents of the easement will need to be determined and a meets and bounds legal description and sketch of the easement should be prepared.

Multi-Jurisdictional Coordination

Piney Creek is located at the western most city limits which is a shared jurisdictional boundary for City of Bastrop and Bastrop County. Both Main Street and Reids Bend will require City and County coordination for the proposed bridge and channel benching improvements. Proposed railroad improvements will need coordination and approval with UPRR to widen the timber railroad bridge. Finally, SH 95 is a TxDOT on-system roadway and will require coordination with TxDOT for the proposed improvements.

Benefit Cost Analysis

The TWDB Benefit Tool Kit was used to determine the Benefit Cost Analysis (BCA) for the Piney Creek Benching project. By creating an all-weather access road crossing at SH 95, the detour mileage is significantly reduced by approximately 30% which directly reduces the emergency services response times. Traffic counts were taking

from the TxDOT TPP Statewide Annual Average Daily Traffic (AADT) for SH 95, Main Street, and Reids Bend. Agricultural damages were also considered based on the Regional Flood Plan database to determine agricultural losses. To determine damages, the 50- and 100-year storm events were used to estimate expected damages for both residential and commercial properties. And finally, green infrastructure was added to the benching areas for additional riparian areas along the project. An electrical substation is located in the floodplain extents but was not included due to unknown information requested by the TPWD Benefit Tool Kit. As the project advances, this data can be obtained to refine the BCA. The known available data was entered into the TPWD Benefit Tool Kit to determine a preliminary benefit cost ratio of 0.6. See **Attachment 1** for the data inputs for the Benefit Cost Analysis (BCA).

No Negative Impact

In accordance with the *TWDB Technical Guidelines for Regional Flood Planning*, “No Negative Impact means that a project will not increase flood risk of surrounding properties. Using best available data, the increase in flood risk must be measured by the 100-year frequency storm event water surface elevation and peak discharge. It is recommended that no rise in water surface elevation or discharge should be permissible, and that the analysis extent must be vast enough to prove proposed project conditions are equal to or less than the existing conditions.”

The preliminary modeling confirms the following:

- Stormwater does not increase inundation in areas beyond the public right-of-way, project property, or easement.
- Stormwater does not increase inundation of storm drainage networks, channels, and roadways beyond design capacity.
- Maximum increase of 1D Water Surface Elevation rounds to 0.0 feet (< 0.05ft) measured along the hydraulic cross-section within the right-of-way.

This memorandum is prepared to serve as certification of no negative impact for the Piney Creek Benching flood mitigation project. As the project is advanced, the impact analysis should be updated to reflect final design and confirm no negative impacts.

Recommendation

Based on the findings presented in this Technical Memorandum it is recommended that Flood Management Evaluation No. 101000102 be reclassified as a Flood Mitigation Project. The City of Bastrop concurs with this recommendation and requests that it be considered by the Regional Flood Planning Group for inclusion in the amended Regional Flood Plan for the Lower Colorado-Lavaca Region.

Technical Memorandum Attachments

Attachment 1. Flood Mitigation Project Documentation

- FMP Summary Sheet
- Cost Estimate
- Benefit Cost Ratio

Attachment 2. Environmental Constraints Report

Attachment 1

Flood Mitigation Project Documentation

Flood Mitigation Project (FMP)

Title ID#
Sponsor (note if City or County) Commitment Yes No
Technical committee recommend Yes No RFPG recommend Yes No

REGION 10

Project Type

STRUCTURAL

Detention Channel modification Bridge/culvert Storm drain Levee/floodwall

Other

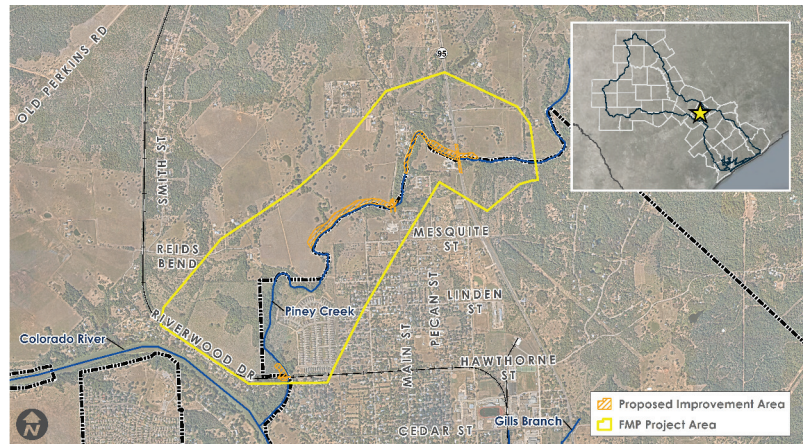
NON-STRUCTURAL

Property buyouts Floodproofing Flood readiness/resilience Flood warning system/gauges

Other

Problem Area

City County
Watershed name(s)
Tributary(ies)
HUC#(s) Stream miles (est.)
Drainage area: square miles, est or acreage, est
Social Vulnerability Index (SVI)
(SVI score 0.0 indicates least vulnerable; 1.0 indicates most vulnerable.)
Other



Flood Risk Description

The existing condition flood risk includes three road crossings that overtop and two subdivisions that flood during the 100-year storm event. Overtopping roads include SH 95, Main Street, and Reids Bend. These roads are access routes for residents in and out of the City of Bastrop. The two subdivisions that are located in close proximity to the channel banks of Piney Creek are Bastrop Estates Mobile Home Park and Mercedes Cove subdivision, both of which are located in the FEMA regulated 100-year floodplain.

Proposed level-of-service Status Atlas 14 rainfall used

Project Description

The proposed improvements provide an all-weather access (100-year level of service) at SH 95 and reduces overtopping at Main Street and Reids Bend during the 100-year storm event. The project improvements include approximately 4,150 LF of channel benching, 2,200 LF of channel clearing or vegetation thinning, and bridge improvements at UPRR bridge, Main Street and pedestrian bridge, and SH 95. UPRR bridge is proposed to be widened from a 150 foot span to a 300 foot span. Main Street bridge is currently a 100 foot span and is being proposed to a 300 foot span. The pedestrian bridge at Main Street is a 50 foot span and is proposed to be a 300 foot span to match Main Street. And finally, SH 95 is currently a 60 foot span and is proposed to be a 250 foot span.

Related Goal(s)

6.1 Reduce the number of structures and critical facilities that are at high risk through the implementation of structural flood mitigation projects. 6.2 Increase the number of entities that mitigate flood risk at vulnerable roadways or waterways.

Estimated Project Cost

Capital cost Ongoing O&M costs Cost/benefit analysis
Potential funding source(s)

Project: Piney Creek Benching
Engineer's Estimate of Probable Construction Cost
Date: April 6, 2023



PAY ITEM NO	DESCRIPTION	UNITS	UNIT PRICE	QTY	TOTALS
UNION PACIFIC RAILROAD					
1	REMOVING CONC (RIPRAP)	SY	\$81	700	\$56,700
2	EXCAVATION (CHANNEL)	CY	\$25	25,657	\$641,425
3	PREPARING ROW	AC	\$40,000	1	\$53,200
4	RIPRAP (STONE PROTECTION)(D ₅₀ =18 IN)	CY	\$223	550	\$122,865
5	REMOV STR (BRIDGE 100 - 499 FT LENGTH)	EA	\$50,000	1	\$50,000
6	RAILROAD	SF	\$150	5,000	\$750,000
7	PERMANENT EROSION CONTROL	SY	\$20	6,437	\$128,740
RAILROAD SUBTOTAL					\$1,802,929.50
8	MOBILIZATION		10%		\$180,293
9	TEMPORARY EROSION CONTROL		2%		\$36,059
10	TRAFFIC CONTROL		2%		\$36,059
CROSSING SUBTOTAL					\$2,055,340
30% CONTINGENCY					\$616,602
BASE TOTAL					\$2,671,942
11	ENVIRONMENTAL PERMITTING		2%		\$53,439
12	ENGINEERING DESIGN & GEOTECH		15%		\$400,791
13	CONSTRUCTION SERVICES & TESTING		10%		\$267,194
UNION PACIFIC RAILROAD					\$3,393,366
MAIN ST					
14	EXCAVATION (CHANNEL)	CY	\$25	138,503	\$3,462,575
15	PREPARING ROW	AC	\$40,000	7.2	\$288,000
16	RIPRAP (STONE PROTECTION)(D ₅₀ =18 IN)	CY	\$223	1,330	\$297,109
17	REMOV STR (BRIDGE 100 - 499 FT LENGTH)	EA	\$50,000	2	\$100,000
18	BRIDGE	SF	\$150	8,688	\$1,303,200
19	BRIDGE (PEDESTRIAN)	SF	\$150	3,270	\$490,500
20	RAIL	LF	\$180	400	\$72,000
21	PERMANENT EROSION CONTROL	SY	\$20	34,850	\$697,000
MAIN ST SUBTOTAL					\$6,710,383.70
22	MOBILIZATION		10%		\$671,038
23	TEMPORARY EROSION CONTROL		2%		\$134,208
24	UTILITY RELOCATION		5%		\$335,519
25	TRAFFIC CONTROL		2%		\$134,208
CROSSING SUBTOTAL					\$7,985,357
30% CONTINGENCY					\$2,395,607
BASE TOTAL					\$10,380,964
26	ENVIRONMENTAL PERMITTING		2%		\$207,619
27	ENGINEERING DESIGN & GEOTECH		15%		\$1,557,145
28	CONSTRUCTION SERVICES & TESTING		10%		\$1,038,096
MAIN ST					\$13,183,824
SH95					
29	EXCAVATION (ROADWAY)	CY	\$25	25	\$625
30	EXCAVATION (CHANNEL)	CY	\$25	55,786	\$1,394,650
31	PREPARING ROW	AC	\$40,000	6	\$240,000
32	REMOV STR (BRIDGE 100 - 499 FT LENGTH)	EA	\$50,000	1	\$50,000
33	BRIDGE	SF	\$150	11,665	\$1,749,750
34	EMBANKMENT (FINAL)(DENS CONT)(TY C)	CY	\$45	25	\$1,125
35	CUT & RESTORING PAVEMENT (BASE AND HMAC)	SY	\$150	75	\$11,250
36	RIPRAP (STONE PROTECTION)(D ₅₀ =18 IN)	CY	\$223	1,300	\$290,407
37	RAIL	LF	\$180	200	\$36,000
SH95 SUBTOTAL					\$3,773,807.00
38	MOBILIZATION		10%		\$377,381
39	TEMPORARY EROSION CONTROL		2%		\$75,476
40	UTILITY RELOCATION		5%		\$188,690
41	TRAFFIC CONTROL		2%		\$75,476
CROSSING SUBTOTAL					\$4,490,830
30% CONTINGENCY					\$1,347,249
BASE TOTAL					\$5,838,079
41	ENVIRONMENTAL PERMITTING		2%		\$116,762
42	ENGINEERING DESIGN & GEOTECH		15%		\$875,712
43	CONSTRUCTION SERVICES & TESTING		10%		\$583,808
SH95					\$7,414,361
PROJECT TOTAL					\$23,991,550

This statement was prepared utilizing standard cost estimate practices. It is understood and agreed that this is an estimate only, and that Engineer shall not be held liable to Owner or third party for any failure to accurately estimate the cost of the project, or any part thereof. Unit prices are in current dollars and should be adjusted as required when letting schedule for project is determined.

Piney Creek Channel Benching Improvements BCA

Data Compilation and Assumptions

- Flooded Streets
 - Values for three crossing improvements, SH 95, Main St, and Reids Bend, combined in spreadsheet as one improvement.
 - Benefiting structures were evaluated based on an assumption of the addition of 3-ft for mobile homes, 1.5-ft for pier and beam, and 0.5-ft for slab on grade from the ground elevation to determine an estimated finished floor elevation. Foundation type was chosen using street view when structures were visible.
 - Miles of flooding: width of floodplain footprint along roadway.
 - Duration of flooding: HMS model data.
 - Daily traffic amounts: most recent TxDOT counts, same values for existing and proposed for all frequencies.
 - Mileage for detour: shortest distance to opposite side of Piney Creek without using roadways that are overtopping within model.
 - Detour time: Minutes for mileage with assumption of traveling at 30 mph.
 - Normal EMS response time: Combined 10 minutes for each crossing resulting in 30 minutes.
 - EMS response time during event: Sum of normal EMS response time with calculated detour time.
 - Number of households/commercial buildings impacted by EMS due to flooded streets: determined approximate area of impact where distance to location is greater using detour than using flooded crossing. Used TWDB structure footprints classified as residential or commercial for counts within determined area.
- Low Water Crossing
 - Values for two crossing improvements, SH 95 and Main St, combined in spreadsheet as one improvement.
 - Depth of flooding: model results. The greatest value in drop down list within TWDB excel document is 48". Although there are improvements in flood depth for proposed conditions for both crossings and both 100 and 50-yr events, the combined values of the two crossings are always greater than 48", therefore no improvements in depth are reflected in the spreadsheet.
 - Duration of flooding: HMS model data.
 - Daily traffic: most recent TxDOT counts, same values for existing and proposed for all frequencies.
- Other Inputs- Agricultural Lands:
 - Values for pasture and crops compiled from Region 10 RFPG agricultural land data derived from USDA NASS CDL. Areas classified as Range/Pasture or Ranching were included as pasture values and areas classified as farming were included as low-value crops. The crop values were estimated using an average of crops listed within the Texas Almanac ([Texas Crop Production: Acres, Yield, Value | TX Almanac \(texasalmanac.com\)](https://www.texasalmanac.com))
- Other Inputs- Green Infrastructure:
 - Benching extents were calculated in acres to determine addition of riparian areas.

Input Into BCA Toolkit		
Project Useful Life	30	
Event Damages	Baseline	Project
50 - year storm	\$21,782,206	\$8,371,514
100 - year storm	\$28,909,437	\$9,818,633
Total Benefits from BCA Toolkit	\$4,537,192	
Other Benefits (Not Recreation)	\$5,223,671	
Recreation Benefits	-	
Total Costs	\$16,010,986	
Net Benefits	-\$6,250,123	
Net Benefits with Recreation	-\$6,250,123	
Final BCR	0.6	
Final BCR with Recreation	0.6	

This workbook has been designed to work in conjunction with FEMA's BCA Toolkit v6.0 to calculate the Benefit-Cost Ratio (BCR) of flood risk management projects for the Texas Water Development Board (TWDB).

The BCA Input Workbook is designed to help collate the necessary input data and to calculate the Baseline (Before Mitigation) and Project (After Mitigation) Damages. These damages are then input into the FEMA BCA Toolkit to calculate the Project benefits.

[Instructions on how to download and install the FEMA BCA Toolkit v6.0 can be found here.](#)

Please refer to Model Instructions for detailed instructions on how to use this workbook.

Input cells are highlighted green.

The TWDB BCA Input Workbook calculates benefits from the following benefit areas, which will be input into the BCA Toolkit:

- Structure damages & associated loss of function
- Reduction in street flooding
- Utility loss of function
- Agricultural damages
- Low water crossings replacements

The following benefit areas are calculated entirely in the BCA Toolkit:

- Critical facility loss of function

The following benefit areas are calculated entirely in the TWDB BCA Input Workbook:

- Recreation benefits
- Water supply benefits
- Environmental benefits of green infrastructure
- Residual value of investment

Project Name	Piney Creek Benching
Project Region	Region 10
Project Type	Channel Benching and Road Crossing Improv
Start Construction Year	2028
End Construction Year	2030

Input up to 3 Recurrence Intervals for which you have water level (H&H) data.
At least 1 Recurrence Interval must be the 100-year storm.
Recurrence Intervals must be input in decreasing order of likelihood (i.e., 50-year storm before 100-year storm).

Recurrence Interval 1	50 year storm
Recurrence Interval 2	100 year storm
Recurrence Interval 3	

Types of Project Impacts

Residential Structure Damage Reduction	Yes	Input structure data and water levels in 'Residential_Structures' sheet; Damage totals will be shown in 'Total Impacts'
Commercial Structure Damage Reduction	Yes	Input structure data and water levels in 'Commercial_Structures' sheet; Damage totals will be shown in 'Total Impacts'
Critical Facility (Police, Fire, Hospital) Loss of Function Reduction	No	
Reduction in Street Flooding	Yes	Input water levels and detour information in the 'Flooded Streets' sheet; Damage totals will be shown in 'Total Impacts'
Utility Outage Reduction	No	
Agricultural Damage Reduction	Yes	Input affected acreages in 'Other Inputs' sheet; Damage totals will be shown in 'Total Impacts'
Water Supply Benefits	No	
Recreation Benefits	No	
Does this project include Green Infrastructure elements?	Yes	Input acreage of green infrastructure elements in 'Other Inputs' sheet; benefit totals will be shown in 'Total Impacts'
Does this project replace a low-water crossing?	Yes	Input water levels in 'Low Water Crossing' sheet; Damage totals will be shown in 'Total Impacts'

Capital Cost	
Right-of-Way	
Utility Relocation	\$524,210
Construction	\$23,467,340
Total Capital Cost	\$23,991,550
Operations & Maintenance (O&M)	
Baseline Annual O&M	
Project Annual O&M	
Increased Annual O&M	\$0
Project Lifespan (years)	30

Structure Information			50 - year storm				100 - year storm			
Location	Structure Type	Number of Structures	Baseline Flood Depth	Baseline Damages	Project Flood Depth	Project Damages	Baseline Flood Depth2	Baseline Damages2	Project Flood Depth2	Project Damages2
1	2106 Dragonfly Loop	Average Home	1	0	0	0	1"	\$29,580	0	0
2	320 Linden Street	Average Home	1	0	0	0	1"	\$29,580	0	0
3	326 Linden Street	Average Home	1	0	0	0	1"	\$29,580	0	0
4	Bastrop Estates Mobile Home Park 1	Average Home	1	0	0	0	1"	\$29,580	0	0
5	Bastrop Estates Mobile Home Park 2	Average Home	1	0	0	0	1"	\$29,580	0	0
6	Bastrop Estates Mobile Home Park 3	Small Home	1	0	0	0	1"	\$11,938	0	0
7	Bastrop Estates Mobile Home Park 4	Average Home	1	0	0	0	1"	\$29,580	0	0
8	Bastrop Estates Mobile Home Park 5	Small Home	1	0	0	0	1"	\$11,938	0	0
9	Bastrop Estates Mobile Home Park 6	Average Home	1	0	0	0	1"	\$29,580	0	0
10	Bastrop Estates Mobile Home Park 7	Average Home	1	0	0	0	1"	\$29,580	0	0
11	Bastrop Estates Mobile Home Park 8	Average Home	1	0	0	0	1"	\$29,580	0	0
12	Bastrop Estates Mobile Home Park 9	Average Home	1	0	0	0	2"	\$29,674	0	0
13	104 Mercedes Cove	Average Home	1	3"	\$32,317	0	5"	\$50,029	0	0
14	107 Mercedes Cove	Average Home	1	0	0	0	1"	\$29,580	0	0
15	105 Mercedes Cove	Average Home	1	0	0	0	1"	\$29,580	0	0
16	103 Mercedes Cove	Average Home	1	0	0	0	1"	\$29,580	0	0
17	102 Mercedes Cove	Average Home	1	0	0	0	1"	\$29,580	0	0
18	101 Mercedes Cove	Average Home	1	0	0	0	1"	\$29,580	0	0
19	703 Poplar Street	Average Home	1	2"	\$29,674	0	5"	\$50,029	0	0
20	2755 N Main Street	Average Home	1	3"	\$32,317	0	5"	\$50,029	1"	\$29,580
21	2759 Old McDade Rd	Average Home	1	0	0	0	1"	\$29,580	0	0
22	548 State Hwy 95	Average Home	1	8"	\$64,823	7"	10"	\$72,224	9"	\$68,524
23	566 State Hwy 95	Small Home	1	0	0	0	2"	\$12,015	0	0
24	129 Old McDade Road	Average Home	1	2"	\$29,674	0	4"	\$42,540	2"	\$29,674
25	804 Poplar Street	Average Home	1	0	0	0	2"	\$29,674	0	0
26	564 State Hwy 95	Small Home	1	0	0	0	1"	\$11,938	0	0
27	568 State Hwy 95	Average Home	1	1"	\$29,580	0	2"	\$29,674	1"	\$29,580
			27	\$218,384		\$61,121		\$845,403		\$157,358
				6		1		27		4

Address or Business Name	Structure Type	Basis of Value	Structure Value	Square Footage	50 - year storm				100 - year storm			
					Baseline Flood Depth	Baseline Damages	Project Flood Depth	Project Damages	Baseline Flood Depth2	Baseline Damages2	Project Flood Depth2	Project Damages2
1 Bastrop Veterinary Hospital	Medical Office	Square Footage		5,178	0		0		2"	\$17,677	0	
2 570 State Hwy 95	Convenience Store	Square Footage		2,277	2"	\$8,659	0		3"	\$11,660	1"	\$5,659
				7,455		\$8,659		\$0		\$29,337		\$5,659

	50 - year storm		100 - year storm	
	Baseline	Project	Baseline2	Project2
How many miles of roadway is flooded >6"?	0.7	0.47	1.05	0.59
How long are the roadways impassable (hours)?	15.55	11.77	19.45	14.25
What is the daily traffic (vehicle count) on the affected roadways?	21,458	21,458	21,458	21,458
How much mileage does the detour add to the route? (Difference between direct route and detour)	50.13	34.58	50.13	34.58
How much time (minutes) does the detour add to the route? (Difference between direct route and detour)	100.26	69.16	100.26	69.16
Normal Emergency Medical Services (EMS) response time (minutes)	30			
EMS response time during storm event	130.26	99	130.26	99
Number of households impacted by EMS delay due to flooded streets	3699	3699	3699	3699
Number of commercial buildings impacted by EMS delay due to flooded streets	292	292	292	292

Input	50 - year storm		100 - year storm	
	Baseline	Project	Baseline2	Project2
Depth of flooding over roadway	48"	48"	48"	48"
Duration of flooding (hours)	7.43	4.67	9.42	5.33
Daily Traffic	21,028			
What is the length of the detour (minutes)?	>60	20 to 40	>60	20 to 40

****Note: These impacts will only be included in the Total Impacts if "Yes" is selected under "Types of Project Impacts" on the Project Information sheet.**

Does the project reduce utility outages?	No			
Does the project increase water supply?	No			
Does the project impact flooding on agricultural lands?	Yes			
	50 - year storm		100 - year storm	
Acreage	Baseline	Project	Baseline2	Project2
Acres of pasture damaged	252.6	185.9	318.9	242.1
Acres of high-value crops damaged				
Acres of low-value crops damaged	18.7	12.4	24.1	16.8
Crop Type	Damage/Acre			
Pasture	\$200			
High-Value Crops				
Low-Value Crops	\$300			
Does the project include any green infrastructure elements?	Yes			
Type of habitat	Acres			
Green open space				
Riparian	14.579592			
Wetlands				
Forests				
Marine & Estuary				

Project Impacts by Recurrence Interval	50 - year storm		100 - year storm	
	Baseline	Project	Baseline2	Project2
Residential Flood Damage	\$445,606	\$102,653	\$1,850,127	\$309,158
Commercial Flood Damage	\$18,759	\$0	\$56,886	\$12,428
Flooded Streets	\$1,461,413	\$760,877	\$1,827,941	\$921,198
Utility Impacts	-	-	-	-
Agricultural Losses	\$56,130	\$40,900	\$71,010	\$53,460
Low Water Crossing Damages	\$19,800,298	\$7,467,084	\$25,103,473	\$8,522,389

Flooded Structures by Recurrence Interval	50 - year storm		100 - year storm	
	Baseline	Project	Baseline2	Project2
Flooded residential structures	6	1	27	4
Impacted Residents	18	3	81	12
Flooded commercial structures	1	0	2	1
Impacted Employees	10	0	20	10

Other Project Impacts	Benefits
Water Supply Benefits	-
Environmental Benefits	\$5,223,671
Residual Value of Investment	\$0
Recreational Benefits	-

Attachment 2

Environmental Constraints Report



Firm Registration No. 312

Environmental Constraints Analysis

Piney Creek Benching Project

for

City of Bastrop, Texas

Prepared by

Halff

AVO 43796

April 2023

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1. Introduction

Halff is conducting a hydrologic and hydraulic study for the proposed Piney Creek Benching Project in Bastrop County. The purpose of the project is to reduce the overtopping depth of Piney Creek at multiple roadway crossings. These roadways include Reids Bend, North Main Street, Riverwood Drive, and Highway 95 North. The study area encompasses approximately 70 acres (see **Appendix A - Figures 1.0 and 2.0**).

2. Summary of Environmental Constraints

Halff prepared this Environmental Constraints Analysis that summarizes the potential environmental constraints and permitting requirements associated with the proposed project. Reviewed data sources include Texas Parks and Wildlife Department (TPWD), U.S. Fish and Wildlife Service (USFWS), U.S. Geological Survey (USGS), and Natural Resource Conservation Service (NRCS) and Topoview. No site visit was conducted to assess environmental constraints.

2.1 AERIAL IMAGERY DESCRIPTION

Aerial imagery maps for 2022 were reviewed and depict the study area as primarily made up of a riparian woodland corridor adjacent to Piney Creek. Four roadways and one railroad intersect the study area. Highway 95 North intersects the northeastern portion of the study area, North Main Street intersects the central portion, Magnolia Street intersects the western portion, and Riverwood Drive intersects the southernmost portion of the study area. The study area is surrounded by urban developments within the city of Bastrop to the south and developed herbaceous land to the north.

2.2 TOPOGRAPHIC MAP DESCRIPTION

The USGS topographic map for 2022 depicts the study area as containing primarily undeveloped land largely made up of a riparian woodland corridor (depicted by green shading) adjacent to Piney Creek (depicted by dashed blue line) (see **Figure 3.0**). The study area intersects four roadways and one railroad crossing (at the southernmost boundary of the study area, crossing over Piney Creek). Urban development is depicted within the city of Bastrop to the south of the study area.

2.3 WATER RESOURCES

Water resources includes surface water features (e.g., wetlands, tributaries, rivers, impoundments, and other potential waters of the United States), floodplains and groundwater features. Water resources within the study area were evaluated to identify local, state, and/or federal permitting requirements that may be associated with construction of the proposed project.

Wetlands are identified as areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Based on the review of USFWS National Wetlands Inventory (NWI) data and USGS National Hydrography Dataset (NHD) data, surface water features within the study area include one freshwater forested/shrub wetland, one freshwater emergent wetland, and one riverine feature (Piney Creek) (see **Figure 4.0**).

Site visits will be required to define the spatial limits of aquatic features located within the study area. These aquatic features include Piney Creek, one freshwater emergent wetland, and one freshwater forested/scrub-shrub wetland.

Federal Emergency Management Agency (FEMA) floodplain data were reviewed to evaluate the location of the mapped floodplains in relation to potential aquatic resources located within the study area. According to the FEMA National Flood Hazard Layer (NFHL) dataset, the entire study area is located within the 1-percent annual chance flood hazard (100-year floodplain) zone. The FEMA NFHL Map depicts the floodplain limits within the study area (see **Figure 5.0**).

2.4 BIOLOGICAL RESOURCES

The USFWS Information for Planning and Consultation (IPaC) report for the study area includes eleven federally listed species that should be considered in an effects analysis for the project. Critical habitats are specific geographic areas that contain features essential for the conservation of a threatened or endangered species and that may require special management and protection. There is one USFWS-designated critical habitat mapped within the study area for the Houston toad (*Bufo houstonensis*) which is listed as federally endangered by USFWS (see **Figure 6.0**).

The TPWD Rare, Threatened, and Endangered Species of Texas (RTEST) list for Bastrop County includes 65 species that are state listed or species of greatest conservation need. A Texas Natural Diversity Database (TXNDD) search was also conducted on March 6, 2023. The TXNDD search identified one element occurrence record (records of sightings of rare or endangered species) for the Texas garter snake within 2 miles of the study area (see **Figure 6.0**).

USFWS and TPWD data cannot substitute for on-site evaluations conducted by qualified biologists. A field visit by a qualified biologist is recommended prior to construction to determine the potential effects and impacts to protected species.

2.5 GEOLOGY

Surface geology data derived from the USGS Texas Geology database were reviewed to identify rock units within the study area. One rock unit, Fluvial terrace deposits (Qt), was identified within the study area (see **Figure 7.0**).

2.6 SOIL SURVEY

Soil data for the study area were obtained from the NRCS Web Soil Survey, which is derived from the U.S. Department of Agriculture (USDA) Soil Survey for Bastrop County, Texas. Soil units within the study area are shown atop an aerial imagery map in **Figure 8.0**. **Table 1** describes characteristics of these soil types.

Table 1: Soil Units within the Study Area

Soil Unit	Topography	Frequency of Flooding	[Hydrologic Soil Group]
Sm – Smithville fine sandy loam	0-1% slopes	None	B
Bo – Bosque loam	0-1% slopes	Occasionally flooded	B
SeD2 – Shep clay loam	3-8% slopes	None	B
No – Weswood silty clay loam	3-8% slopes	None	B
Sa – Sayers fine sandy loam	0-1% slopes	Occasionally flooded	A
AfC2 – Edge fine sandy loam	2-5% slopes	None	D

Note: Hydric soil groups are a classification system defined by NRCS in which soils are categorized into four runoff potential groups.

- Group A: High permeability, little to no runoff potential (>90% sand and <10% clay).
- Group B: High permeability, moderately low runoff potential (50-90% sand and 10-20% clay).
- Group D: Low permeability, high runoff potential (<50% sand and >40% clay).

2.7 CULTURAL RESOURCES

Because the project is being developed by the City of Bastrop, a political sub-entity of the State of Texas, it falls under purview of the Antiquities Code of Texas (Title 9, Chapter 191 of the Texas Natural Resources Code), which requires the Texas Historical Commission (THC) to review actions that have the potential to impact archeological historic properties within the public domain. The project is currently in the planning stages and is evaluating potential channel benching as a flood mitigation solution within the 69.8-acre study area.

Halff conducted desktop research to determine the potential for the project to impact archeological historic properties eligible for listing on the National Register of Historic Places (NRHP) or State Antiquities Landmark (SAL) designation. The Texas Archeological Sites Atlas maintained by the Texas Historical Commission (THC Atlas) was reviewed to determine whether any archeological historic properties, NRHP properties/districts, SALs, cemeteries, Official Texas Historical Markers (OTHM), and previous cultural resource surveys are documented within or adjacent to the study area.

THC Atlas Review

The review of the THC Atlas records revealed that there is one NRHP property (a late-19th century bridge) is documented within the study area, the majority of which has not undergone previous cultural resources surveys. In addition, two archeological historic properties have been documented in the surrounding 1-kilometer (km) vicinity. A list and description of the previously recorded archeological historic properties identified in the study area and surrounding 1-km radius is provided below in **Table 2**. The NRHP property documented in the study area consists of a cast iron truss bridge over Piney Creek that dates from 1875–1899. The property is eligible under NRHP Criterion A for its association with historic events and significance as the oldest remaining 19th century bridge in the city of Bastrop.

Table 2: Cultural resources within the study area and 1-km radius (THC Atlas 2023).

Resource ID	Resource Type	Chronology	Explanation of Resource	NRHP/ SAL Eligibility	Distance from Study Area	Year(s) Recorded
41BP81	Open campsite	Paleo Indian and Late Archaic	Scattered lithic debitage representing all stages of reduction including flakes, cores, and projectile points	Ineligible	140 meters (m)	1977, 1992
41BP82	Historic structure	Late-19 th – early-20 th century	Scattered bricks from chimney and sandstone piers with scattered artifacts	Undetermined	20 m	1977
78003292	NRHP Property	1875-1899	Truss iron bridge made by Missouri Valley Bridge & Ironworks	Listed NRHP	0 m	1978

3. Conclusions

Based on the assessment of potential environmental constraints within the study area, additional actions regarding potential environmental impacts may be required. These actions are included in **Appendix B**. The study area contains aquatic resources which may be regulated as waters of the United States (WOTUS) by the U.S. Army Corps of Engineers (USACE) under Section 404 of the Clean Water Act (Section 404). Aquatic resources within the study area including Piney Creek may be considered WOTUS to the extent of the ordinary high water mark (OHWM), and adjacent wetlands where present. To facilitate avoidance of these resources, Halff proposes to perform an on-the-ground delineation of aquatic resources within the study area in accordance with the USACE “Wetland Delineation Manual, Technical Report Y-87-1” and the “Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Great Plains Region (Version 2.0).” Additionally, to demonstrate compliance with the Endangered Species Act (ESA), Halff proposes to conduct a threatened and endangered species and habitat (T&E) assessment, which includes an evaluation of federal and state-listed threatened and endangered species for Bastrop County.

3.1 WATER AND BIOLOGICAL RESOURCES

At a minimum, recommended additional studies include a WOTUS delineation, and a T&E assessment. The WOTUS delineation would include employing GPS surveying techniques per USACE Fort Worth District’s operating procedures to delineating the limits of potential WOTUS, including wetlands; completing necessary wetland data forms and take on-site photography for representative site features; and, preparing draft and final reports describing the methodology and results of the investigation, so that the report may satisfy the jurisdictional determination requirement for future permits, if necessary. Geographic Information System shapefiles of the field data collected will be provided with the final report. The T&E assessment would include an effects determination for species occurring within the study area. The effect determination would identify whether any listed species are likely to be present; whether the project affects or has the potential to affect federal-listed species; and Halff shall address the best management practices for avoiding impacts to other wildlife during construction, specifically migratory birds and bald and golden eagles. At this phase of project development, the preliminary cost estimate for these additional studies is \$28,000.

3.1 CULTURAL RESOURCES

The desktop review revealed that future proposed ground disturbing activities within the study area could impact one NRHP property given its location within the study area and previously documented archeological historic property 41BP82 given its proximity to the study area. In addition, ground disturbing construction activities within the study area could impact undocumented cultural resources given that the majority has not been previously surveyed and is within an environmental setting that is considered conducive to past human occupation and activity. Therefore, cultural resources surveys will be required prior to any proposed ground disturbing activity within the study area to comply with the Antiquities Code of Texas (ACT). In addition, compliance with Section 106 of the National Historic Preservation Act (Section 106) would be required should the project require any federal funding or permitting. It is Halff’s recommendation that direct or indirect effects to the NRHP property documented within the study area should be avoided.

3.1.1 Additional services

The above-described cultural resources services will be implemented when the extent of ground disturbing activities have been identified (e.g., during the project design phases). Compliance with the ACT and Section 106 will at minimum require direct coordination with the THC and submittal of an ACT permit application and scope of work to perform the required field investigations in the study area. Upon issuance of the ACT permit number assigned to the project by the THC, Halff will conduct an intensive cultural

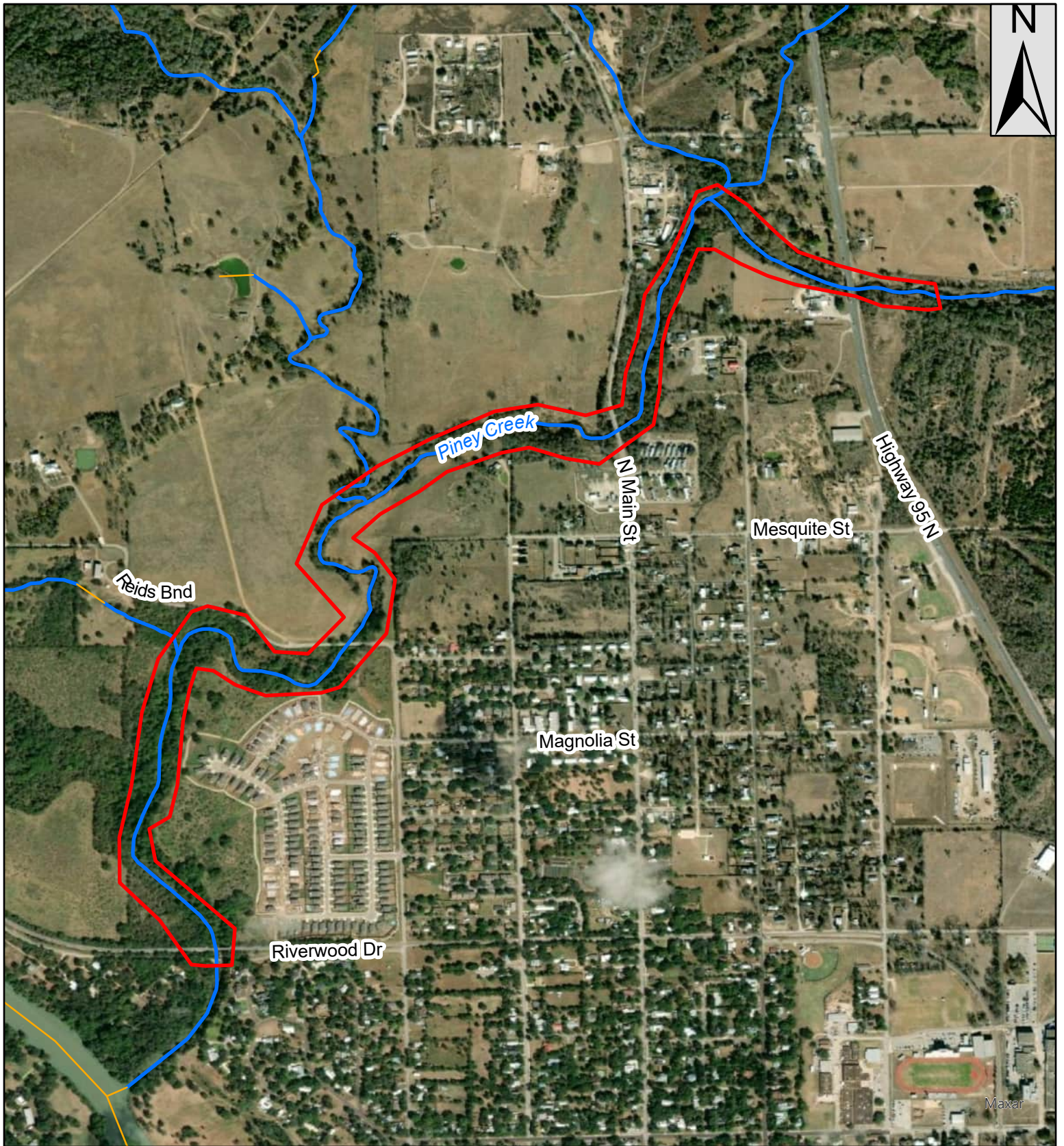
resources survey that conforms to the standards outlined by the Council of Texas Archeologists and approved by the THC. The survey will be performed by Halff archeologists who meet the U.S. Secretary of the Interior's (SOI) Professional Qualification Standards for Archeology and Historic Preservation under the direction of an SOI-qualified Principal Investigator. The survey may include pedestrian reconnaissance, shovel testing and mechanized trenching within the proposed study area, depending on the extent of proposed ground disturbance. For example, if proposed construction activities are greater than 3 feet in depth, mechanized trenching may be required to test for deeply-buried archeological sites. An SOI-qualified architectural historian will perform an effects assessment of any above-ground historic-age resources (i.e., greater than 50 years old) identified within or adjacent to the study area, including the NRHP listed bridge.

At the conclusion of the field survey, Halff will prepare and submit a draft report that conforms to the SOI Guidelines for Archaeology and Historic Preservation. The report will summarize the findings of the cultural resources survey, provide recommendations regarding any effects to archeological historic properties and determine whether additional ACT or Section 106 compliance is required. Following a period of City review, the draft report will be submitted for review by THC and all other applicable state/federal agencies as needed. After acceptance of the draft report by the THC, a final report will be submitted and all field records, photographs and collected artifacts will be prepared for permanent curation at the Center for Archaeological Studies located at Texas State University in San Marcos, Texas.

The preliminary cost estimate for the cultural resources services described above is \$30,000, which is subject to change based on the project design. Any further ACT and Section 106 requirements, including but not limited to formal NRHP/SAL eligibility evaluations of archeological historic properties discovered in the study area, and the documentation, exhumation or repatriation of human burials discovered in the study area would be scoped separately as additional services.

Appendix A – Figures

Appendix B – Environmental Constraints Table



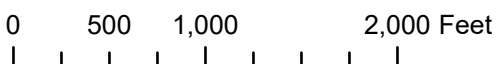
Legend

Study Area

NHD

— Stream/River

— Artificial Path



Notes:

1. Map Center: 97.32256°W
30.12853°N
2. World Imagery: Maxar, Microsoft
3. USGS National Hydrography Dataset

Piney Creek Benching Project

Bastrop County, Texas

Figure 1.0 - Location Map

AVO: 43796

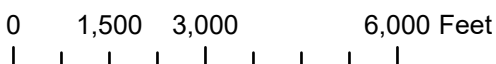
Date: 3/20/2023





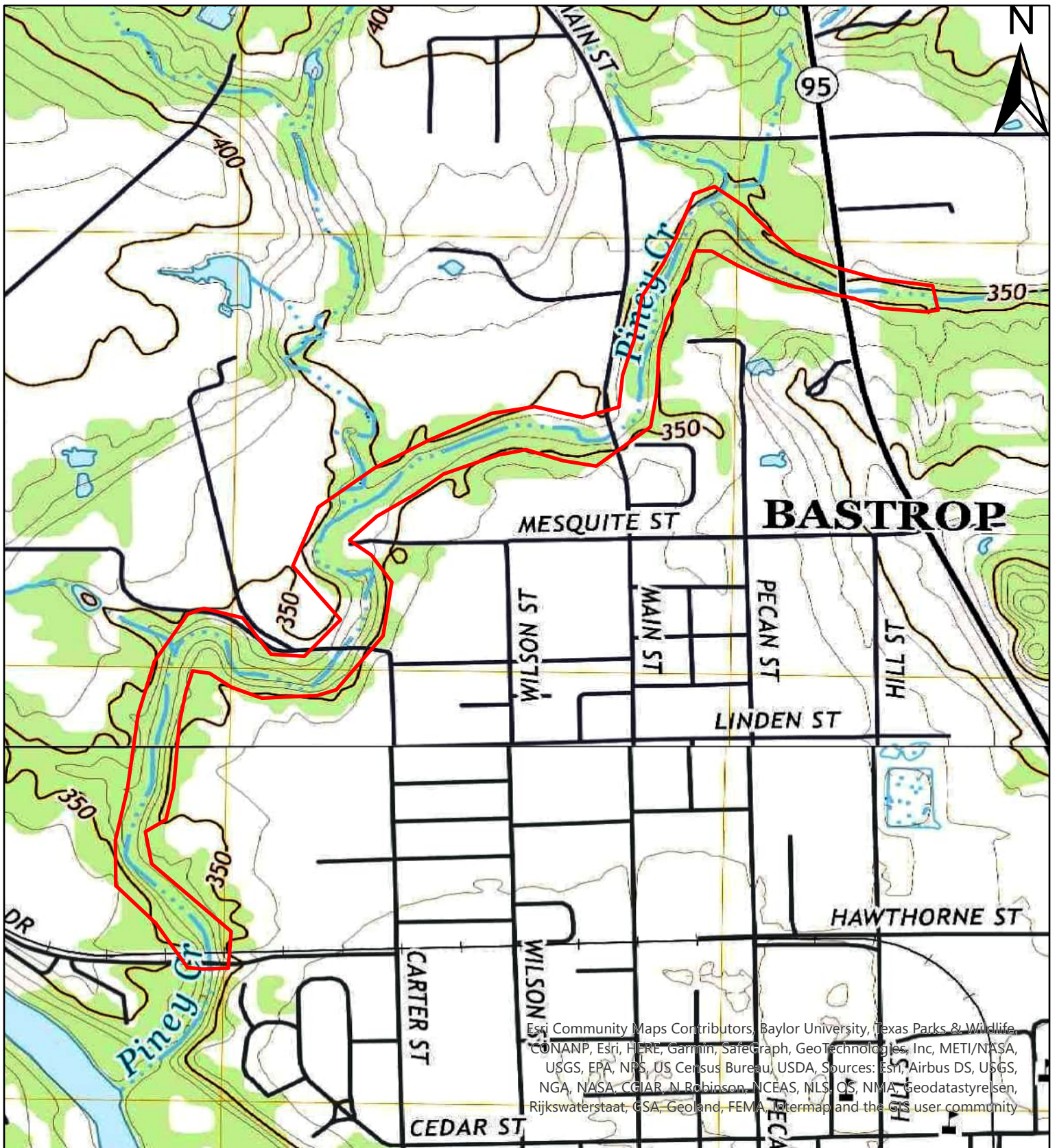
Legend

- Study Area
- City Boundary




Notes:
 1. Map Center: 97.32256°W
 30.12853°N
 2. World Street Map: Baylor University, Texas Parks & Wildlife, CONANP, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/ NASA, USGS, EPA, NPS, US Census Bureau, USDA
 3. TXDOT City Boundaries

Piney Creek Benching Project
Bastrop County, Texas
Figure 2.0 - Vicinity Map
 AVO: 43796
 Date: 3/20/2023



Legend

 Study Area

0 500 1,000 2,000 Feet

Notes:
1. Map Center: 97.32256°W
30.12853°N
2. topoview - "Bastrop, Texas;
Lake Bastrop, Texas" USGS
Quadrangle 2022

Piney Creek Benching Project

Bastrop County, Texas

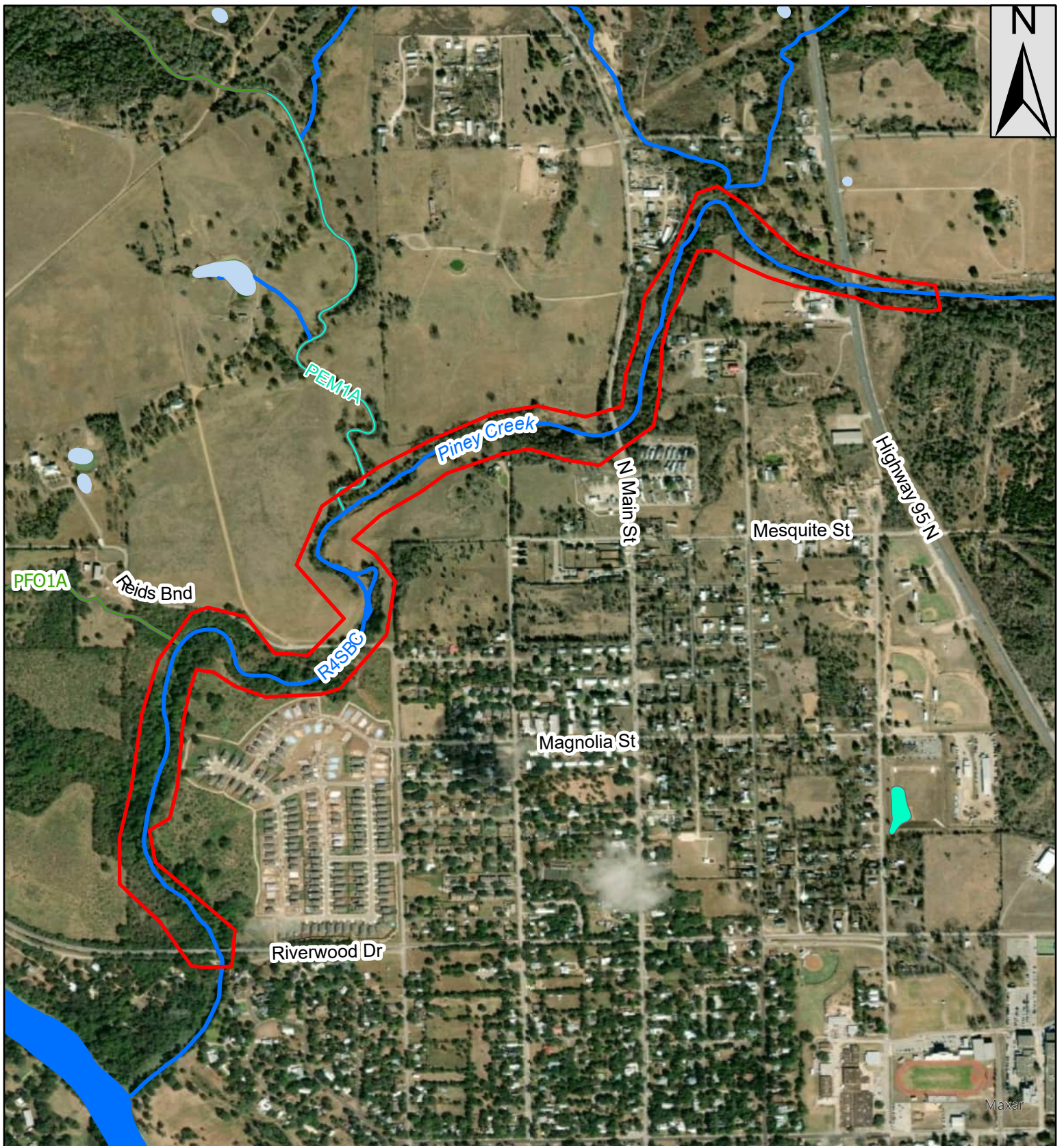
Figure 3.0 - 2022 USGS

Topographic Map

AVO: 43796

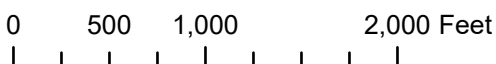
Date: 3/9/2023





Legend

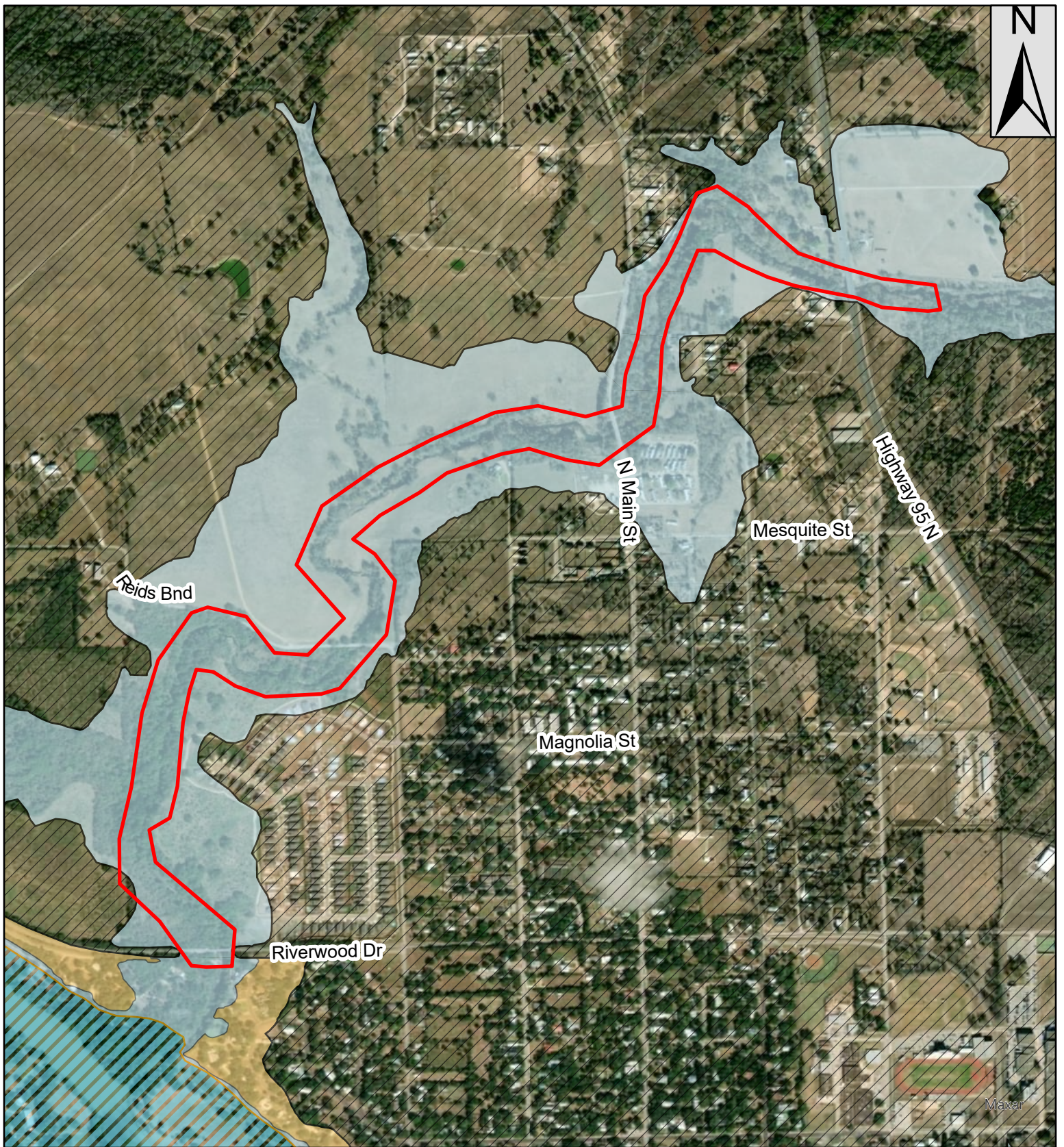
- Study Area
- Lake
- NWI**
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- NHD**
- Stream/River
- Artificial Path



Notes:
 1. Map Center: 97.32256°W
 30.12853°N
 2. World Imagery: Maxar, Microsoft
 3. USFWS National Wetland Inventory
 4. USGS National Hydrography Dataset

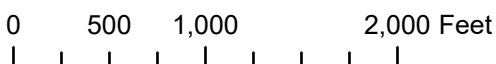
Piney Creek Benching Project
 Bastrop County, Texas
 Figure 4.0 - NWI/NHD Map
 AVO: 43796
 Date: 3/20/2023





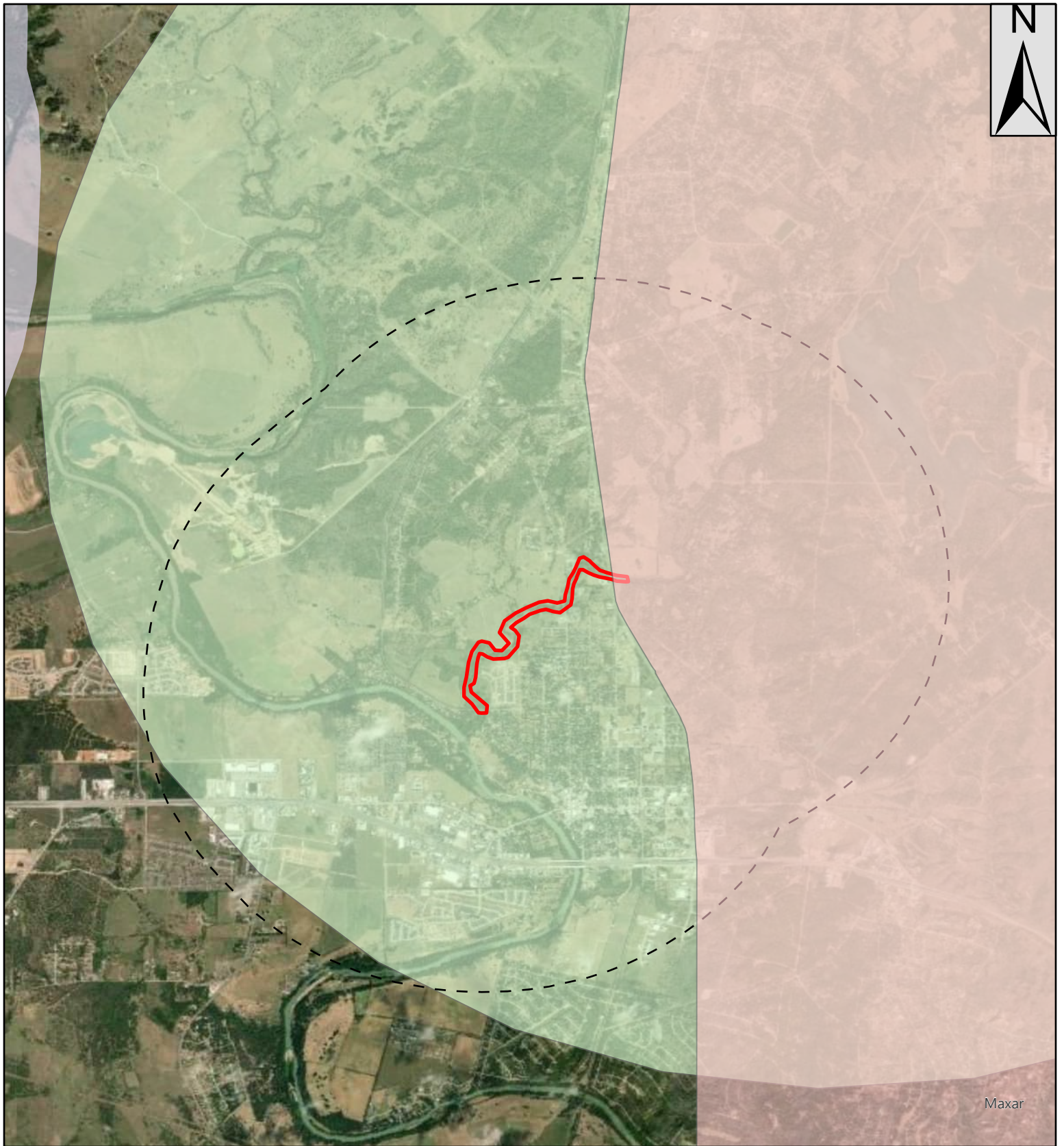
Legend

- Study Area
- 1% Annual Chance Flood Hazard
- 0.2% Annual Chance Flood Hazard
- Area of Minimal Flood Hazard
- FLOODWAY



Notes:
 1. Map Center: 97.32256°W
 30.12853°N
 2. World Imagery: Maxar, Microsoft
 3. FEMA NFHL Layer

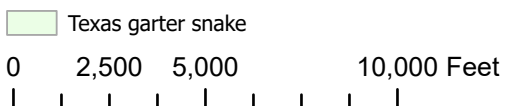
Piney Creek Benching Project
Bastrop County, Texas
Figure 5.0 - FEMA NFHL Map
AVO: 43796
Date: 3/20/2023



Maxar


Legend

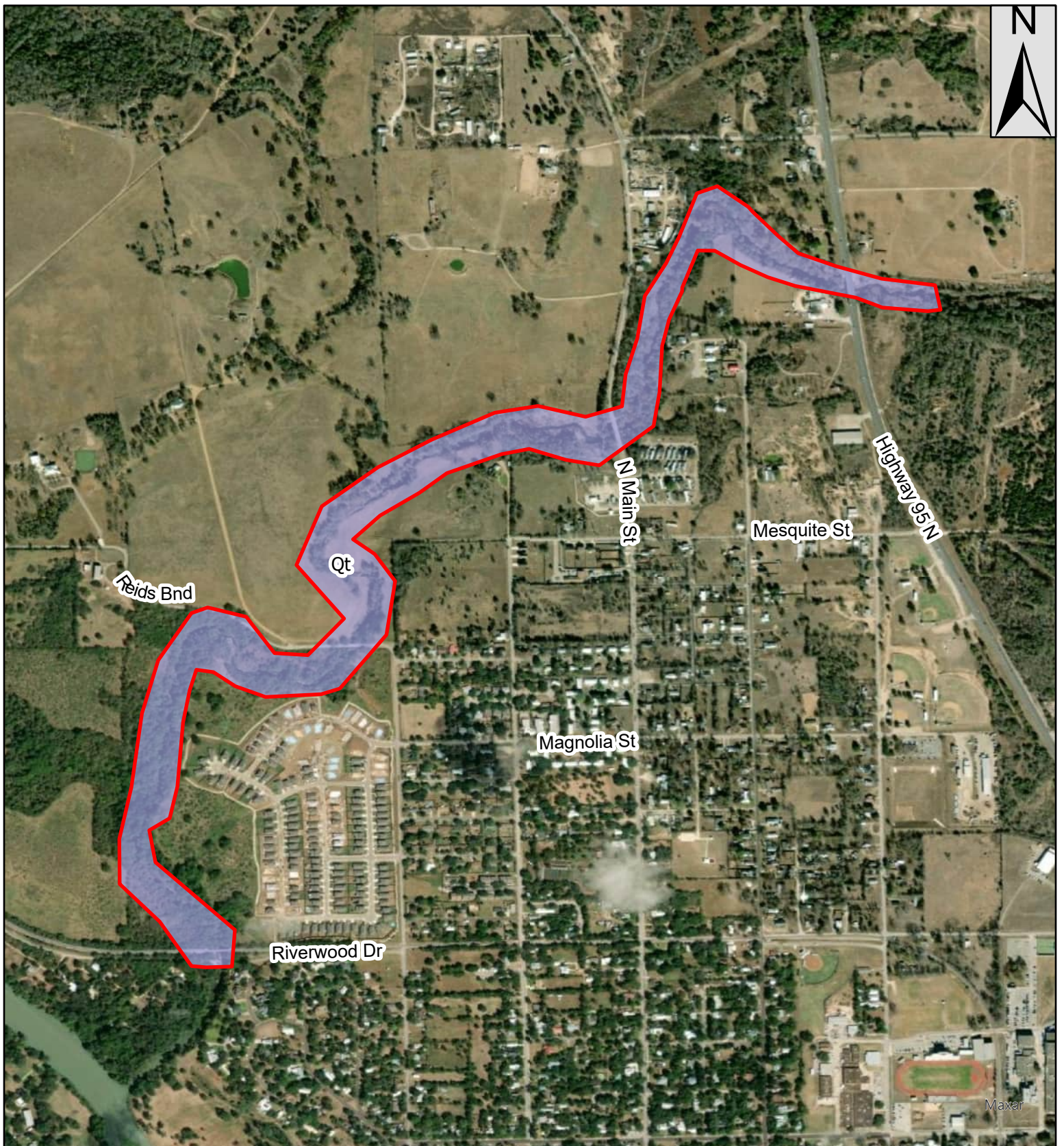
- Study Area
- 2-Mile Buffer
- Texas garter snake
- Bald eagle
- Houston toad
- USFWS Species Critical Habitat



Notes:
 1. Map Center: 97.32425°W
 30.13474°N
 2. World Imagery: Maxar, Microsoft
 3. TPWD TXNDD Element Occurrence
 4. USFWS Critical Habitat Database

Piney Creek Benching Project
 Bastrop County, Texas
 Figure 6.0 - TPWD TXNDD Map
 AVO: 43796
 Date: 3/20/2023







Legend

 Study Area

USGS Rock Unit

 Fluvial terrace deposits (Qt)

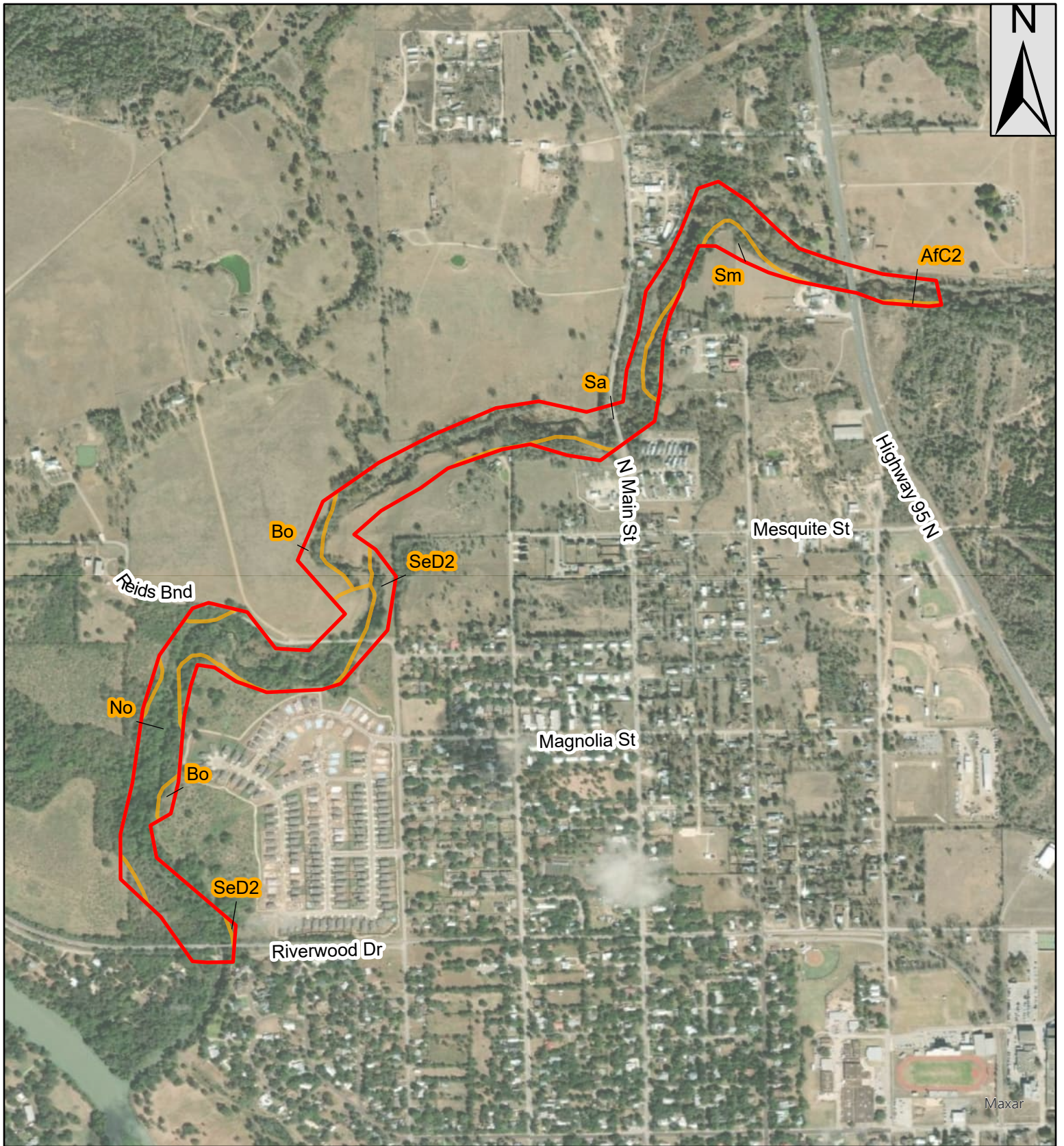
0 500 1,000 2,000 Feet



Notes:
 1. Map Center: 97.32256°W
 30.12853°N
 2. World Imagery: Maxar,
 Microsoft
 3. USGS Geology of Texas

Piney Creek Benching Project
 Bastrop County, Texas
 Figure 7.0 - USGS Geologic Rock
 Unit Map
 AVO: 43796
 Date: 3/20/2023





Legend

Study Area

NRCS Soils

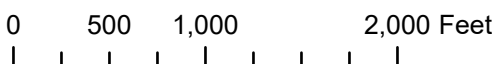
Edge fine sandy loam (AFC2)
 Bosque loam (Bo)

Weswood silty clay loam (No)

Sayers fine sandy loam (Sa)

Shep clay loam (SeD2)

Smithville fine sandy loam (Sm)



Notes:
 1. Map Center: 97.32258°W
 30.12846°N
 2. World Imagery: Maxar, Microsoft
 3. USDA Web Soil Survey
 NRCS SSURGO

Piney Creek Benching Project
 Bastrop County, Texas
 Figure 8.0 - NRCS Soil Map
 AVO: 43796
 Date: 3/20/2023

Environmental Constraints Table

Resource / Regulating Entity (or Policy)	Database Review	Database Findings	Applicable Regulations & Following Steps
Water Resources			
Jurisdictional Waters of the U.S. / U.S. Army Corps of Engineers (USACE), Section 404 of the Clean Water Act (CWA)	Data from the National Hydrography Dataset, The USFWS National Wetland Inventory (NWI), aerial imagery and LiDAR data were reviewed to identify mapped surface waters and wetlands within the study area. The database review is utilized only as a general guide to the potential location of aquatic resources and does not substitute for site surveys to identify and delineate streams and wetlands regulated under Section 404.	NHD data shows Piney Creek within the study area. The study area contains NWI-mapped wetlands.	<ul style="list-style-type: none"> The USACE regulates activities within jurisdictional waters, such as streams, rivers and lakes. Conduct a site survey to identify any USACE regulated water features and delineate boundaries. Follow USACE permitting procedures under Section 404 of the CWA, if applicable. Depending on the nature of activity, activities that result in the placement of fill within waters of the U.S. under ½-acre or below 300 linear feet are generally authorized under a nationwide permit. A pre-construction notification and compensatory mitigation may be required. Impacts to waters of the U.S. above these thresholds may require an individual permit.
Floodplains / Federal Emergency Management Agency (FEMA)	Digital data derived from FEMA Flood Insurance Rate Maps were reviewed.	The majority of the study area is located within the 100-year floodplain (Zones A, AE).	<ul style="list-style-type: none"> Comply with FEMA floodplain regulations and local ordinances, and coordinate with the local floodplain administrator. If federal funding is utilized, comply with Executive Order (EO) 11988.

Environmental Constraints Table

Resource / Regulating Entity (or Policy)	Database Review	Database Findings	Applicable Regulations & Following Steps
Impaired Assessment Units / TCEQ, Section 303(d) of the CWA	The 2020 Texas Integrated Report – Texas 303(d) List was reviewed in conjunction with TCEQ geospatial data to determine if any impaired assessment units occur within the study area.	No impaired assessment units occur within the study area.	No applicable regulations or following steps.
Biological Resources			
Protected Species / USFWS	A USFWS Information for Planning and Consultation (IPaC) Trust Resource Report was generated for Bastrop County.	According to data in the IPaC report, four bird species, two amphibian species, one insect species, three arachnid species, and one plant species are federally listed as either threatened or endangered in Bastrop County. One insect species is as a candidate for listing, and four clam species are proposed threatened or endangered.	<ul style="list-style-type: none"> The Endangered Species Act (ESA) regulates for the protection of habitat and species. Based on the report findings and a review of aerial photography, the study area has the potential to contain habitat for listed species. A site visit, conducted by a qualified biologist, should occur to determine if habitat for listed species is present within the footprint of the proposed roadway project.

Environmental Constraints Table

Resource / Regulating Entity (or Policy)	Database Review	Database Findings	Applicable Regulations & Following Steps
Critical Habitat / USFWS	The USFWS Critical Habitat for Threatened & Endangered Species online mapper was reviewed.	Critical habitat for the Houston toad (<i>Bufo houstonensis</i>) is mapped within the study area.	<ul style="list-style-type: none"> • The ESA identifies critical habitat for listed species. • Based on review of mapped critical habitat and review of aerial photography, the study area has the potential to contain habitat for the Houston toad. • A site visit, conducted by a qualified biologist, should occur to determine if habitat for listed species is present within the footprint of the proposed roadway project. • Due to the occurrence of critical habitat within the study area, if the project will impact WOTUS then a pre-construction notice (PCN) will be required. • If a PCN is necessary, a biological assessment and correspondence with USFWS will be included as a part of the PCN package.

Environmental Constraints Table

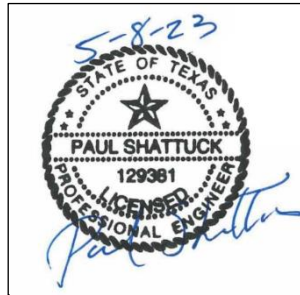
Resource / Regulating Entity (or Policy)	Database Review	Database Findings	Applicable Regulations & Following Steps
Rare, Threatened, and Endangered Species of Texas (RTEST) / TPWD	The TPWD's RTEST by County lists were reviewed for Bastrop County. TPWD's Texas Natural Diversity Database data were obtained for the study area.	<p>There are 65 species listed on TPWD's RTEST list for Bastrop County that include the following: Amphibians (5), birds (13), crustaceans (1), fish (5), insects (7), mammals (13), mollusks (2), reptiles (9), plants (10).</p> <p>One element occurrence record for the Texas garter snake (SGCN) is located within the study area.</p>	<ul style="list-style-type: none"> The Texas Parks and Wildlife (TPW) Code and Texas Administrative Code (TAC) protect state-listed species and prohibit take of state-listed species. Comply with TPW Code and the TAC for laws and regulations pertaining to endangered or threatened species. Based on the report findings and a review of aerial photography, the study area has the potential to contain habitat for listed species. A site visit, conducted by a qualified biologist, should occur to determine if habitat for listed species is present within the footprint of the proposed roadway project.
Wildlife Management Areas / TPWD	The TPWD's wildlife management areas (WMAs) were reviewed.	No WMAs occur within the study area.	No applicable regulations or following steps.
Farmland / Natural Resources Conservation Service (NRCS),	The U.S. Department of Agriculture (USDA) NRCS Web Soil Survey was utilized to identify prime farmland, farmland of statewide importance, farmland of local importance, or unique farmland within the study area.	Portions of the study area are not located within an urbanized area. Based on the soil survey, soils mapped as prime farmland or farmland of statewide importance are not mapped within the study area.	No applicable regulations or following steps.

Flood Management Evaluation Memorandum

TO: Lower Colorado-Lavaca Regional Flood Planning Group
Lower Colorado River Authority
P.O. Box 220
Austin, TX 78767

DATE: May 8, 2023

FROM: Paul Shattuck, PE
HDR Engineering, Inc.
Firm No. 754
4401 W Gate Blvd Ste 400
Austin, TX 78745



PROJECT: LCRA Contract No. 5809
Halff AVO 43796.001
HDR PN 10304676

SUBJECT: **FME ID: 101000189**

Project Sponsor: City of Edna (Municipality)

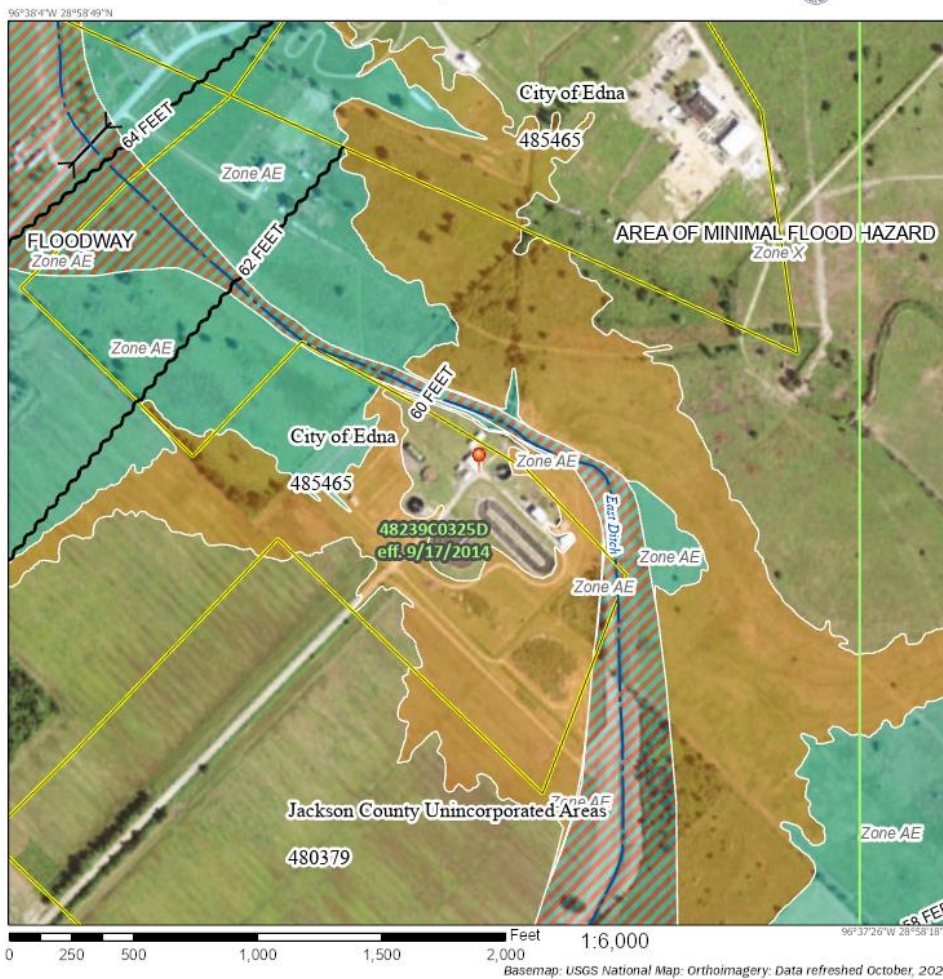
Project Name: Wastewater Treatment Plant Floodproofing

On September 15, 2022, the Lower Colorado-Lavaca Regional Flood Planning Group (RFPG) approved the evaluation of this Flood Management Evaluation (FME) to identify, evaluate and recommend additional potentially feasible Flood Mitigation Projects (FMP).

Introduction

The City of Edna (City), located in Jackson County Texas, has requested that the RFPG advance the study of flood risk at its wastewater treatment plant (WWTP). The plant serves the City population of approximately 6,000 residents. The plant was constructed in the 1950s with a major renovation in the 1990s. This WWTP outfalls into the adjacent East Ditch of Dry Creek and its grounds are generally surrounded by the 100-year (1% annual chance flood hazard) FEMA floodplain associated with the East Ditch. In addition to poor local drainage and generally flat terrain, City personnel identified a large flooding event in May 2020. During this flooding event, the plant experienced a process failure of the ultraviolet (UV) disinfection system.

National Flood Hazard Layer FIRMette



Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS

- Without Base Flood Elevation (BFE) Zone A, V, A99
- With BFE or Depth Zone AE, AD, AH, VE, AR
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD

- 0.2% Annual chance Flood Hazard. Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile. Zone X
- Future Conditions 1% Annual Chance Flood Hazard Zone X
- Area with Reduced Flood Risk due to Levee. See Notes. Zone X
- Area with Flood Risk due to Levee. Zone 0

OTHER AREAS

- NO SCREEN: Area of Minimal Flood Hazard Zone X
- Effective LOMRs
- Area of Undetermined Flood Hazard Zone 0

GENERAL STRUCTURES

- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES

- 20.2 Cross Sections with 1% Annual Chance Water Surface Elevation
- 17.5 Coastal Transect
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS

- Digital Data Available
- No Digital Data Available
- Unmapped

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards.

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 4/3/2023 at 5:56 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

Figure 1: FEMA National Flood Hazard Layer FIRMette (effective 09/17/2014)

This memorandum documents the assumptions, methodologies and processes used to evaluate the FME as a potentially feasible FMP in accordance with the Texas Water Development Board (TWDB) Exhibit C Technical Guidelines for Regional Flood Planning FMP requirements.

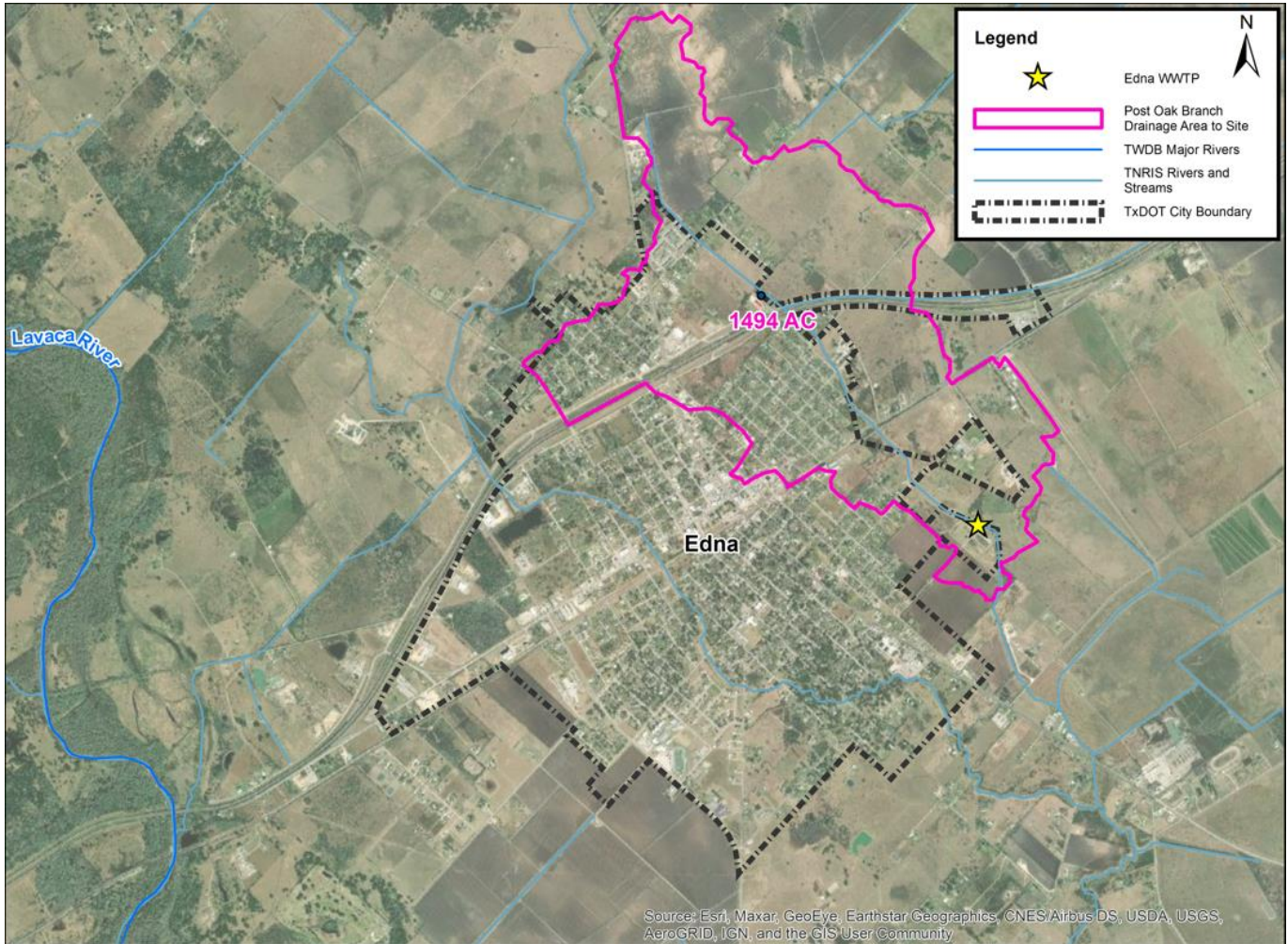


Figure 2: Study Area Location

Modeling Analysis

The following sections provide an overview of the data, hydrologic analysis, and hydraulic analysis used to identify the existing condition flood risk to the WWTP.

Data Collection and Site Visits

Data collection for this study consists of conversations with City personnel, on-site observations and measurements of various WWTP components, and the compilation of digital files in geographic information system (GIS) and Excel format.

HDR visited the City of Edna WWTP on March 3rd, 2023 and met with City Manager Gary Broz as well as the WWTP operator Wayne James. High water marks from the recent flood event in May 2020 were estimated by the City of Edna during the meeting. There were no debris lines or staining at evident flood depths, and the City’s best high-water mark (HWM) estimation was a recollection of debris height of approximately 24 inches at the plant fencing, adjacent to the East Ditch at the WWTP outlet. See Figure 3. The HWM was assumed to be directly related to flood waters from the East Ditch, however, this was not visually verified during the actual WWTP outage.

During the visit the HDR team took additional estimated elevation measurements for floodplain model validation and water damage cost evaluation.



Figure 3: Reported HWM along fence near WWTP outlet

HDR gathered and compiled the following geospatial data:

- National Oceanic and Atmospheric Administration (NOAA) - Atlas 14 Point Precipitation Frequency Data for the Edna Texas
- Historical Rainfall data from local “DataWise Environmental Monitoring Inc.” gage DW035 “Dry Creek at West Main” for May 2020
- Historical NOAA gridded radar data for Edna and surrounding areas during May 2020 event
- Texas Natural Resources Information System (TNRIS) - United States Geological Survey (USGS) 1 meter resolution 2018 LiDAR based digital elevation models (DEMs)
- United States Department of Agriculture Natural Resources Conservation Service (NRCS) – 2019 Web Soil Survey Geographic Database (SSURGO) data for Jackson County
- TWDB – 2021 Texas Buildings with SVI and Estimated Population (TWDB, CDC, ORNL)
- Texas Department of Transportation (TxDOT) – 2016 TxDOT Roadways Geospatial Data

Hydrology

The contributing area to the East Ditch at the WWTP, including the WWTP site area, is approximately 1,494 acres as shown in Figure 2. Two types of storm events were evaluated for this analysis: frequency storms based on Atlas 14 24-hour rainfall data and a re-creation of the May 2020 storm when the UV system failed.

Rainfall

The NOAA Atlas 14, 24-hour duration, frequency storm temporal distribution was utilized to compute frequency storm events for the 2-year, 10-year, 25-year, and 100-year probabilities in Edna (Table 1).

Table 1: NOAA Precipitation Frequency Estimates for WWTP Watershed Centroid in Edna, Texas

Duration	Average Recurrence Interval (years) ¹			
	2	10	25	100
5-min:	0.573	0.797	0.934	1.14
15-min:	1.15	1.59	1.86	2.27
60-min:	2.17	3.01	3.53	4.31
2-hr:	2.74	3.93	4.7	5.93
3-hr:	3.09	4.53	5.49	7.09
6-hr:	3.68	5.58	6.91	9.21
12-hr:	4.24	6.67	8.4	11.5
24-hr:	4.83	7.83	10	13.9

¹All precipitation frequency estimates in inches

The May 2020 historical event rainfall data came from analysis of a rainfall gage located in Edna, TX, operated by DataWise Environmental Monitoring Inc. The gauge records precipitation on a 1-minute time scale. The HDR team compiled the rainfall data and identified a large storm on the evening of May 12th and incorporated data from approximately 8:30pm until 6:30am the next morning May 13th. See cumulative gauge precipitation data in Figures 4 and 5 below. The observed historical storm event produced a rainfall depth of over 5.8 inches in about three hours which exceeds a 25-year, 3-hr design storm event as shown in Table 1. The location of the rainfall gage is near the WWTP but not near the center of the watershed, therefore there are uncertainties with the assumption that the total rainfall amount fell over the entire watershed as modeled herein.

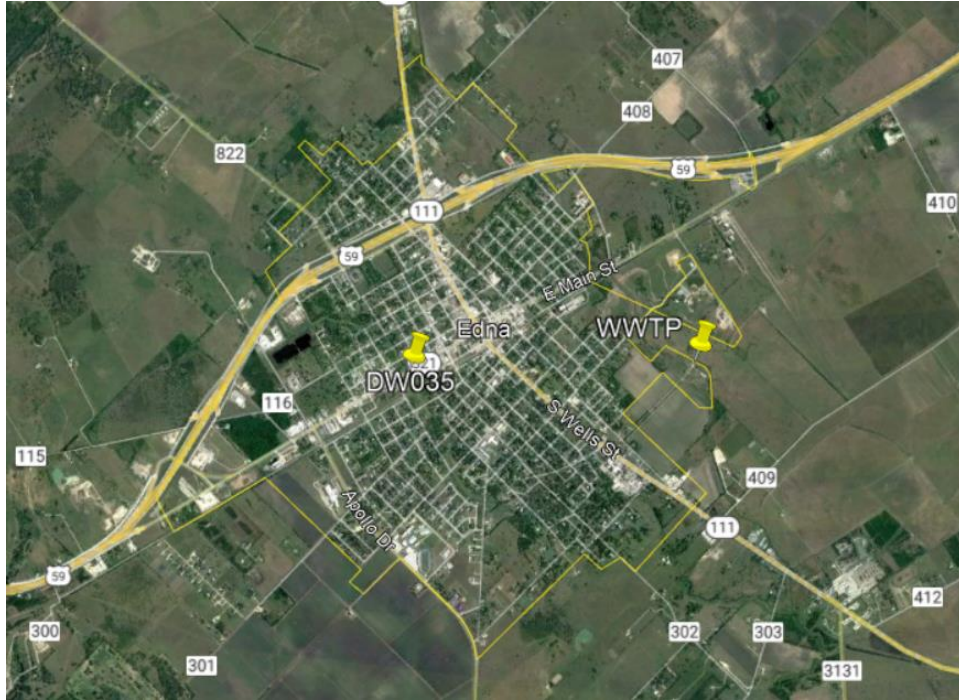


Figure 4: DataWise Environmental Monitoring Inc. Gage DW035 Location

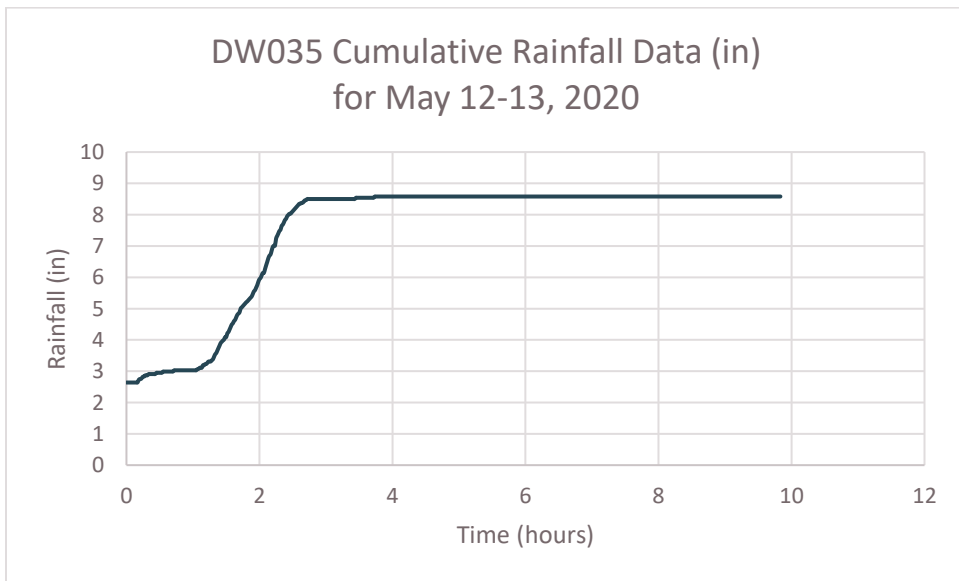


Figure 5: May 2020 Cumulative Rainfall Data Gauge DW035 at Dry Creek

Loss

Initial losses were calculated using the SCS Curve Number loss rate method incorporating the SSURGO soil data, TWDB Planimetric building data, and TxDOT roadway data for Edna, Texas. The following table summarizes the curve number and impervious cover values calculated for the basin.

Table 2: Calculated Loss Data

Soil Type	Area (AC)	Open Space Base Curve Number	Percent Impervious Cover
A	0	39	-
B	0	61	-
C/D	834.3	74	8.3%
D	659.6	80	8.1%
Basin Total / Average	1,493.9 (Total)	77 (Average)	8.2% (Average)

Transform

Time of concentration was calculated using the TR-55 methodology and was determined to be approximately 189 minutes, with a lag time of 113 minutes.

Results

Results of the HEC-HMS simulation are summarized below. These discharges are applied as direct runoff hydrographs upstream of the WWTP in the 2D domain and represent runoff to the WWTP.

Table 3: HEC-HMS Peak Flow Results

Storm Event	Peak Flow (cfs)	Precipitation Volume (in)
2 yr	990	4.83
10 yr	1,810	7.83
25 yr	2,360	10.00
100 yr	3,250	13.90
May 2020	1,960	5.86

Hydraulics

Hydraulic analysis was performed using 2D HEC-RAS version 6.2. 2018 TNRIS LiDAR for Jackson County was imported and used to represent the underlying terrain. 2D cells are sized at approximately 20' by 20'. Breaklines were added throughout the model to capture hydraulically impactful features such as riverbanks, roads, and other features.

Record Event Recreation

High Water Mark Points

- The plant operator confirmed that the WWTP UV system flooded in the May 2020 event and that this process failure caused the WWTP to not meet effluent standards.
- Of the several estimated HWMs at various locations throughout the plant, the City of Edna had most confidence in a HWM along the fence adjacent to the WWTP outlet. The estimated HWM is two feet above the approximate ground surface elevation of 60.5 ft-msl at this location. This corresponds to an estimated water surface of 62.5 ft-msl in the May 2020 event. See Figure 3.

- This elevation and location are based on recollection from an event over 2 years ago and may not be accurate.
- The approximate critical elevation of the UV system that would impact operations is between 62.3 and 62.7 ft-msl.

Model Ground Truthing and Verification

- Typical roughness values were initially assigned based on the land use categories in Table 4. These values are conservative (i.e. high) in an attempt to more closely simulate the HWM water surface elevation.
- Land use for the surrounding area is generally grassland and pasture with minimal trees and brush. There are many short embankments in the area at creek banks and roads.

Table 4: Manning's N Roughness Values – Typical Assumed Values

Land Use Category	Manning's N Value
Channel	0.05
Open Space (overbank)	0.07
Brush	0.1

- Hydraulic model roughness was adjusted attempting to align hydrologic output, the high-water mark, and hydraulic output.
 - A roughness of 0.1 was applied to the entire 2D domain. This value of 0.1 is assumed to be the maximum roughness that could be considered reasonable for the areas.
 - After maximizing the roughness at the site, modeled depths in the record event at the high-water mark location were approximately 61.5 ft-msl, which is one foot lower than the approximate HWM and one foot lower than the UV system.
 - The peak flow required to reproduce depths that would flood the UV system exceed the 100-year storm.
- An analysis using ROM to evaluate localized site drainage were performed and produced depths adjacent to the UV system of approximately 1". These depths are assumed to not cause flood damage.

Considering the potential unreliability of HWM data from an event from over 2 years ago and the initial model results, HDR estimates that it was unlikely that creek or local flooding directly caused the UV system failure in May 2020. The UV system and a large portion of the WWTP infrastructure is on relatively higher terrain than adjacent surrounding areas. The cause of the failure at the UV process is uncertain and further investigation is suggested.

The 2D HEC-RAS model runs are outlined in Table 5 below.

Table 5: HEC-RAS version 6.2 Model Runs

Event	Typical Roughness	Typical Roughness ROM	0.1 Maximum Roughness	0.1 Maximum Roughness ROM
2-yr	Est_Ex002C	Est_Ex002CL	Ex002C	Ex002CL
10-yr	Est_Ex010C	Est_Ex010CL	Ex010C	Ex010CL
25-yr	Est_Ex025C	Est_Ex025CL	Ex025C	Ex025CL
100-yr	Est_Ex100C	Est_Ex100CL	Ex100C	Ex100CL
May 2020	Est_May2020	Est_May2020_ROM_GARR	May2020	ROM_GARR

*Note that the runs with prefix "Est_" utilize the typical roughness values from Table 4.

The result of the roughness changes in Table 6 below demonstrate that model adjustment was not sufficient to align with the measured HWM of 62.5 ft-msl nor conclude that the WWTP was inundated from local or riverine flooding.

Table 6: 2D Water Surface Elevation Modeling Results

Event	Water Surface Elevation at measured HWM (ft-msl)			
	Typical Roughness	Typical Roughness ROM	0.1 Maximum Roughness	0.1 Maximum Roughness ROM
2-yr	60.47	60.62	60.74	60.88
10-yr	60.99	61.14	61.27	61.42
25-yr	61.23	61.37	61.53	61.69
100-yr	61.53	61.67	61.86	62.04
May 2020	61.03	61.20	61.3	61.47

* Note: The UV system is adjacent to this HWM and has an elevation of approximately 62.3 to 62.7 ft-msl.

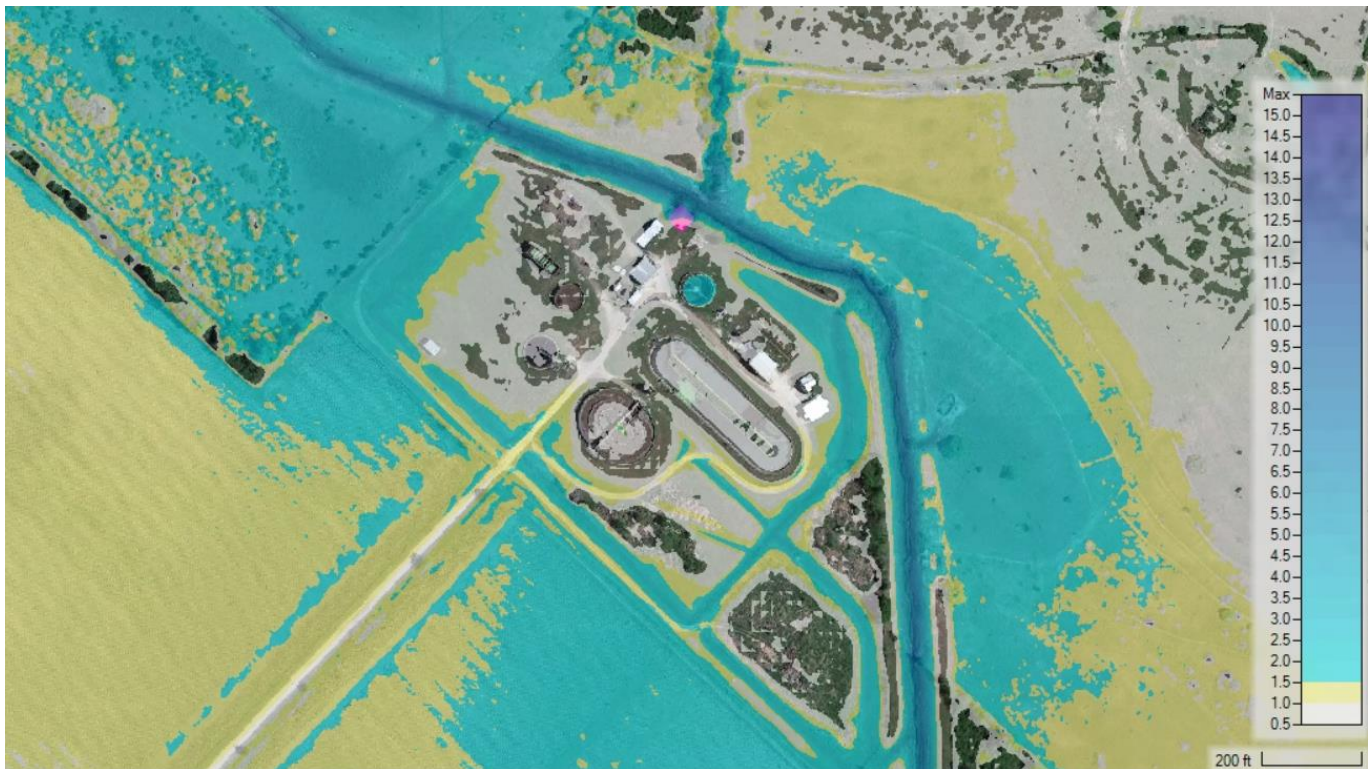


Figure 6: May 2020 Historical Event Combined Creek and Local Flood Depth (includes ROM)

Hydraulic Analysis

Riverine Flooding

Direct runoff hydrographs are obtained from HEC-HMS and are applied just upstream of the WWTP to the boundary condition lines of the 2D mesh. The downstream boundary condition was set to a normal depth 0.007 ft/ft based on the energy grade line of the water surface elevation and iterative simulations.

Local Flooding

In order to analyze local drainage in the project area, each storm event was run with a combination of direct runoff flow hydrographs from HEC-HMS, and additional ROM precipitation excess data from HEC-HMS. The

precipitation excess values were developed using the local maxima of the basin area in HEC-HMS, while this same data was applied to a small 2D area in HEC-RAS.

Rain on Mesh Analysis

For the sole purpose of evaluating local site drainage, all storm simulations were rerun to include a rain on mesh (ROM) component. Over the 2D domain, which contains only the plant area and adjacent floodplain, a HEC-HMS calculated excess precipitation hyetograph is applied. Although a minor amount precipitation is doubled counted in this approach, these ROM runs show the marginal effect of local discharge to structural flood risk and creek flooding (Table 6).

Existing Condition Flood Risk

Some limited flood risk exists at the site, however, most of the infrastructure including the UV system appear to be at an elevation above the estimated 100-year design storm. There does not appear to be significant increased flood risk after including localized rainfall and drainage effects in the model simulation. Moreover, the analysis results from the 2020 storm event re-creation do not support the assumption that flood waters from the East Ditch or onsite areas caused the WWTP shutdown during the 2020 storm event.

Based on a preliminary assessment of the WWTP operations, there may be plant hydraulic processes that may be adversely impacted by excessive inflow and infiltration (I&I) that could cause a failure of the UV system.

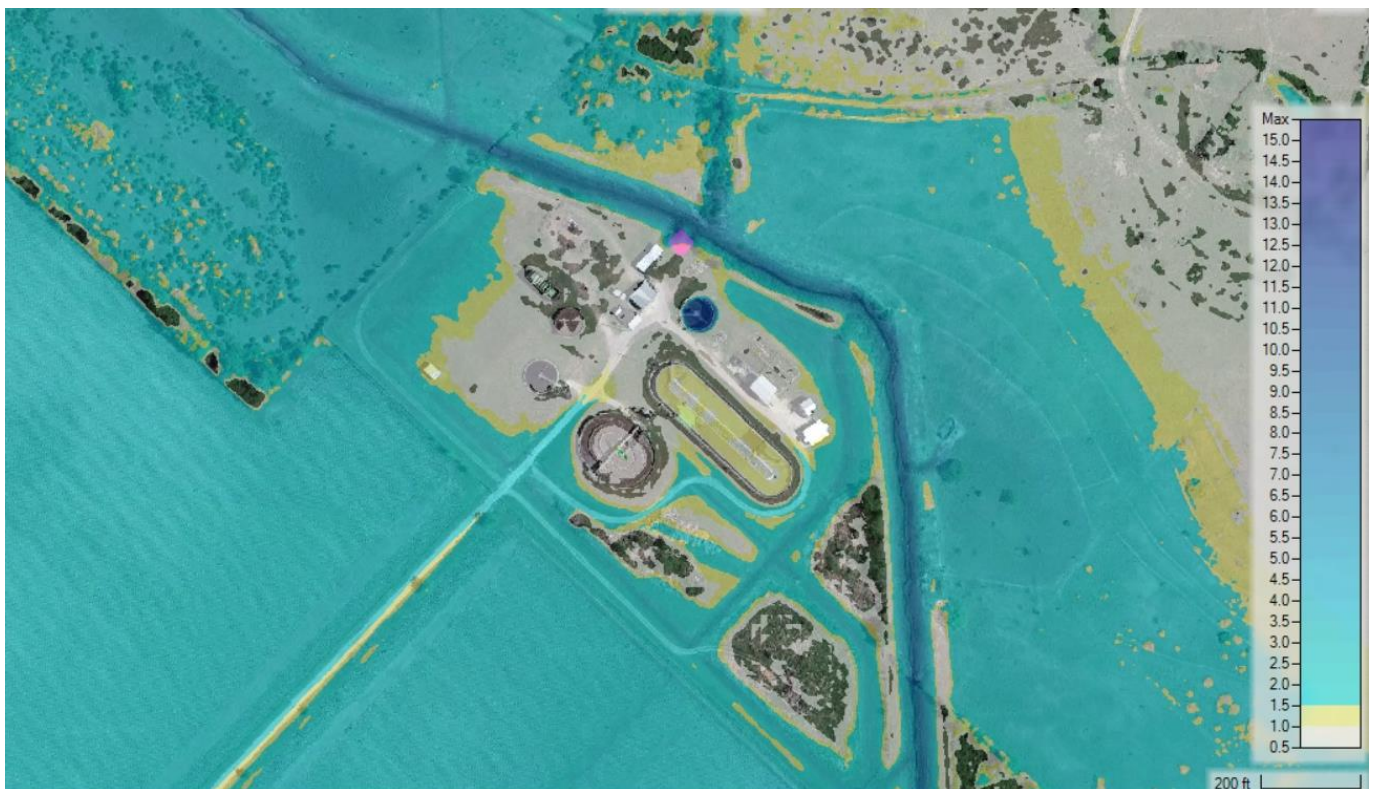


Figure 7: Existing Condition 100-year Combined Creek and Local Flood Depth

Recommendation

Based on the findings presented in this Technical Memorandum it is recommended that Flood Management Evaluation No. (101000189) be removed from the Regional Flood Plan. The City of Edna concurs with this

recommendation and understands that its removal will be considered by the Regional Flood Planning Group in the amended Regional Flood Plan for the Lower Colorado-Lavaca Region.