APPENDIX E

Task 12: Flood Mitigation Evaluation Memorandums

Lower Colorado-Lavaca
REGIONAL FLOOD PLANNING GROUP
REGION 10

Lower Colorado-Lavaca
REGIONAL FLOOD
PLANNING GROUP
REGION 10

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 5, 2023
FROM:	Jay Scanlon, PE, CFM Freese and Nichols, Inc. F-2144 10431 Morado Circle, Suite 200 Austin, TX 78759	PROJECT:	LCRA Contract No. 5809 Halff AVO 43796.001 FNI HAF21363
SUBJECT:	**FME ID:** 101000053 **Project Sponsor:** City of Fredericksburg **Project Name:** Creek Street at Barons Creek		

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).

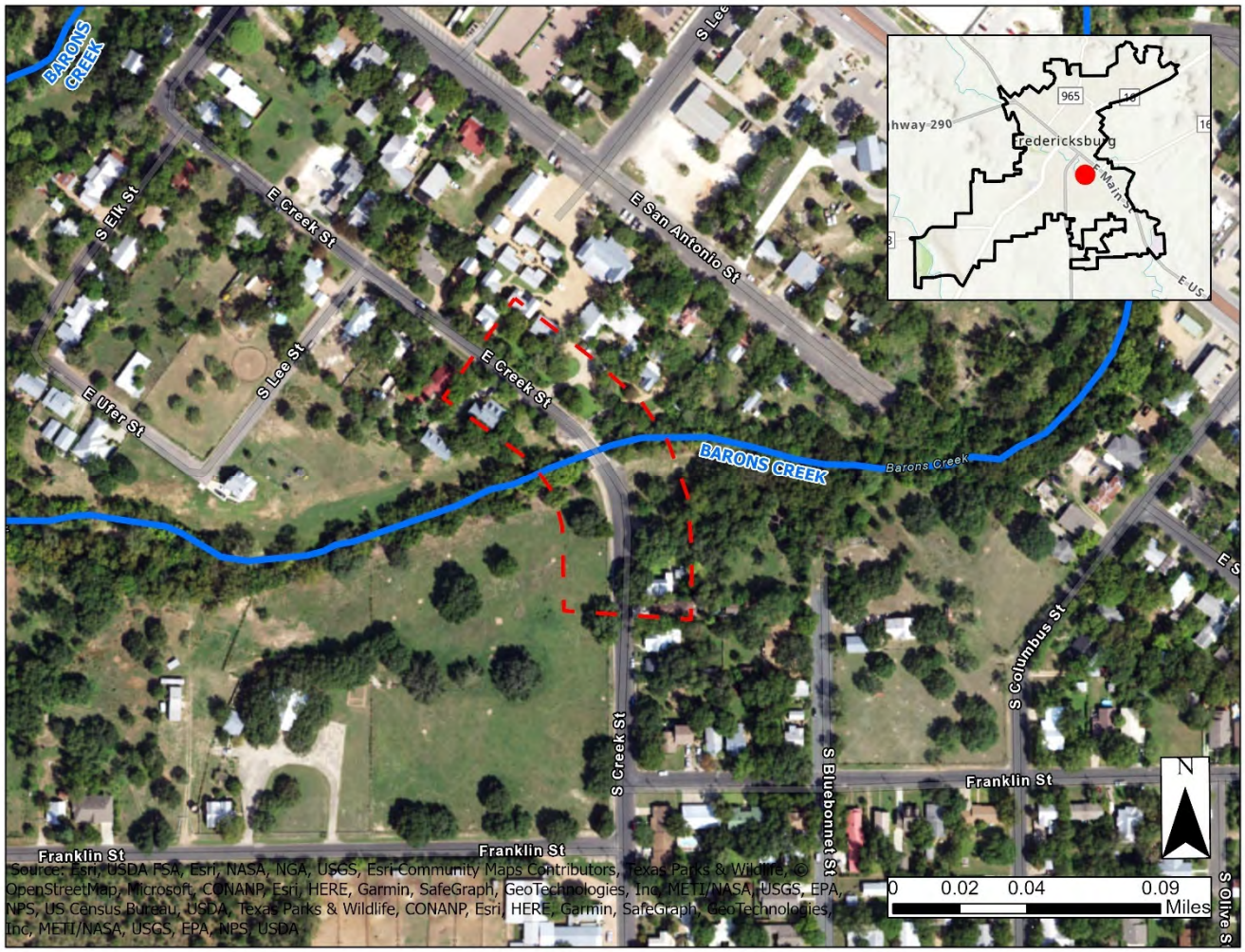
Introduction

The City's 2016 Drainage Master Plan (DMP) proposed the implementation of a Flood Early Warning System (FEWS) at Creek Street. This action is included in the adopted Regional Flood Plan as a recommended FMP that anticipated installation of the flood early warning system with no structural improvements to the roadway crossing. However, during the preparation of the Regional Flood Plan the City indicated they would prefer to look at structural solutions. Based on the Sponsor request, the Regional Flood Planning Group (RFPG) recommended inclusion in the Regional Flood Plan (RFP) as FME 101000053.

Mr. Garret Bonn, Assistant City Engineer, and Interim Director of Development Services, was contacted to confirm the City's support to have the RFPG perform this FME, as described herein, as part of the Task 12 effort. Mr. Bonn confirmed the general nature of the flood problem, is supportive of the study, and assisted with local information and will review the report deliverables.

This FME includes updating the FEMA flood hazard analysis and mapping with ATLAS 14 rainfall data and evaluation of mitigation alternatives. This FME also includes preliminary capital cost estimates, quantification of flood risk reduction benefits, benefit-cost analyses, adverse impacts evaluation, and a high-level evaluation of potential constraints including environmental permitting, utility relocations, right-of-way acquisition, and constructability issues in accordance with adopted FMP screening criteria.

Figure 1: Study Area Location



Modeling Analysis

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

Data Collection

The sources of the key data collected and leveraged for analysis are listed below.

- Terrain Data: 2019 LiDAR (70cm), obtained from Texas Natural Resources Information System (TINRIS).
- Soils Data: 2022 Natural Resource Conservation Service (NRCS) Web Soil Survey.
- Land Use Data: 2019 National Land Cover Database (NLCD).
- Survey Data: Creek St Culvert survey data was provided by City of Fredericksburg.
- Hydraulic model: HEC-RAS 1D model for Barons Creek was obtained from Federal Emergency Management Agency (FEMA) Base Level Engineering (BLE) Tools and Resources website.
- FEMA effective model: obtained from the 2016 DMP study.
- Spot elevations (survey) provided by the City.

Hydrology

In the original HEC-RAS 1D BLE model, Regression Equation was applied to calculate the peak flows. There is no HEC-HMS model available for the entire BLE area. To update the hydraulic model with NOAA Atlas 14 rainfall, a HEC-RAS 2D Rain-on-Grid model was developed to generate peak flows for the HEC-RAS 1D BLE model.

- Modeling Software: HEC-RAS version 6.3.1
- Rainfall Data: NOAA Atlas 14, 24-hour duration (2-, 5-, 10-, 25-, 50-, 100-, and 500-year frequency storms).
- Loss Method: NRCS Curve Number loss rate method

Hydraulics

The HEC-RAS 1D BLE model was updated with Atlas 14 computed flows and utilized for hydraulic analysis. Because the 1D BLE model is a low-detail engineering approach to provide a baseline understanding of the flood hazards, no hydraulic structures are included in the model. Structure data from FEMA effective model in the vicinity of project area were added to the model (Lincoln St, Washington St, Creek St, Main St, and FM 1631).

- Modeling Software: HEC-RAS version 6.3.1, 1D steady-state simulation
- Hydrologic Data: see above
- Boundary Conditions: Downstream normal depth

Existing Condition Flood Risk

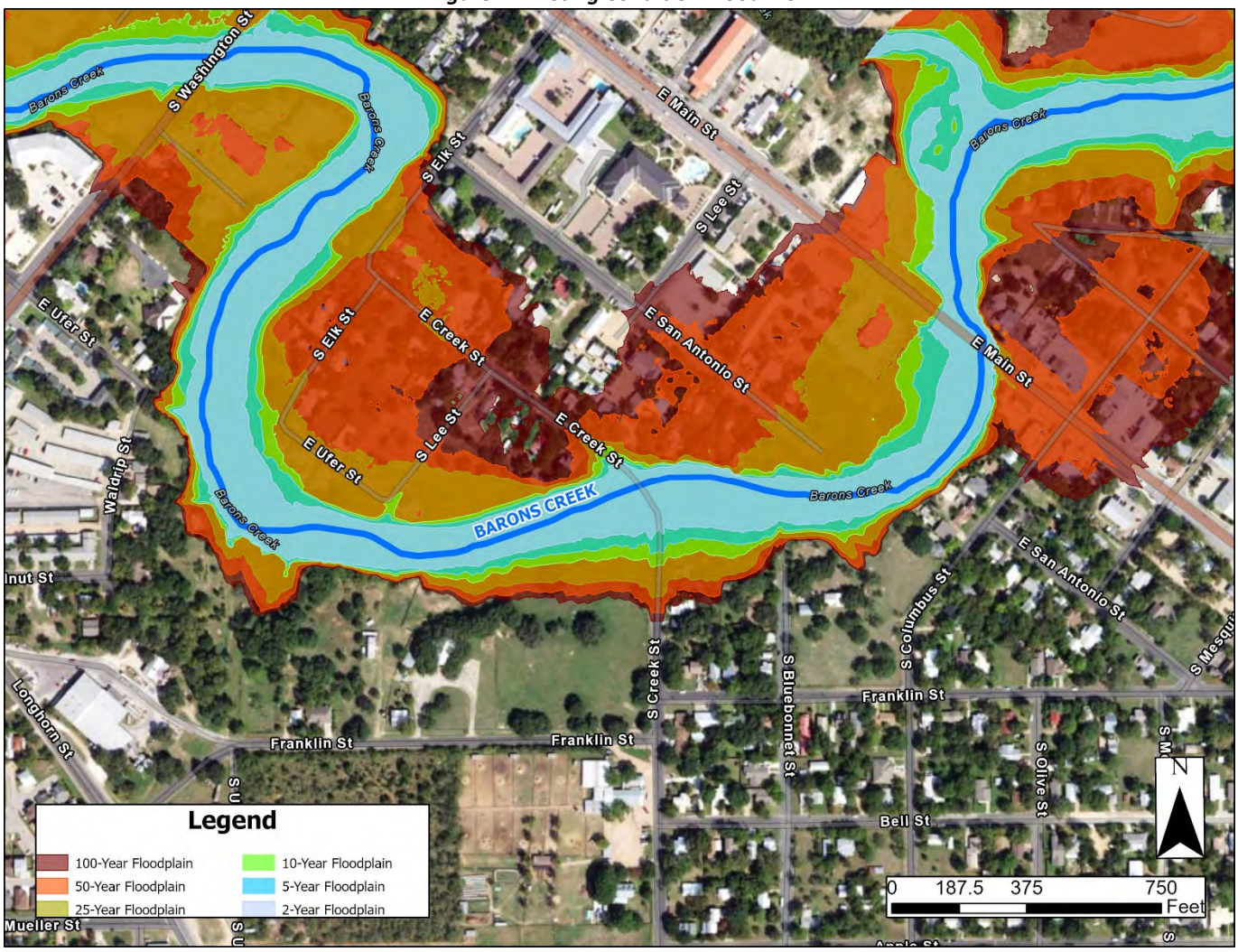
The existing structure on Creek Street over Barons Creek is a triple 8’ x 7’ concrete box culvert. The capacity of the culvert is approximately 1,005 cfs without overtopping the road. Peak water surface elevations for the Q2 through Q100 storm events are presented in **Table 1**.

Table 1: Peak Flow Rates

Storm Event (YR)	Water Surface Elevation (FT)	Overtopping Depth (FT)
2	1,648.58	3.58
5	1,651.68	6.68
10	1,654.20	9.20
25	1,659.82	14.82
50	1,662.34	17.34
100	1,663.91	18.91

The road elevation is approximate elevation 1,645 feet, which is lower than the 2-year storm maximum water surface elevation. Thus, the existing crossing provides less than 2-year level of service. The roadway has an average daily traffic count of 885 and, according to the City, this is an important north-south connector street. The existing inundation map for each of the 2-, 5-, 10-, 25-, 50-, and 100-year frequency storm is presented in **Figure 2.**

Figure 2: Existing Condition Flood Risk



Proposed Improvements

Alternatives evaluated included cleaning the existing structure to remove significant sediment blockages, adding box culverts to increase capacity, and replacing the existing box culverts with a bridge. A summary of the results is presented in **Table 2**.

Table 2 – Summary of Results

Improvement ID	Proposed Improvement		
	Culvert Improvement	Roadway Improvement	Overtopping Event
Clean Out	Desilt existing RCBs	-	2-YR
4-8x7RCB	Additional 8'x7' RCB barrel	-	2-YR
Road Raise (10 year)	-	Raise to 1658.50 feet	25-YR
Road Raise (100 year)	-	Raise to 1665.50 feet	>100-YR

Due to the depth of overtopping and because overtopping is dominated by the channel capacity and flow depth rather than culvert capacity (the road and culvert do not act as a dam causing overtopping) desilting the existing structure and addition of conveyance (additional box culverts) do not increase the level-of-service (i.e. reduce flood risk) for this crossing. Therefore, alternatives to raise the elevation of the roadway were considered. Those alternatives included raising the road to increase the level of service to safely pass the 10-year and 100-year events. Initial results were discussed with Mr. Bonn and the 100-year bridge (corresponding to 24-hour rainfall depth of 11.93 inches) was determined to not be feasible due to the configuration of the road as well as the number of adjacent privately owned parcels and structures. The City determined the 10-year event (corresponding to a 24-hour rainfall of 6.46 inches) is feasible, will provide significant safety and mobility improvements, and would be supported as a potential FMP.

The 10-year road raise alternative will require local channel modifications to offset rises in the 100-year water surface elevation. Those improvements include widening the channel from the road crossing to a point approximately 225 feet upstream with limited downstream improvements to tie into the existing channel.

Estimate of Probable Cost

The capital cost estimates for the flood mitigation alternative are based on previous expereince with similar project and unit costs and reviewing bid tabulations. The opinion of probable construction costs is an AACE Class 4 Estimate with an accuracy range of -20 to +30 percent. Total project costs include anticipated costs for final design, construction inspection, and easement acquisition. The opinion of probable construction cost was developed for elevation of the roadway above the 10-year storm event at a roadway deck elevation of 1,658.5 feet. The total construction cost is approximately $1,613,000 and the total estimated project cost is approximately $2,027,000.

Project Constraints

The purpose of identifying constraints early is twofold. The first is to confirm there are no unusual obstacles to implementation that would make a project not feasible. The second is an effort to identify and capture total project costs to minimize cost increases and delays in implementation. Potential constraints include environmental permitting, utility conflicts and relocations, right-of-way acquisition, and constructability.

As noted above, elevating the roadway will require channel modifications to mitigate potential increases in the 100-year water surface elevation. Because this is an existing crossing it is anticipated that the modifications would be eligible to be permitted under a U.S. Army Corps of Engineers (USACE) Nationwide Permit (NWP) 14 for linear transportation projects. NWPs have thresholds for maximum disturbances such as excavation and fill within Waters of the United States as well as other cultural and environmental permitting requirements. If the thresholds are exceeded USACE may require public notification, mitigation, and potentially could require an individual permit. There are no known threatened or endangered species or previously identified cultural resources present in the project area.

Preliminary channel modifications and mitigation are based on HEC-RAS cross-section data and LiDAR topographic data and therefore lack the level of detail that will be included in final design; however, based on preliminary modeling the increases can be mitigated. Preliminary design indicates the bottom of the flood channel will need to be approximately 75 feet wide and will extend 225 feet upstream of the road.

Final design will include refinements to the selected alternative and hydraulic models based on survey. It is recommended final design include considerations such as natural channel design in the development of the final mitigation design. Natural channel design considerations should include preserving the existing low-flow channel or constructing an inset flood bench (multi-stage channel) to replace the low flow channel if needed, using natural channel boundary materials such as rock and boulders to provide grade control or erosion protection, and site restoration using native grasses, understory plants, and trees. These features will preserve/mitigate impacts to the natural functions of the channel necessary for permitting, preserve the existing character of the creek, and reduce or eliminate the need for long-term maintenance.

The project may require localized utility adjustments to accommodate the design and construction of the roadway improvements but nothing that is atypical for this type of project. There is at least one driveway that will need to be adjusted to tie into the new road and an easement (fully inside the 100-year floodplain) will be required for the channel modifications.

Benefit Cost Analysis

The TWDB Benefit Cost Calculation tool was used to develop pre- and post-project damage estimates and the FEMA BCA Toolkit was used to annualize those costs over a 30-year project life. The project is primarily focused on accessibility and the pre- and post-project damage estimates reflect the impacts of detours, delayed emergency access, and damage to the roadway and structure. The project benefits are the difference between the pre- and post-project damages annualized over the life of the project. The average daily traffic count was sourced from the Texas Department of Transportation, System Support Branch's TPP District Traffic Database. Expected damages were calculated with recurrence intervals at the 5-, 10- and 100-year storm events. Overtopping Impact (duration) was assumed to be 12 hours per 1-ft of inundation. The TWDB tool estimated benefits due to these factors are approximately $719,200 with annualized benefits of $301,960 from the FEMA BCA Toolkit. TWDB's tool includes other project benefits which, for this type of project include the residual value of the investment and environmental benefits. The TWDB tool estimates the residual value of the investment at $79,620 and the environmental benefits at approximately $268,900.

The Benefit Cost Analysis (BCA) generated a Benefit Cost Ratio (BCR) of 0.3. It is important to note that the environmental benefits identified above assume the natural channel design/riparian corridor elements recommended above are included in the final design. If those benefits are not realized the BCR will be reduced to 0.2.

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 the 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."

Mitigation Measures

Table 3 presents the results of the pre- and post- 100-year water surface elevations for the culvert cleanout, additional box culvert, and the elevation of the roadway above the 10-year flood depth with and without mitigation measures. As shown, structural improvements to the crossing without mitigation will result in a maximum rise in the 100-year water surface elevation of 0.67 feet at Station 27210. Model results including the proposed mitigation show there will be a minor decrease in the 100-year water surface elevation for a short distance upstream and downstream of the crossing. The lack of visible post-project 100-year floodplain in **Figure 3** reinforces the fact that it is overlaid entirely by the pre-project floodplain.

This memorandum is prepared to serve as certification of no negative impact for the Creek Street Roadway Improvements project. As the project is advanced the impact analysis should be updated to reflect the final design and to confirm no negative impacts.

Recommendation

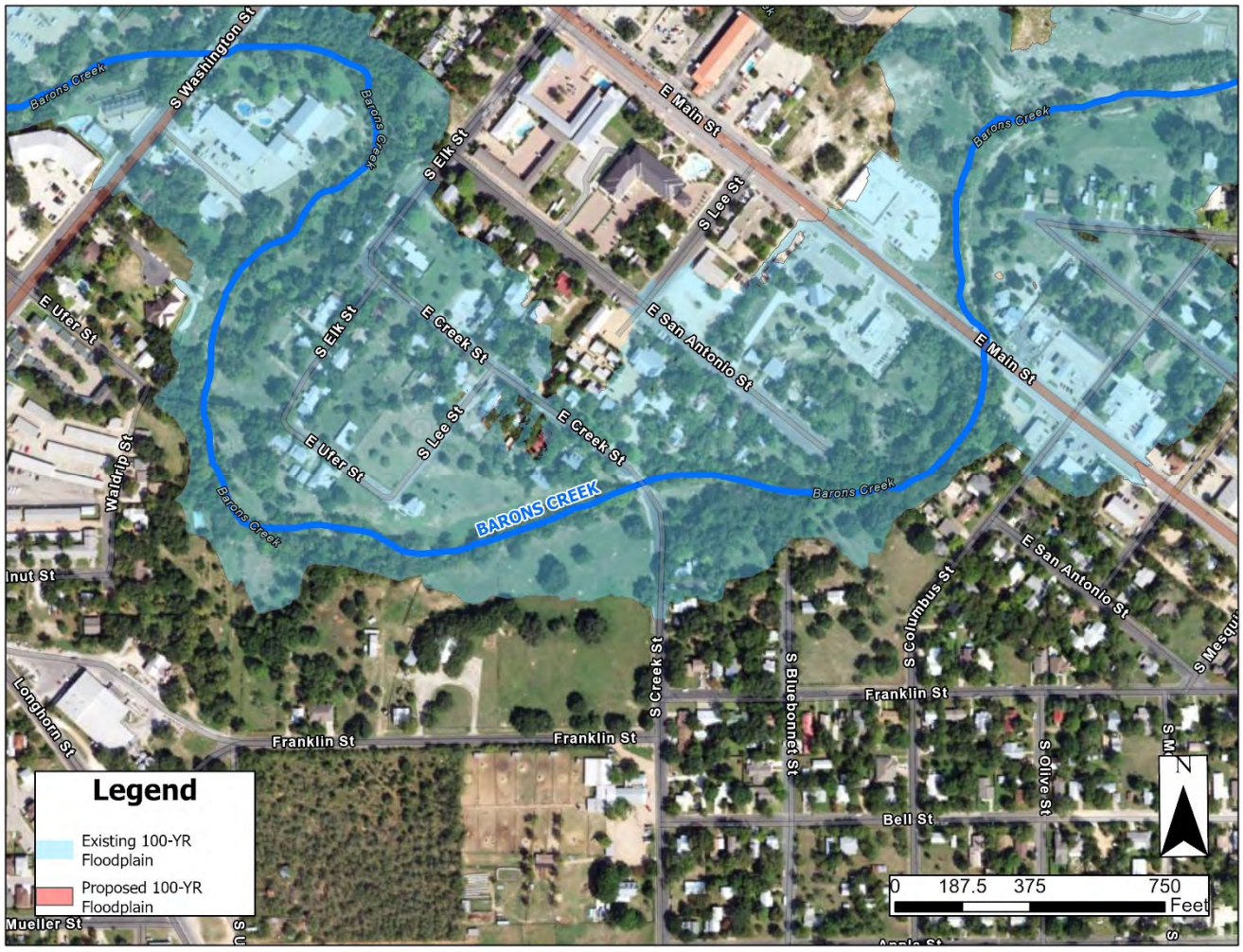
Based on the results of this evaluation, and with concurrence from the Sponsor, we recommend the RFPG consider including the Creek Street Improvements as a new FMP in the Amended Plan.

Table 3 Comparison of Pre- and Post-Project Water Surface Elevations

	Existing Conditions	4-8x7 RCBs		Clean Out		Road Raise Above 10-YR		Road Raise Above 10-YR with Channel Improvements	
Cross Section	WSEL	WSEL	Difference	WSEL	Difference	WSEL	Difference	WSEL	Difference
37042	1698.57	1698.57	0.00	1698.57	0.00	1698.57	0.00	1698.57	0.00
36500	1696.51	1696.51	0.00	1696.51	0.00	1696.51	0.00	1696.51	0.00
35951	1691.54	1691.54	0.00	1691.54	0.00	1691.54	0.00	1691.54	0.00
35184	1690.92	1690.92	0.00	1690.92	0.00	1690.92	0.00	1690.92	0.00
34429	1689.33	1689.33	0.00	1689.33	0.00	1689.33	0.00	1689.33	0.00
34078	1686.47	1686.47	0.00	1686.47	0.00	1686.47	0.00	1686.47	0.00
33632	1685.08	1685.08	0.00	1685.08	0.00	1685.08	0.00	1685.08	0.00
32855	1684.34	1684.34	0.00	1684.34	0.00	1684.34	0.00	1684.34	0.00
32568	1683.61	1683.61	0.00	1683.61	0.00	1683.61	0.00	1683.61	0.00
32134	1682.20	1682.2	0.00	1682.2	0.00	1682.2	0.00	1682.2	0.00
31681	1678.96	1678.96	0.00	1678.96	0.00	1678.96	0.00	1678.96	0.00
31267	1678.00	1678	0.00	1678	0.00	1678	0.00	1678	0.00
31177	1677.26	1677.26	0.00	1677.26	0.00	1677.26	0.00	1677.26	0.00
30806	1675.59	1675.59	0.00	1675.59	0.00	1675.59	0.00	1675.59	0.00
30292	1675.41	1675.41	0.00	1675.41	0.00	1675.41	0.00	1675.41	0.00
30109	1673.22	1673.22	0.00	1673.22	0.00	1673.23	0.01	1673.22	0.00
29279	1671.50	1671.5	0.00	1671.5	0.00	1671.51	0.01	1671.5	0.00
28712	1669.92	1669.92	0.00	1669.92	0.00	1669.93	0.01	1669.92	0.00
28040	1666.46	1666.47	0.01	1666.46	0.00	1666.76	0.3	1666.41	-0.05
27416	1663.70	1663.73	0.03	1663.72	0.02	1664.36	0.66	1663.59	-0.11
27210	1663.75	1663.78	0.03	1663.77	0.02	1664.42	0.67	1663.64	-0.11
CREEK STREET CULVERT CROSSING									
27094	1663.49	1663.47	-0.02	1663.5	0.01	1663.47	-0.02	1662.82	-0.67
26869	1663.05	1663.05	0.00	1663.05	0.00	1663.05	0.00	1662.35	-0.70
26466	1661.22	1661.22	0.00	1661.22	0.00	1661.22	0.00	1661.22	0.00
26049	1660.91	1660.91	0.00	1660.91	0.00	1660.91	0.00	1660.91	0.00
25736	1658.28	1658.28	0.00	1658.28	0.00	1658.28	0.00	1658.28	0.00
25440	1657.80	1657.8	0.00	1657.8	0.00	1657.8	0.00	1657.8	0.00
25052	1656.49	1656.49	0.00	1656.49	0.00	1656.49	0.00	1656.49	0.00
24679	1655.53	1655.53	0.00	1655.53	0.00	1655.53	0.00	1655.53	0.00
24337	1654.05	1654.05	0.00	1654.05	0.00	1654.05	0.00	1654.05	0.00
23798	1652.49	1652.49	0.00	1652.49	0.00	1652.49	0.00	1652.49	0.00
23353	1650.11	1650.11	0.00	1650.11	0.00	1650.11	0.00	1650.11	0.00
22917	1649.35	1649.35	0.00	1649.35	0.00	1649.35	0.00	1649.35	0.00
22728	1649.27	1649.27	0.00	1649.27	0.00	1649.27	0.00	1649.27	0.00
22636	1648.66	1648.66	0.00	1648.66	0.00	1648.66	0.00	1648.66	0.00

22404	1648.14	1648.14	0.00	1648.14	0.00	1648.14	0.00	1648.14	0.00
21870	1646.99	1646.99	0.00	1646.99	0.00	1646.99	0.00	1646.99	0.00
21329	1643.72	1643.72	0.00	1643.72	0.00	1643.72	0.00	1643.72	0.00
20682	1642.31	1642.31	0.00	1642.31	0.00	1642.31	0.00	1642.31	0.00
20210	1641.55	1641.55	0.00	1641.55	0.00	1641.55	0.00	1641.55	0.00
19672	1640.62	1640.62	0.00	1640.62	0.00	1640.62	0.00	1640.62	0.00
19135	1637.75	1637.75	0.00	1637.75	0.00	1637.75	0.00	1637.75	0.00
18731	1634.43	1634.43	0.00	1634.43	0.00	1634.43	0.00	1634.43	0.00
18575	1634.11	1634.11	0.00	1634.11	0.00	1634.11	0.00	1634.11	0.00
18423	1633.37	1633.37	0.00	1633.37	0.00	1633.37	0.00	1633.37	0.00
18121	1631.78	1631.78	0.00	1631.78	0.00	1631.78	0.00	1631.78	0.00
17494	1627.66	1627.66	0.00	1627.66	0.00	1627.66	0.00	1627.66	0.00

Figure 3: 100-Year Stormwater Inundation Boundary



- **End of Memorandum -**

Technical Memorandum Attachments

Attachment 1. Flood Mitigation Project

- FMP Summary Sheet
- Cost Estimate
- Benefit Cost Ratio

Lower Colorado-Lavaca
REGIONAL FLOOD
PLANNING GROUP
REGION 10

Attachment 1

Flood Mitigation Project

Flood Mitigation Project (FMP)

Lower Colorado-Lavaca
REGIONAL FLOOD PLANNING GROUP
REGION 10

Title: Creek St at Barons Creek | ID#: 103000065

Sponsor (note if City or County): Fredericksburg (Municipality) | Commitment: ✓ Yes ☐ No

Technical committee recommend: ☐ Yes ☐ No | RFPG recommend: ☐ Yes ☐ No

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: Fredericksburg | County: Gillespie

Watershed name(s): Barons Creek

Tributary(ies): Barons Creek

HUC#(s): 12090206 | Stream miles (est.): TBD

Drainage area: square miles, est: 0.01 | or acreage, est:

Social Vulnerability Index (SVI): 0.1

(SVI score 0.0 indicates least vulnerable; 1.0 indicates most vulnerable.)

Other:

Flood Risk Description

The crossing on Creek Street at Barons Creek is in a residential area approximately 1,100 feet south of Interstate 290. Hydraulic analysis shows the overtopping of Creek Street to a depth of 3.38 feet during the 2-year event and 18.9 feet during the 100-year event.

Proposed level-of-service: 10-year | Status: N/A | Atlas 14 rainfall used: Yes

Project Description

Proposed improvements include the construction of a new bridge including approximately 300-ft of roadway improvements and approximately 225 feet of channel modifications. Final design considerations for the channel modifications include incorporating natural channel design features such as a multi-stage channel section, use of natural materials for the channel bottom and side slopes, and native vegetation for site restoration.

Related Goal(s)

6.2 Increase the number of entities that mitigate flood risk at vulnerable roadways or waterways (e.g., low-water crossings, irrigation canals).

Estimated Project Cost

Capital cost: $2,027,000 | Ongoing O&M costs: TBD | Cost/benefit analysis: 0.3

Potential funding source(s): TBD

FREESE AND NICHOLS

Innovative approaches
Practical results
Outstanding service

OPINION OF PROBABLE CONSTRUCTION COST

PROJECT NAME	Creek Street Low Water Crossing	DATE	3/31/2023
CLIENT	City of Fredericksburg	GROUP	1149
% SUBMITTAL	Regional Flood Plan	PM	Jay Scanlon

ESTIMATED BY	QC CHECKED BY	FNI PROJECT NUMBER
Justin Tran	3/31/2023	HAF21363

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
GENERAL CIVIL					
1	MOBILIZATION (NTE 5% OF NEW CONSTRUCTION COSTS)	1	LS	$ 53,100.00	$ 53,100
2	CARE AND CONTROL OF WATER (FLOW DIVERSION)	1	LS	$ 20,000.00	$ 20,000
3	CLEARING AND GRUBBING	0.5	AC	$ 10,000.00	$ 5,000
4	STORMWATER POLLUTION PREVENTION PLAN	600	LF	$ 10.00	$ 6,000
5	SITE RESTORATION (FINAL GRADING, CLEAN-UP, RIPARIAN RESTORATION)	0.5	AC	$ 100,000.00	$ 50,000
6	TRAFFIC CONTROL PLAN	6	MO	$ 7,500.00	$ 45,000
NEW CONSTRUCTION - ROADWAY IMPROVEMENTS					
7	REMOVAL AND DISPOSAL OF EXISTING CREEK STREET BRIDGE CULVERT	1	LS	$ 75,000.00	$ 75,000
8	EXCAVATION	10170	CY	$ 20.00	$ 203,400
9	STRUCTURAL FILL	300	CY	$ 250.00	$ 75,000
10	REINFORCED HORIZONTAL CONCRETE (ABUTMENTS)	100	CY	$ 1,000.00	$ 100,000
11	REINFORCED VERTICAL CONRETE (ABUTMENTS)	90	CY	$ 1,000.00	$ 90,000
12	REINFORCED CONCRETE SLAB	9000	SF	$ 20.00	$ 180,000
13	36" DIAMETER DRIVEN PILE 25' LONG	375	LF	$ 200.00	$ 75,000
14	APPROACH SLAB	50	CY	$ 600.00	$ 30,000
15	PRESTRESSED CONCRETE GIRDER TX-28	900	LF	$ 150.00	$ 135,000
16	RAIL TY C221	680	LF	$ 75.00	$ 51,000
17	RIP RAP	50	CY	$ 350.00	$ 17,500
18	SEALED EXP JOINTS	300	LF	$ 100.00	$ 30,000
		SUBTOTAL			$ 1,241,000
		CONTINGENCY		30%	$ 372,300

OPINION OF PROBABLE CONSTRUCTION COSTS (INCLUDES CONTINGENCY)	**$ 1,613,300**
ENGINEERING DESIGN FEES (15%)	**$ 242,000**
CONSTRUCTION MANAGEMENT, INSPECTION & MATERIALS TESTING (10%)	**$ 161,300**
RIGHT-OF-WAY / EASEMENT ACQUISITION	**$ 10,000**
TOTAL OPINION OF PROBABLE CONSTRUCTION COSTS	**$ 2,026,600**

The Engineer has no control over the cost of labor, materials, equipment, or over the Contractor's methods of determining prices or over competitive bidding or market conditions. Opinions of probable costs provided herein are based on the information known to Engineer at this time and represent only the Engineer's judgment as a design professional familiar with the construction industry. The Engineer cannot and does not guarantee that proposals, bids, or actual construction costs will not vary from its opinions of probable costs.

NOTES:

1 FNI OPCC classified as an AACE Class 4 Estimate with accuracy range or -20 to +30.

Texas Water Development Board

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	Creek Street and Barrons Creek	
Project Region	Region 10	
Project Type	Drainage Improvement	

Start Construction Year	2023
End Construction Year	2024

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	5	year storm
Recurrence Interval 2	10	year storm
Recurrence Interval 3	100	year storm

Types of Project Impacts

Residential Structure Damage Reduction	No	
Commercial Structure Damage Reduction	No	
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	No	
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	$0
Utility Relocation	$0
Construction	$2,026,600
Total Capital Cost	**$2,026,600**
Operations & Maintenance (O&M)	
Baseline Annual O&M	$1,000
Project Annual O&M	$1,000
Increased Annual O&M	**$0**
Project Lifespan (years)	50

	5 - year storm		10 - year storm		100 - year storm	
	Baseline	Project	Baseline2	Project2	Baseline3	Project3
How many miles of roadway is flooded >6"?	0.1	0	0.1	0	0.1	0.1
How long are the roadways impassable (hours)?	77.76	0	108	0	224.4	65.04
What is the daily traffic (vehicle count) on the affected roadways?	885	885	885	885	885	885
How much mileage does the detour add to the route? (Difference between direct route and detour)	1.05	0	1.05	0	1.05	1.05
How much time (minutes) does the detour add to the route? (Difference between direct route and detour)	5	0	5	0	13	13
Normal Emergency Medical Services (EMS) response time (minutes)	8					
EMS response time during storm event	13	8	13	8	13	13
Number of households impacted by EMS delay due to flooded streets	25	25	25	25	25	25
Number of commercial buildings impacted by EMS delay due to flooded streets	0	0	0	0	0	0

Texas Water Development Board

	5 - year storm		10 - year storm		100 - year storm	
Input	**Baseline**	**Project**	**Baseline2**	**Project2**	**Baseline3**	**Project3**
Depth of flooding over roadway	48"	0	48"	0	48"	48"
Duration of flooding (hours)	3.24	0	4.5	0	9.35	2.71
Daily Traffic	885					
What is the length of the detour (minutes)?	5 to 20	<5	5 to 20	<5	5 to 20	5 to 20

Texas Water Development Board

**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?	**No**
Does the project include any green infrastructure elements?	**Yes**

Type of habitat	Acres
Green open space	
Riparian	0.5
Wetlands	
Forests	
Marine & Estuary	

Project Impacts by Recurrence Interval	5 - year storm		10 - year storm		100 - year storm	
	Baseline	Project	Baseline2	Project2	Baseline3	Project3
Residential Flood Damage	-	-	-	-	-	-
Commercial Flood Damage	-	-	-	-	-	-
Flooded Streets	$10,972	$0	$15,239	$0	$67,358	$19,523
Utility Impacts	-	-	-	-	-	-
Agricultural Losses	-	-	-	-	-	-
Low Water Crossing Damages	$145,356	$0	$201,883	$0	$419,469	$121,579

Flooded Structures by Recurrence Interval	5 - year storm		10 - 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	$268,846
Residual Value of Investment	$79,620
Recreational Benefits	-

Input Into BCA Toolkit

Project Useful Life **30**

Event Damages	Baseline	Project
5 - year storm	**$156,328**	**$0**
10 - year storm	**$217,123**	**$0**
100 - year storm	**$486,827**	**$141,102**

Total Benefits from BCA Toolkit	$301,960
Other Benefits (Not Recreation)	$348,465
Recreation Benefits	-
Total Costs	$1,960,309
Net Benefits	-$1,309,884
Net Benefits with Recreation	-$1,309,884
Final BCR	**0.3**
Final BCR with Recreation	**0.3**

Lower Colorado-Lavaca
REGIONAL FLOOD
PLANNING GROUP
REGION 10

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 5, 2023
FROM:	Jay Scanlon, PE, CFM Freese and Nichols, Inc. F-2144 10431 Morado Circle, Suite 200 Austin, TX 78759	PROJECT:	LCRA Contract No. 5809 Halff AVO 43796.001 FNI HAF21363
SUBJECT:	**FME ID:** 101000043 **Project Sponsor:** City of Fredericksburg **Project Name:** Edison Street at Barons Creek		

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).

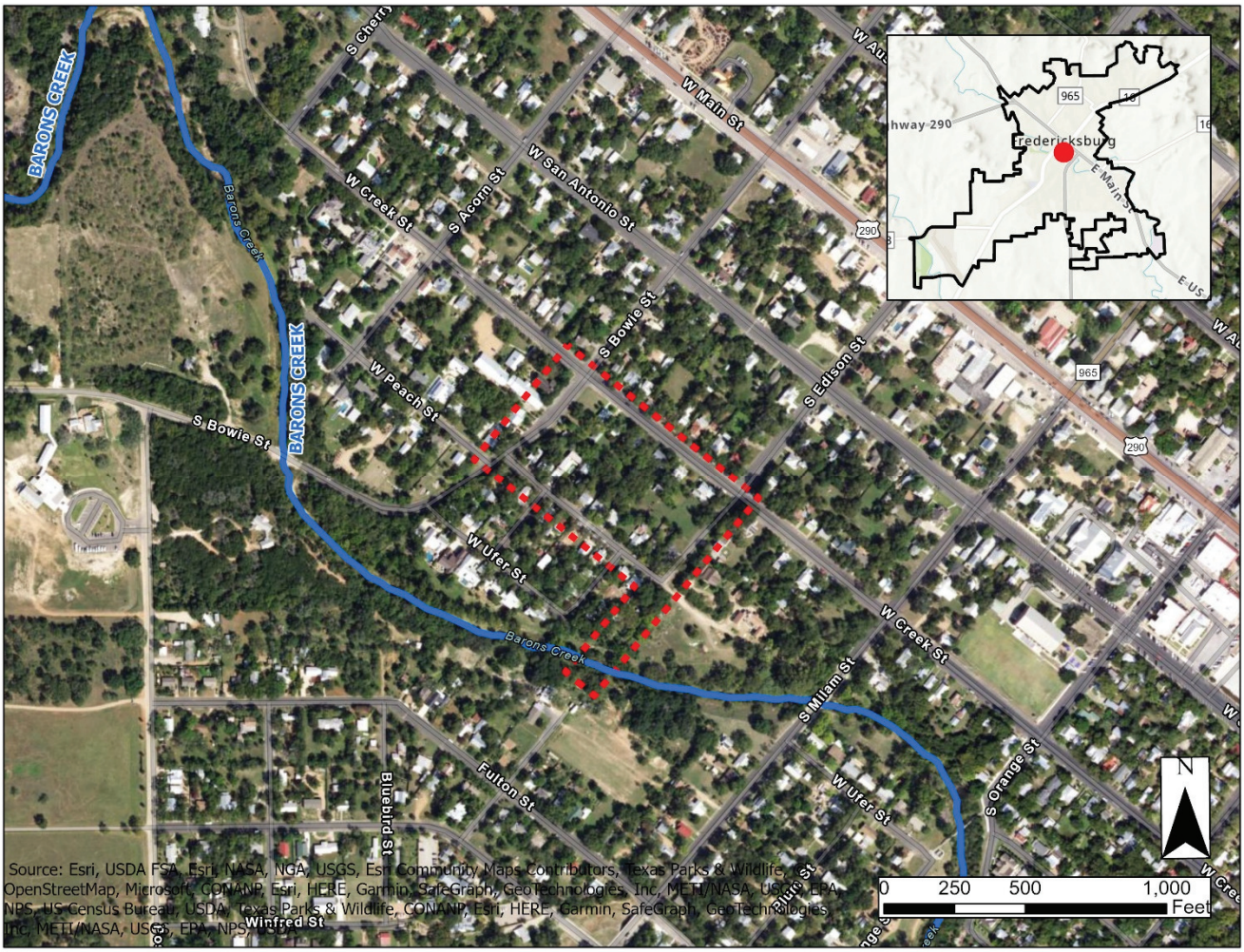
Introduction

The City's 2016 Drainage Master Plan (DMP) proposed local drainage improvements to Edison Street at Barons Creek. This action is included in the adopted Regional Flood Plan as a recommended FMP that anticipated local drainage improvements to include increasing the capacity of an existing channel and upsizing two culverts to provide safe access to adjacent houses. The project was identified and prioritized based on staff knowledge rather than detailed modeling. Based on the Sponsor request, the Regional Flood Planning Group (RFPG) recommended inclusion in the Regional Flood Plan (RFP) as FME 101000043.

Mr. Garret Bonn, Assistant City Engineer, and Interim Director of Development Services, was contacted to confirm the City's support to have the RFPG perform this FME, as described herein, as part of the Task 12 effort. Mr. Bonn confirmed the general nature of the flood problem, is supportive of the study, and assisted with local information and will review the report deliverables.

This FME includes updating the FEMA flood hazard analysis and mapping with ATLAS 14 rainfall data and evaluation of mitigation alternatives. If an alternative is determined to be feasible and provides flood risk reduction benefits the FME will include preliminary capital cost estimates, quantification of flood risk reduction benefits, benefit-cost analyses, adverse impacts evaluation, and a high-level evaluation of potential constraints including environmental permitting, utility relocations, right-of-way acquisition, and constructability issues in accordance with adopted FMP screening criteria.

Figure 1: Study Area Location



Modeling Analysis

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

Data Collection

The sources of the key data collected and leveraged for analysis are listed below.

- Terrain Data: 2019 LiDAR (70cm), obtained from Texas Natural Resources Information System (TNRIS).
- Soils Data: 2022 Natural Resource Conservation Service (NRCS) Web Soil Survey.
- Land Use Data: 2019 National Land Cover Database (NLCD).
- Hydraulic model: HEC-RAS 1D model for Barons Creek was obtained from Federal Emergency Management Agency (FEMA) Base Level Engineering (BLE) Tools and Resources website.
- FEMA effective model: obtained from the 2016 DMP study.
- Spot elevations obtained from LiDAR and City Proposed design drawings.

Hydrology

In the original HEC-RAS 1D BLE model, a Regression Equation was applied to calculate the peak flows. There is no HEC-HMS model available for the entire BLE area. To update the hydraulic model with NOAA Atlas 14 rainfall, a HEC-RAS 2D Rain-on-Grid model was developed to generate peak flows for the HEC-RAS 1D BLE model.

- Modeling Software: HEC-RAS version 6.3.1
- Rainfall Data: NOAA Atlas 14, 24-hour duration (2-, 5-, 10-, 25-, 50-, 100-, and 500-year frequency storms).
- Loss Method: NRCS Curve Number loss rate method

Hydraulics

Because the study area is outside the main channel of Barons Creek, the HEC-RAS 2D rain-on-grid model with the Atlas 14 computed flows was utilized for hydraulic analysis. Structure data for the existing channel was developed using the LiDAR data and verified using plans developed for the proposed City design.

- Modeling Software: HEC-RAS version 6.3.1, 2D unsteady-state simulation.
- Hydrologic Data: see above.
- Boundary Conditions: Downstream normal depth

Existing Condition Flood Risk

The initial project was developed based on previous staff knowledge of street flooding and access issues in the vicinity of Edison Street at Peach Street. The streets within the study are considered residential and neighborhood collectors ranging in width from approximately 28- to over 50-ft wide. Curbs vary from non-existent to 12-inches. Based on model results, the maximum 100-year water depths in Edison Street and Bowie Street are approximately 1.31 and 1.71 feet, respectively. In addition, the maximum 100-year water surface elevation along the rear property lines between Edison and Bowie Streets is approximately 0.98 feet.

Table 1 presents maximum water surface depths for the 10-, 25- and 100-year events in Edison Street, Bowie Street, and at the rear property lines for the properties between the two streets. The existing inundation map is presented in **Figure 2.**

It is important to note that although the inundation map shows some structures within the study area are at-risk, the city does not have records of structural flooding. This is common for preliminary studies based on LiDAR data. The inundation limits reflect water surface elevations based on LiDAR generated contours and do not reflect constructed finished floor elevations. **Figure 3** is the street view of one of the potentially at-risk structures that shows the finished flood elevated above the nearest adjacent ground.

Table 1: Peak Water Surface Depths

	10-yr (ft)	25-yr (ft)	100-yr (ft)
Edison Street	1.50	1.65	1.83
Bowie Street	1.81	1.98	2.09
Rear Property Line	1.25	1.35	1.57

Figure 2: Existing Condition Flood Risk

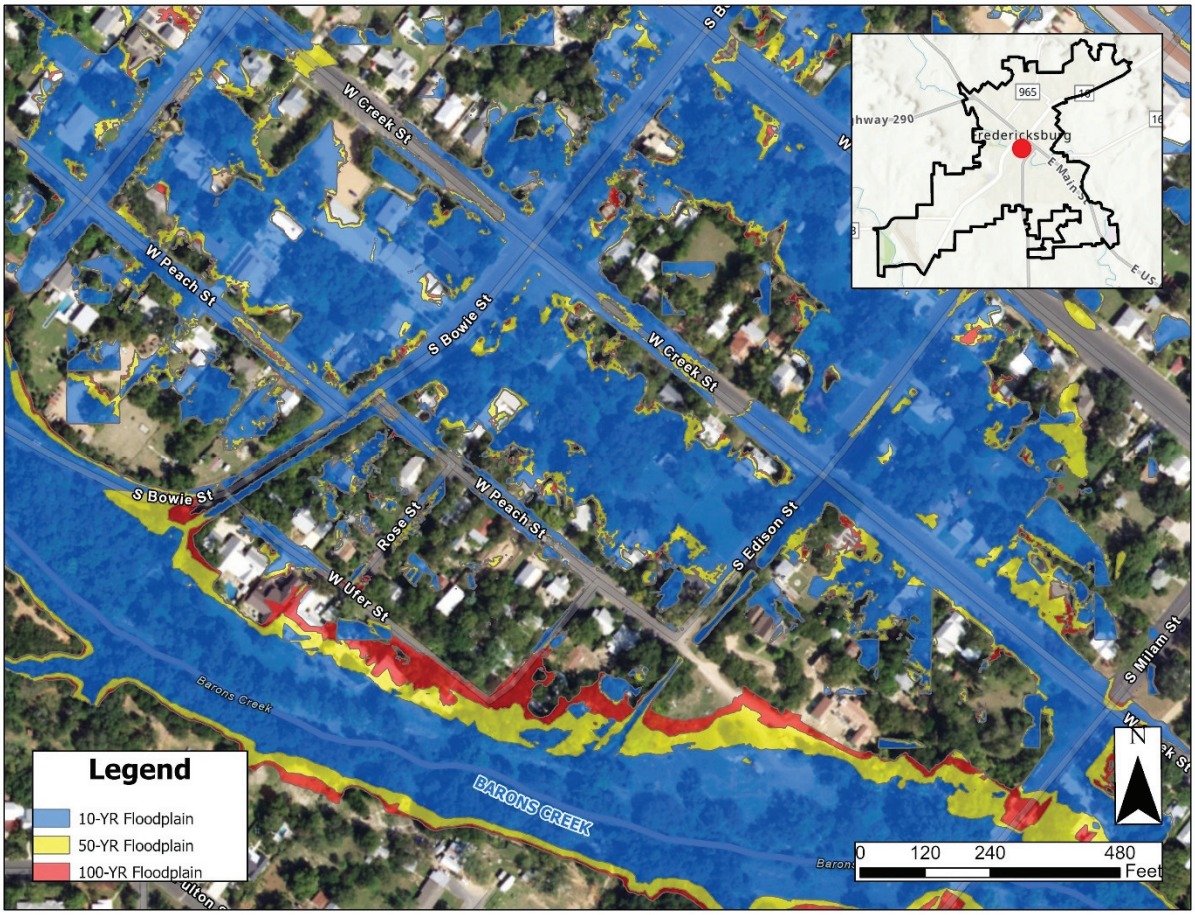


Figure 3: Example of Elevated Finished Floor

Proposed Improvements

Alternatives evaluated included the originally proposed design and two alternatives. The alternate design included:

- Original Proposed Design – Modifications to upsize the existing channel and culverts on the east side of Edison Stret.
- Alternate 1 – Expand the original design to include a swale along the rear property lines (between Bowie and Edison Streets), install an area inlet and culvert to capture and convey flows to the improved channel on Edison Street.
- Alternate 2 – Expand the proposed storm drains (consisting of curb inlets and 8' x 6' RCB trunk lines) to capture and convey runoff directly to Barons Creek in Acorn Street, Bowie Street, and Edison Street.

A comparison of the maximum water surface depths is presented in **Table 2.**

Table 2: Peak Water Surface Depths

	10-yr (ft)			25-yr (ft)			100-yr (ft)		
	Original	Alt 1	Alt 2	Original	Alt 1	Alt 2	Original	Alt 1	Alt 2
Edison Street	1.37	1.37	1.05	1.42	1.42	1.14	1.77	1.77	1.31
Bowie Street	1.79	1.79	0.63	1.93	1.93	0.80	2.08	2.08	1.71
Rear Property Line	1.20	1.20	0.16	1.28	1.28	0.47	1.50	1.50	0.98

The proposed inundation maps are shown in **Figures 4 and 5**. Because there is no measurable difference between the original design and Alternate 1, both are represented in Figure 4.

Figure 4: Original Design and Alternative 1 Inundation Mapping

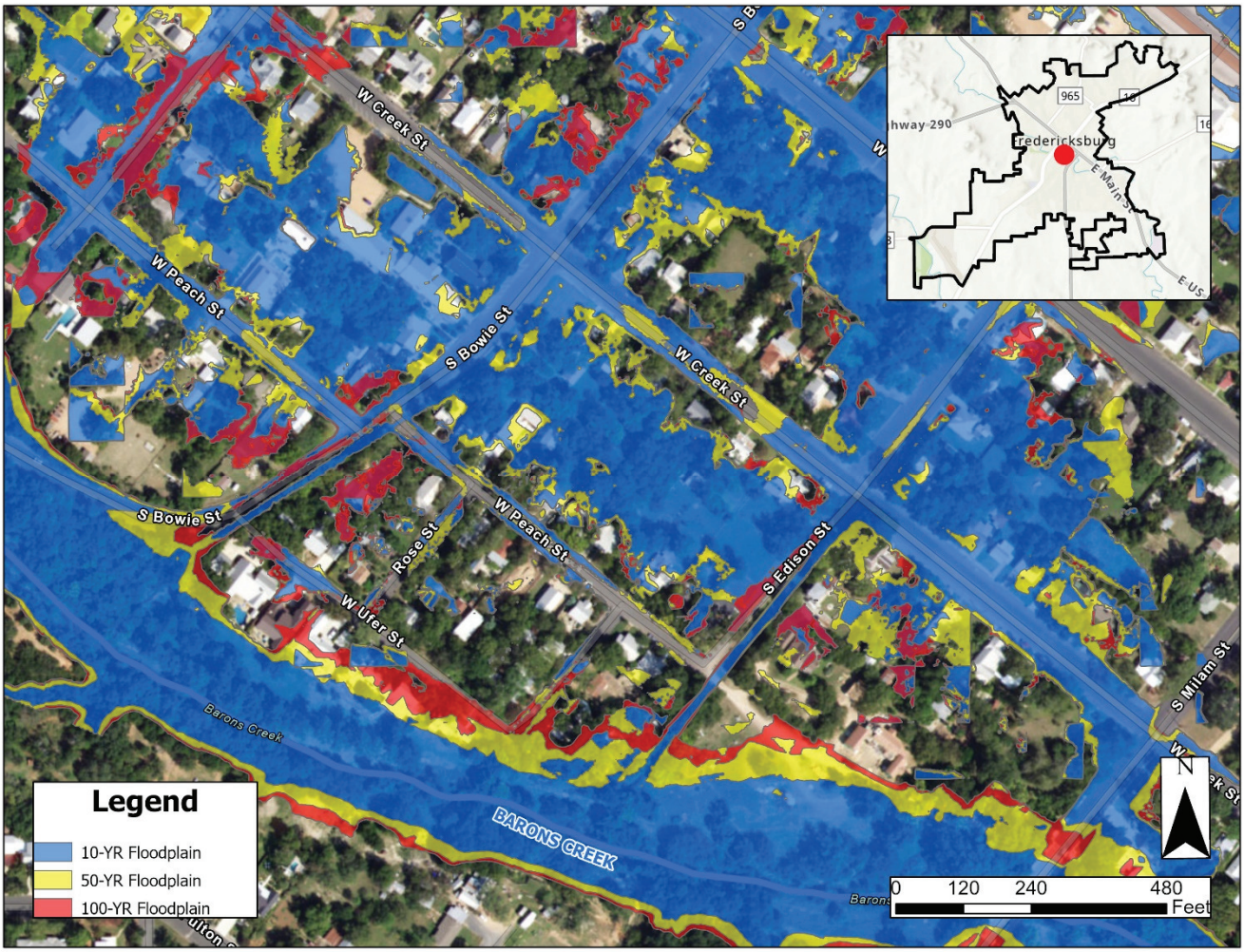
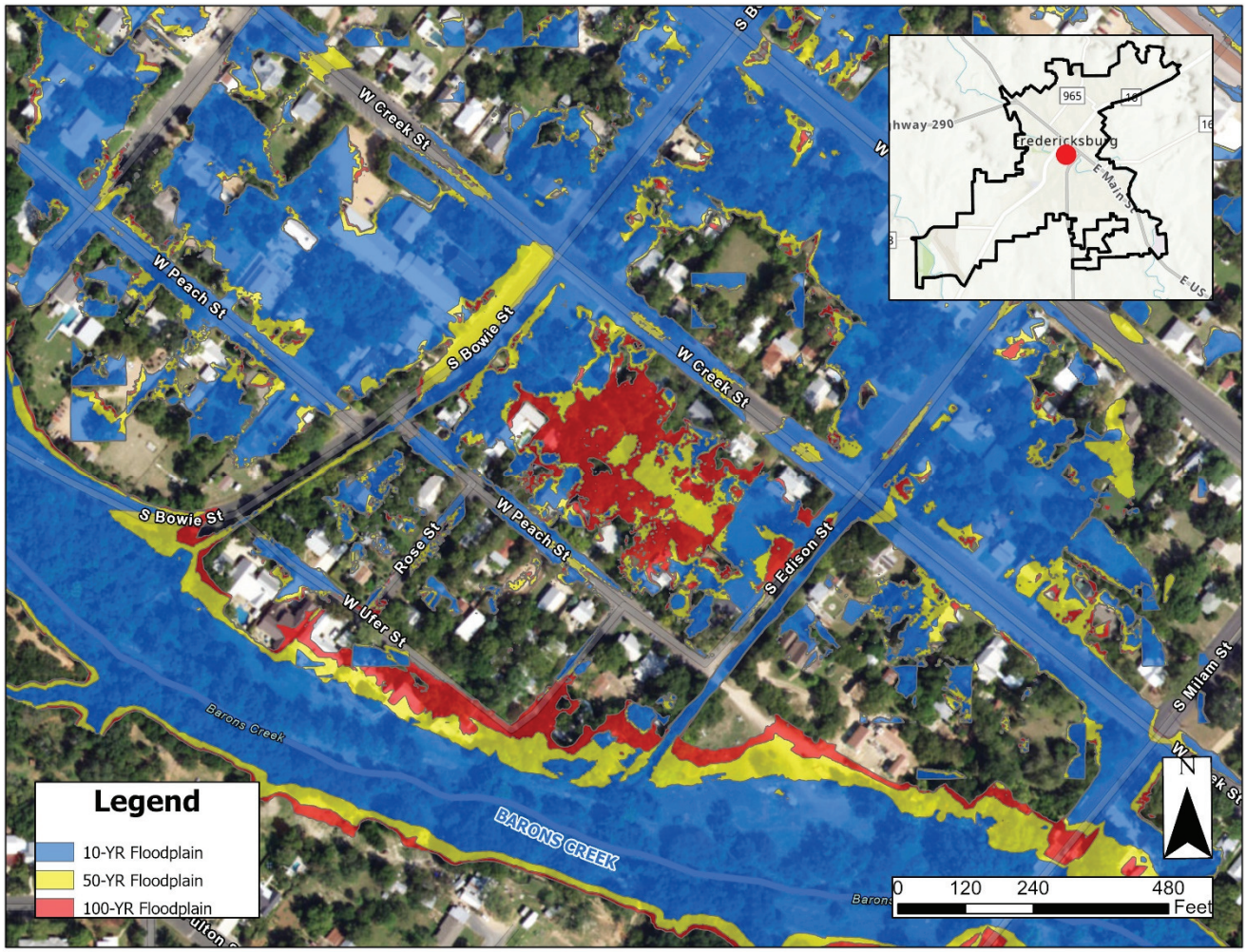


Figure 5: Alternative 2 Inundation Mapping

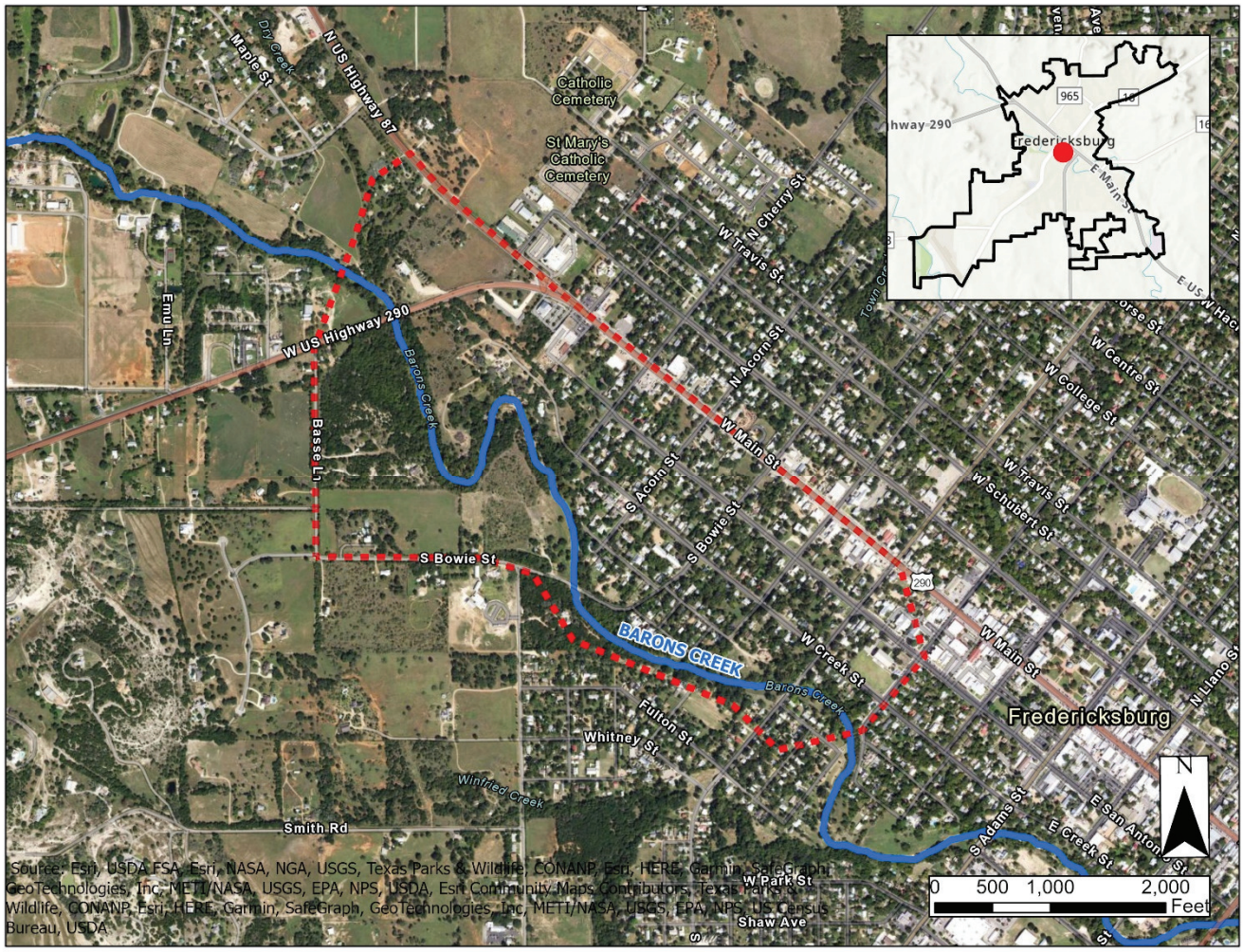


Freese and Nichols discussed the results of the alternatives evaluation with Mr. Garret Bonn. Mr. Bonn indicated that based on the limited flood risk reduction and potential cost of the system, the project is not feasible and he would not support advancing the study to an FMP. However, he did indicate the city has concerns with outfalls from the TxDOT system along Main Street (Highway 89/290) as well as other upstream road crossings on Barons Creek. After further discussion, Mr. Bonn stated his preference to modify the existing Flood Management Evaluation (FME) to study the area southwest of Main Street from upstream of State Highway 16 to upstream of U.S. 290.

Proposed Improvements

Based on the limited flood reduction benefits versus cost of this FME, and with concurrence from the Sponsor, we recommend FME101000043 be modified to reflect a more comprehensive evaluation of the area reflected in **Figure 6**.

Figure 6: Revised Future Study Area



- **End of Memorandum -**

Flood Management Evaluation (FME) STUDY

Lower Colorado-Lavaca
REGIONAL FLOOD PLANNING GROUP
REGION 10

Title: Barons Creek Watershed - Southwest City
ID#: 101000043
Sponsor (note if City or County): Fredericksburg (Municipality)
Commitment: ✓ Yes ☐ No

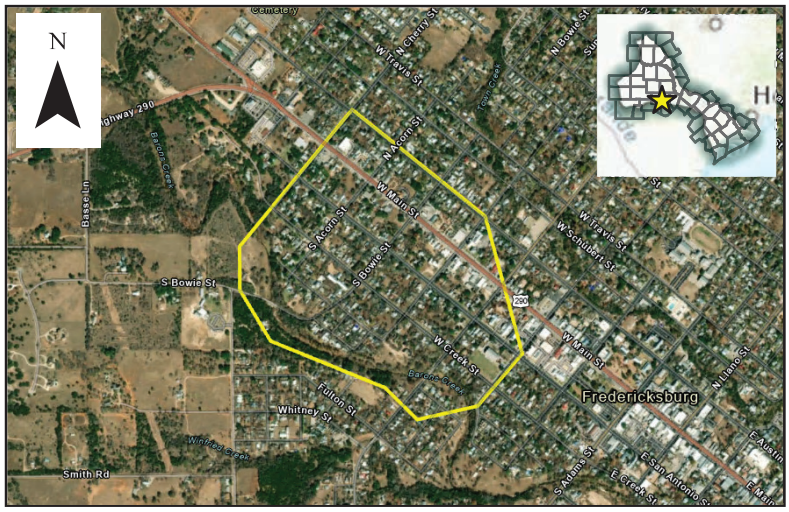
Study Type

☐ Emergency preparedness ☐ Floodplain modeling, mapping and risk assessment ✓ Feasibility study ☐ Preliminary project engineering
☐ Other

Problem Area

City: Fredericksburg
County: Gillespie
Watershed name(s): Pedernales
Tributary(ies): Barons Creek
HUC#(s): 12090206
Stream miles (est.): 1.55
Drainage area: square miles, est: 0.28
or acreage, est: 182.13
Social Vulnerability Index (SVI): 0.10
(SVI score 0.0 indicates least vulnerable; 1.0 indicates most vulnerable.)

Other: Drainage System and Roadway/Crossing Improvements



Flood Risk Description

This study evolved out of the previous Edison Street at Barons Creek Study. The project was identified based on staff knowledge and was intended to reduce local street flooding, mobility, with possible structural risk reduction. The project was evaluated under Task 12 of the planning process. A 2D rain-on-grid model was developed to analyze proposed local drainage improvements and related alternatives. Due to the limited local flood risk reduction benefits, the city amended the action to include a broader study area to evaluate potential drainage system and/or roadway improvements for the residential areas upstream of Milam Street.

Population at risk: 830
Structures at risk: 274
Critical facilities at risk (number): 0
Farm/Ranch land impacted (acres): 0
Roadway(s) impacted (miles): 1.49

Scope of Study

Study will include hydrologic and hydraulic modeling (with Atlas 14 rainfall), preliminary design of improvements, risk reduction analysis, verification of no adverse impact, preparation of cost estimate and a benefit-cost-analysis, and an evaluation of potential constraints (environmental, utility conflicts, right-of-way needs, and constructability.

Related Goal(s)

6.1 Reduce the number of structures and critical facilities that are at high risk of repetitive loss through the implementation of structural flood mitigation project.

Estimated Study Cost

Cost: $150,000
Potential funding source(s): TBD

Technical Memorandum Attachments

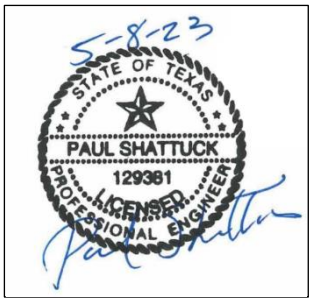
Attachment 1. Flood Mitigation Project

- FMP Summary Sheet

Lower Colorado-Lavaca
REGIONAL FLOOD
PLANNING GROUP
REGION 10

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, Inc. Firm No. 754 4401 West Gate Blvd., Suite 400 Austin, TX 78745	PROJECT:	LCRA Contract No. 5809 Halff AVO 43796.001 HDR PN 10304676



SUBJECT: **FME ID: 101000167**
Project Sponsor: City of Marble Falls
Project Name: Broadway Avenue at Backbone Creek Low Water Xing Upgrade

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 purpose of this FME was to perform a flood mitigation alternatives analysis and select a preferred solution for final design to replace/upgrade the Broadway Street bridge crossing at Backbone Creek within the City of Marble Falls as shown in Figure 1 below. The Broadway Street bridge is one of the most commonly closed low water crossings in Marble Falls and in located in a Zone AE special flood hazard with a designated floodway. It is a heavily trafficked street, providing an alternative route to the US 281/1431 intersection, as well as a frequented route for emergency response vehicles which are stationed nearby. Existing conditions model results indicate the Broadway Street bridge crossing incapable passing the 2-Year event without roadway overtopping. Alternatives analysis will include upsizing of the bridge crossing to allow for greater level-of-service vehicular traffic.

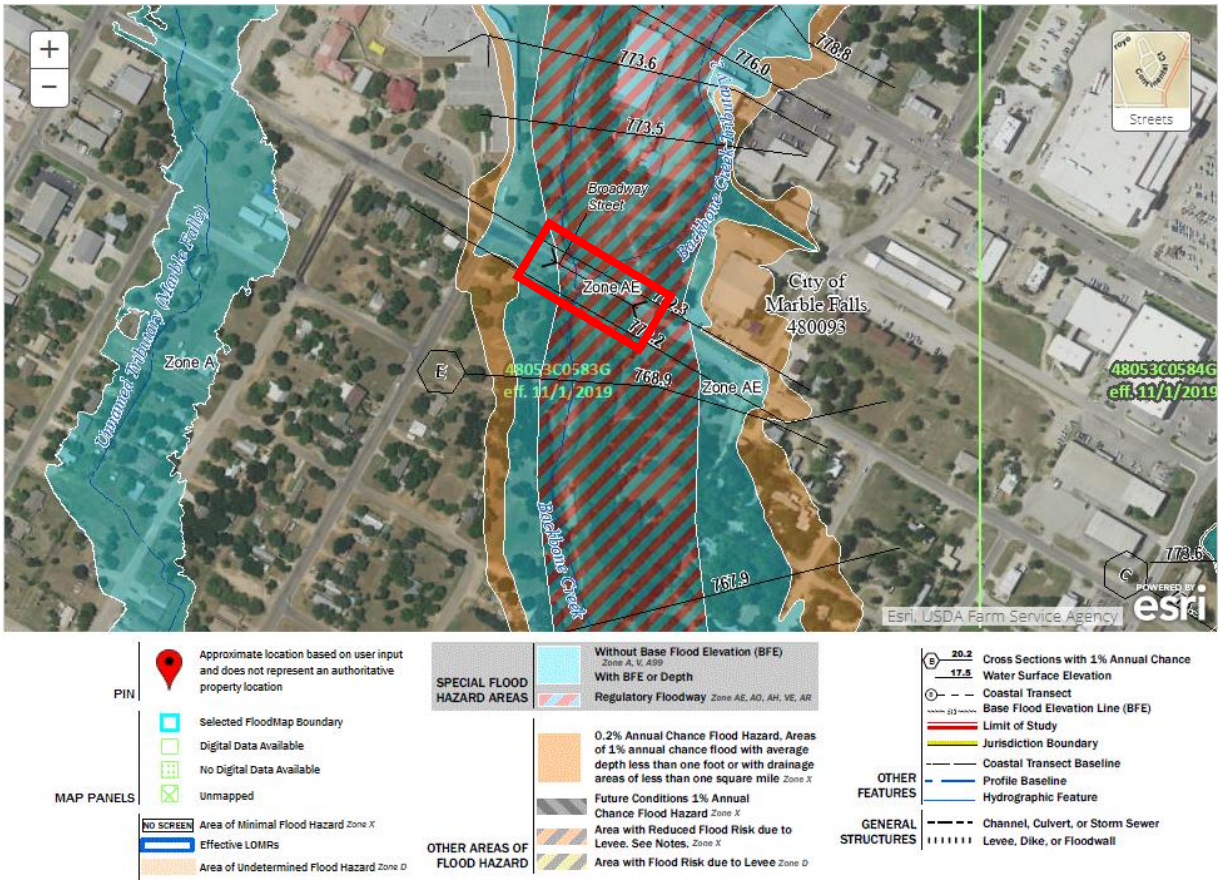


Figure 1: Study Area Location of the Broadway Street Low Water Crossing

Modeling Analysis

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

Data Collection and Site Visits

A one-meter resolution bare-earth ground digital elevation model (DEM) was created for the project area using a combination of 2019 United States Geological Survey LiDAR data (USGS 2019) and 2020 Texas Strategic Mapping (StratMap) Program LiDAR data from North and Central Texas (StratMap 2020). The processed DEM was used to update the existing conditions model 1-D HEC-RAS cross sections near Broadway Street and to provide a starting point in the development of proposed improvement model cross sections. In addition to the desktop DEM processing in GIS, a field reconnaissance of the Broadway Street bridge crossing was performed by HDR staff to inspect surface level features and related infrastructure potentially impacted by proposed crossing improvements.

Hydrology

A HEC-HMS hydrologic model of Backbone Creek, which includes Whitman Branch, was provided to HDR from Halff Associates and is considered best the available model. This model was developed circa 2014 as part of a flood study by Halff Associates for the City of Marble Falls. This HEC-HMS model is believed to be the source of, and to match the regulatory model for Backbone Creek because the model output matches regulatory HEC-RAS hydraulic model flow inputs. The model includes basin models representing both existing and fully developed

conditions of Backbone Creek. Only the fully developed basin model was used for this FMP. The provided HMS model was updated to include Atlas 14 rainfall.

- Modeling Software: HEC-HMS version 3.5
- Rainfall Data: NOAA Atlas 14, 24-hour duration, frequency storm temporal distribution
- Initial Losses: Not revised or verified for this study. Basin model representing ultimate / fully developed conditions was used.
- Hydrograph Approach: NRCS TR-55 unit hydrograph. This methodology was not revised or verified for this study.
- Routing: Provided model utilizes Modified Puls and Muskingum Cunge reach routing methodologies. These values were not revised or verified for this study.
- Areal Reduction: Depth-Area reduction of the rainfall data was calculated internally within HEC-HMS using the storm area of the Backbone Creek watershed of 31.605 square miles approximately at the point of interest of the Broadway Street and 10th Street bridges.

HEC-HMS NOAA Atlas 14 rainfall inputs and corresponding peak flows in the HEC-RAS model are provided in Table 1.

Table 1: HEC-HMS Rainfall Input Values and Calculated Peak Flows (Future Conditions Land Use)

Rain Event	2YR	10YR	25YR	100YR
Rainfall (inches)	3.76	6.13	7.91	11.30
HEC-RAS XS Station	Peak Flows (cfs)			
13725	7950	19260	26730	36560
12132	8190	19750	27360	38440
8144	8190	19750	27350	38470
6481	8180	19730	27300	38450
6119	8240	19860	27480	38880
5366	8330	20060	27760	39790
4835	8320	20010	27700	39790
3426	8310	19900	27560	39710
2397	9370	21710	30710	48180
838	9350	21670	30570	48090

Hydraulics

An Existing Conditions 1-D HEC-RAS model previously developed by TWDB Flood Protection Planning Study in 2014 for Backbone Creek served as a starting point for the hydraulic modeling efforts for Broadway Street bridge analysis. Model cross sections in the immediate vicinity of the bridge (approximately 500 feet upstream and downstream) were reviewed and updated using the processed DEM as previously discussed. Peak flows from the HEC-HMS model were entered into the HEC-RAS model to simulate existing conditions (based on future land use hydrology) and bridge alternatives flood inundation depths and extents. The remainder of the HEC-RAS hydraulic cross sections outside of the immediate project area were left unchanged. The downstream boundary condition at the outlet of Backbone Creek entering the Colorado River was also left unchanged and assumes a normal depth condition friction slope of 0.0053.

Existing Condition Flood Risk

Figure 2 shows the existing conditions water surface profile for the 2, 10, 25 and 100 year, 24-hour duration rain events at the Broadway Street and 10th Street bridges. As shown on Figure 3, the Broadway Street bridge is overtopped during the 2-year event while the 10th Street Bridge is overtopped during the 10-year event. Within Marble Falls critical lifeline services (emergency management services, fire, and police) are divided on opposite sides of Backbone Creek cutting off services to residents and businesses during flood events.

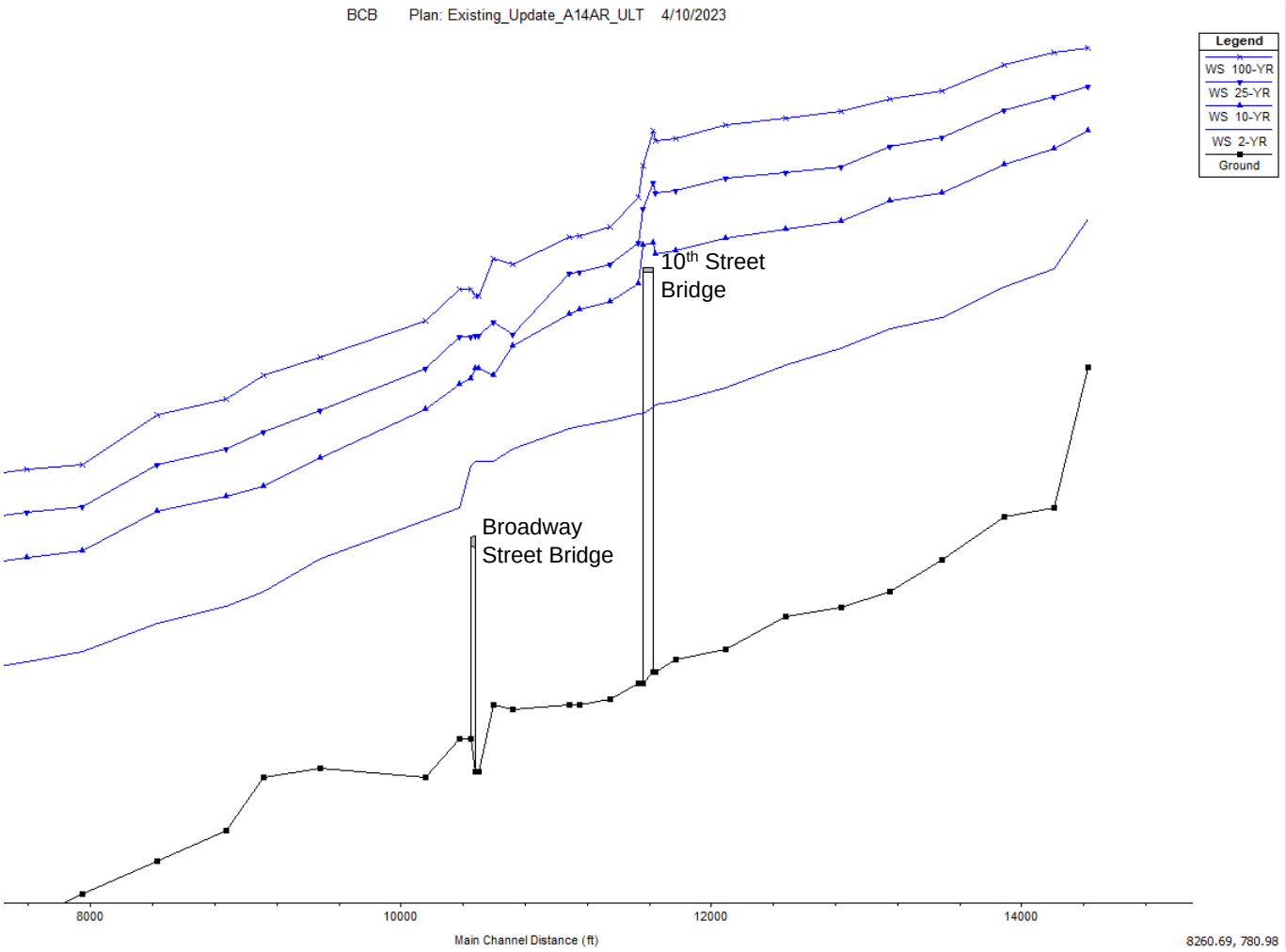


Figure 2: Existing Condition Flood Risk – Water Surface Elevation Profile for the 2, 10, 25, and 100-Year, 24-Hour Rain Events

Based on results from the HEC-RAS model, existing flow capacity of the Broadway Street Bridge and the 10th Street Bridge without experiencing roadway overtopping are equal to approximately 6,000 cfs and 17,000 cfs, respectively.

Figure 3 shows the existing conditions 100-year event flood inundation extents with adjacent building footprint near the project study area.

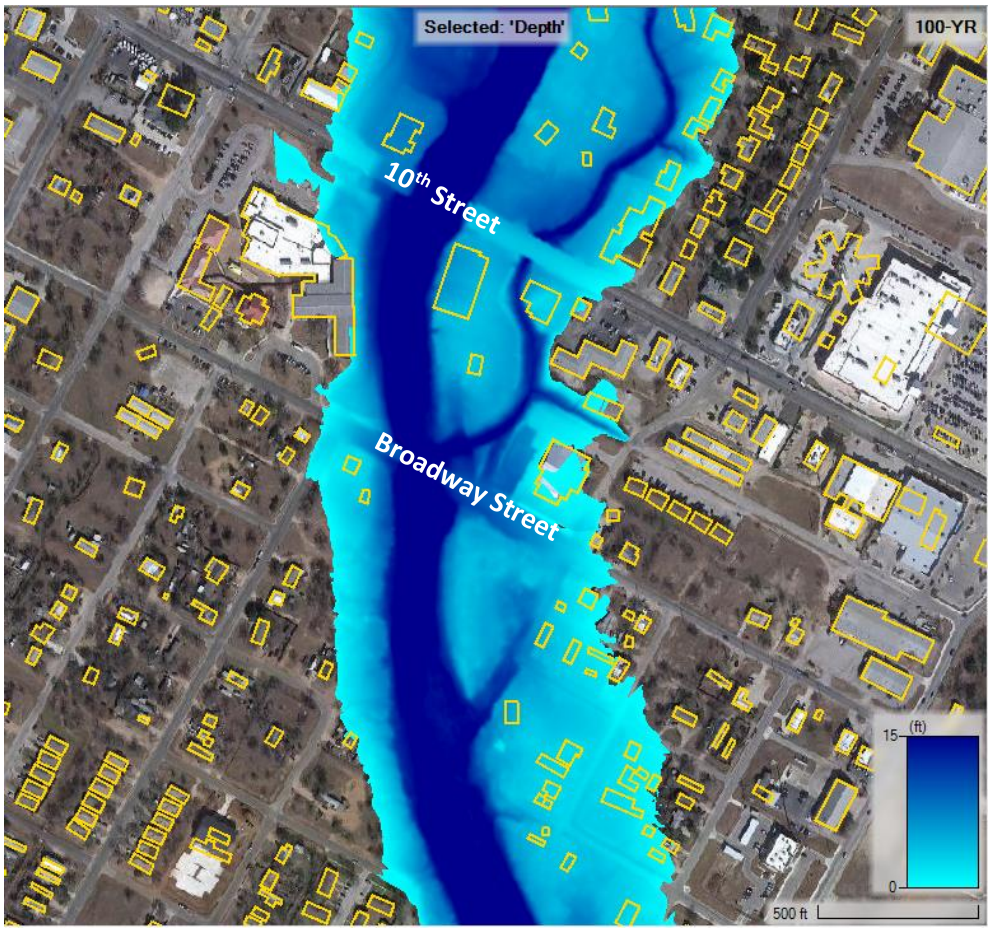


Figure 3: Existing Condition 100-Year Flood Inundation Extents

Proposed Improvements

Proposed improvements for the project area include full replacement of the existing Broadway Street bridge, stream channel improvements, and increasing conveyance and storage in the adjacent floodplains. The proposed bridge selected for the modeling analysis is based on Texas Department of Transportation Prestressed Concrete Slab Beam Spans for a 28' wide roadway (SPSB-28) with 50-foot-long spans and 2-foot-wide piers at the ends of each span. The bridge deck includes a 32-inch rail on top of the deck as per Texas Department of Transportation Type T221 Traffic Rail. The existing bridge is approximately 150 feet in length with the top of the bridge deck at an elevation of 763.5 feet. The new bridge deck length will be increased to approximately 350 feet be raised up 10.5 feet to elevation 773. To cover the 350-foot distance of the new bridge, approximately seven 50-foot concrete spans and seven rows of bridge piers will be needed. Included as part of the bridge replacement are raising and repaving the existing road approach sections from intersection to intersection to match the bridge deck elevation of 773 feet, replacing existing sidewalks and raising manhole rim elevations near the intersection with Avenue S, and installing a new retaining wall to protect and maintain access to an existing sewage pump station near Avenue Q. A schematic of the proposed bridge improvements is shown in Figure 4.

The proposed project increases the maximum flow capacity of the bridge at Broadway Street without roadway overtopping to approximately 39,000 cfs (from approximately 6,000 cfs in Existing Conditions).

Figure 4: Proposed Bridge Improvements

As previously mentioned, the proposed project includes stream channel and floodplain improvements to increase conveyance capacity and floodplain storage. The Existing Condition and Post-Project DEMs are shown in Figure 5. The total excavated soil quantity as part of the proposed project is equal to approximately 35,500 cubic yards.

Existing water and sewer utilities were obtained and reviewed from Marble Falls. It assumed that utility relocations will not be needed as part of the project as it appears that existing infrastructure is below the bottom of the existing stream channel. All proposed stream channel and floodplain grading improvements are proposed to be above this elevation therefore not impacting existing subsurface water and sewer utilities. However this assumption should be confirmed via survey under future design work.

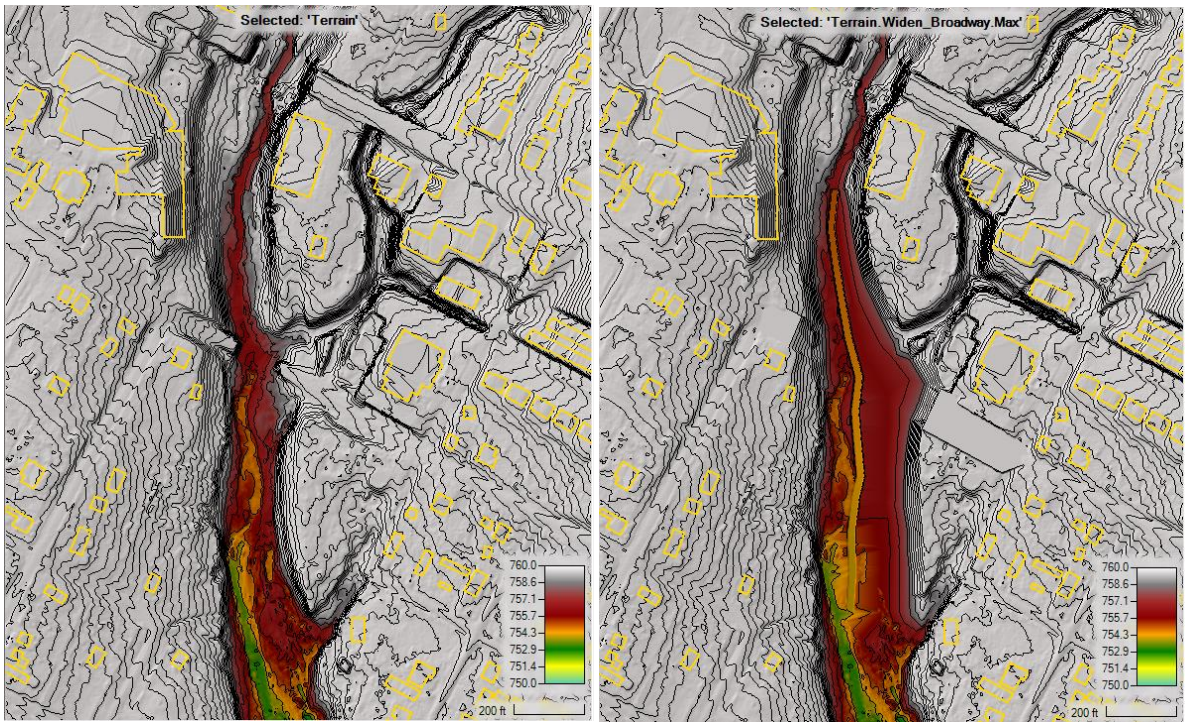


Figure 5: Existing Conditions (Left) and Post Conditions (Right) Stream Channel and Floodplain Conveyance Improvements

Project Benefits

Project benefits were evaluated for three categories: flood risk reduction to residential and commercial buildings, low water crossing damages, and flooded streets detours due to hours impassible over Backbone Creek.

Table 2 and Figure 6 indicates the flood risk reduction benefits to commercial and residential buildings for the 2-, 10-, 25-, and 100-year events. As shown in Table 2, adjacent flood reduction benefits are minimal for the proposed project.

Table 2: Risk Reduction Benefits

Flood Risk Condition	Reduction in the Number of Flooded Commercial Buildings	Reduction in the Number of Flooded Residential Buildings
50% Annual Chance (2-year)	0	0
10% Annual Chance (10-year)	0	0
4% Annual Chance (25-year)	0	0
Existing Condition 1% Annual Chance (100-year)	2	1

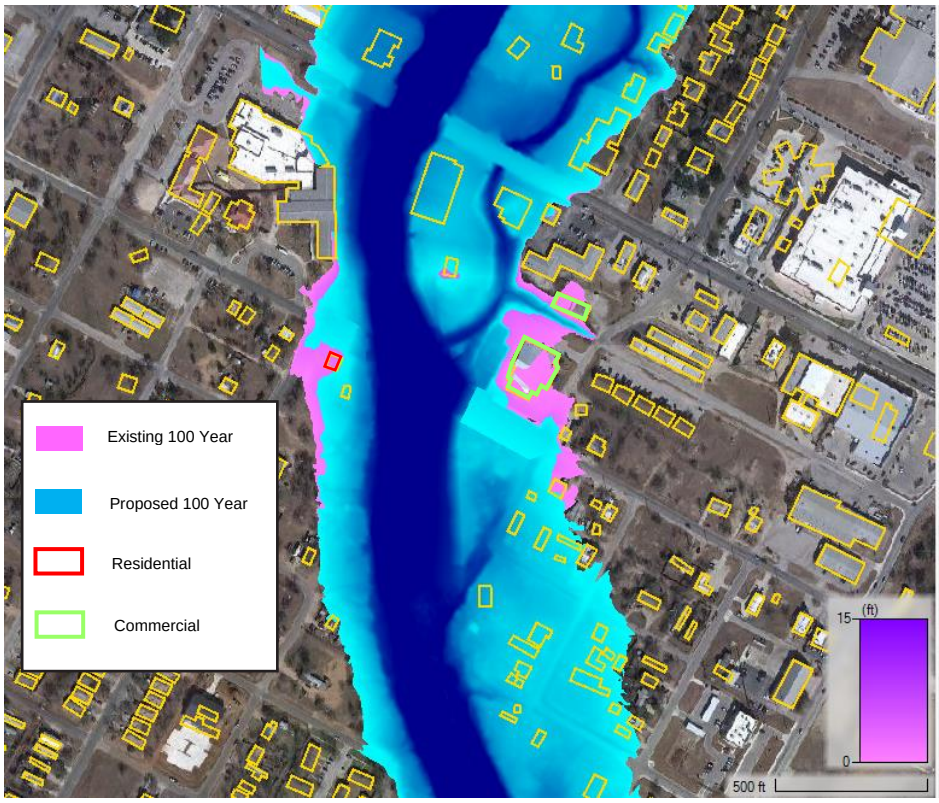


Figure 5: Flood Risk Reduction Benefits for the 100-Year Event

To determine low water crossing damages and flooded streets project benefits an understanding of the hours impassible for the project area is needed. Hours impassible for Broadway Street and 10th Street bridges was calculated by comparing the maximum flow capacity without overtopping of each bridge (existing conditions and proposed project) and the design storm hydrograph output from HEC-HMS. Any hydrographs flows exceeding the flow capacity of the bridge were considered as impassible. The timing analysis is based on a design storm hydrograph and actual hydrograph durations are expected to differ. The impassible hours calculation results are shown in Table 3.

Table 3: Total Hours Impassible Reduction Benefits

Flood Risk Condition	Broadway Street		10th Street	
	Hours Impassible During Existing Conditions	Hours Impassible During Proposed Conditions	Hours Impassible During Existing Conditions	Hours Impassible During Proposed Conditions
50% Annual Chance (2-year)	1.3	0	0	0
10% Annual Chance (10-year)	3.3	0	1.4	0
4% Annual Chance (25-year)	4.2	0	2.3	1.5
Existing Condition 1% Annual Chance (100-year)	6.2	0	3.2	3.1

In addition to hours impassible low water crossing damages and flooded streets benefits require total vehicular traffic counts for the project area. A total daily vehicular traffic count of 18,478 cars was used for the analysis. Total vehicular counts were determined using Texas Department of Transportation State Wide Traffic Counts Web Map for TX-1431 (10th Street).

Finally the detour route is needed to determine the flooded streets benefits. The detour route for Marble Falls Emergency Services, fire, and police to access the opposite banks of Backbone Creek would require approximately 16 additional miles for a total of 28 minutes. The detour route is shown in Figure 6. The proposed project would eliminate this detour up to approximately the 25-year event.

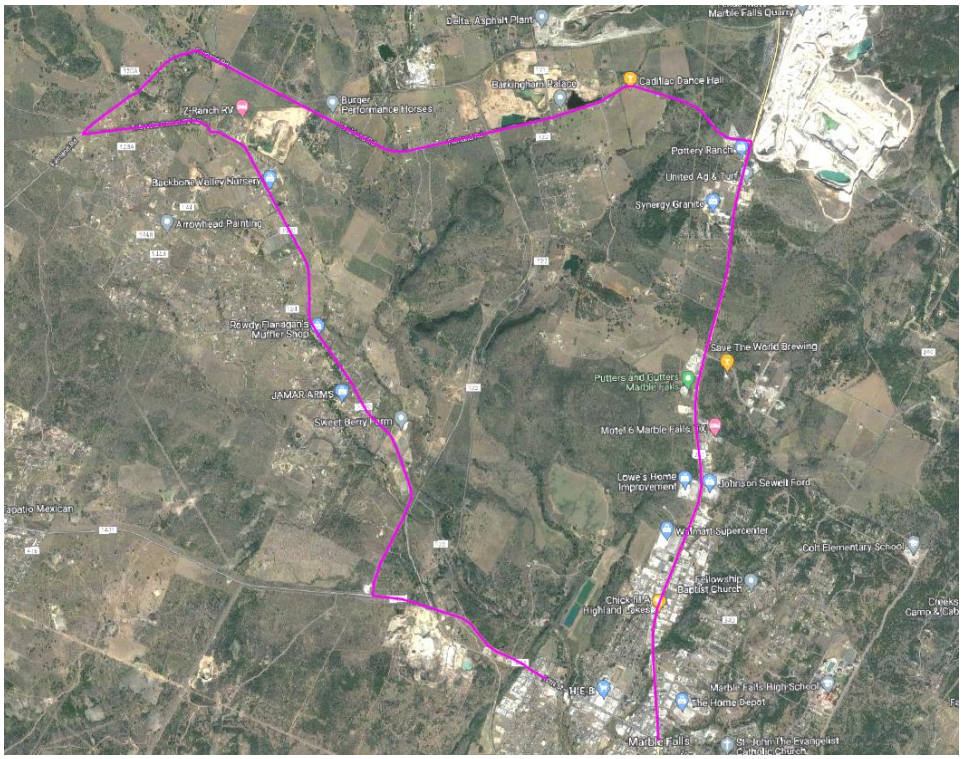


Figure 5: Detour Route for Emergency Management Services, Fire, and Police

Each of the above benefit assumptions were used as inputs in the cost benefit analysis spreadsheets.

Estimate of Probable Cost

The proposed project is estimated to cost $5,234,400 in 2023 dollars. Cost of the project include construction costs, land acquisition (assume assessed value using Burnet Central Appraisal District data multiplied by three to account for cost uncertainties), design and permitting (15%), and contingency (35%). An itemized breakdown of the cost estimate is provided in Table 4.

Table 4: Itemized Cost Estimate for the Proposed Project

Materials/Facilities/Services	$/Unit	Unit	Quantity	Construction	Acquisition	2023 Cost	2020 Cost (adjusted using ENR CCI)
Silt Fence for Erosion Control	$ 6.00	LF	2400	$ 14,400.00		$ 14,400.00	$ 12,568.14
Preparing the Right of Way	$ 20,000.00	LS	1	$ 20,000.00		$ 20,000.00	$ 17,455.75
Remove Existing Bridge/Road/Sidewalk	$ 15.00	SY	3800	$ 57,000.00		$ 57,000.00	$ 49,748.88
Floodplain Tree Removal/Clearing of Brush	$ 500.00	EA	50	$ 25,000.00		$ 25,000.00	$ 21,819.68
Relocate Overhead Electrical Utilities	$ 10,000.00	EA	2	$ 20,000.00		$ 20,000.00	$ 17,455.75
Excavation (Floodplain and New Stream Channel)	$ 10.00	CY	35500	$ 355,000.00		$ 355,000.00	$ 309,839.52
Embankments	$ 10.00	CY	0	$ -		$ -	$ -
MSE Retaining Wall Near Existing Pump Station	$ 60.00	SF	700	$ 42,000.00		$ 42,000.00	$ 36,657.07
Bridge (All Structural Elements)	$ 150.00	SF	12600	$ 1,890,000.00		$ 1,890,000.00	$ 1,649,568.16
Replace Asphalt Pavement for Road Approach	$ 110.00	SY	1300	$ 143,000.00		$ 143,000.00	$ 124,808.60
Replace Sidewalk West Side Only	$ 70.00	SY	300	$ 21,000.00		$ 21,000.00	$ 18,328.54
Raise Manholes	$ 1,000.00	EA	2	$ 2,000.00		$ 2,000.00	$ 1,745.57
Seeding of Floodplain and Embankments (STRAW/HAY MLCH SEED(PERM)(RURAL)(CLAY))	$ 0.57	SY	30400	$ 17,328.00		$ 17,328.00	$ 15,123.66
Tree plantings in floodplain	$ 300.00	EA	50	$ 15,000.00		$ 15,000.00	$ 13,091.81
Soil Retention Blanket Class A; Type G	$ 5.00	SY	8200	$ 41,000.00		$ 41,000.00	$ 35,784.28
Care of Surface Water	$ 60,000.00	LS	1	$ 60,000.00		$ 60,000.00	$ 52,367.24
Traffic Control	$ 80,000.00	LS	1	$ 80,000.00		$ 80,000.00	$ 69,822.99
TOTAL CONSTRUCTION COST				$ 2,802,728.00	$ -	**$ 2,802,728.00**	**$ 2,446,185.65**
Design and Permitting (15% construction cost)	15%					$ 420,409.20	$ 366,927.85
CLOMR/LOMR Preparation and Fees	$50,000	LS				$ 50,000.00	$ 43,639.37
Environmental; archaeological & historical resources	$ 60,000.00	LS				$ 60,000.00	$ 52,367.24
Temporary and/or permanent easements; land acquisition	$ 424,781.61	LS				$ 424,781.61	$ 370,744.03
Mobilization	11%					$ 308,300.08	$ 269,080.42
Legal assistance; fiscal services & costs (bond counsel); outreach; land acquisition (3% construction cost)	3%					$ 84,081.84	$ 73,385.57
Interest during construction (*assume 1Yr)	3.5%					$ 98,095.48	$ 85,616.50
Inspection; pilot testing; warranty; manuals	$ 5,000.00	LS				$ 5,000.00	$ 4,363.94
Contingency(s) (35% construction cost)	35%					$ 980,954.80	$ 856,164.98
TOTAL ADDITIONAL COST						**$ 2,431,623.01**	$ 2,122,289.89
TOTAL COST						**$ 5,234,351.01**	$ 4,568,475.54

Project Constraints

Restraints include uncertainties with existing water, sewer, and overhead electrical utility conflicts. Within the project area are an existing sewage pump station, a sanitary sewer stream crossing, and potable water mains. The buried elevations and condition of this infrastructure is unknown. Costs associated with relocating this infrastructure are not included as part of the estimate and is assumed that the proposed project (new bridge and grading) can work around and accommodate this infrastructure as necessary. Channel modifications must also be refined to support authorization under a USACE Section 404 permit.

Benefit Cost Analysis

A benefit cost analysis was performed using TWDB BCA workbook version 2 and FEMA's BCA Excel Add-in Tool. From the spreadsheets it was determined that the Low Water Crossing benefits have the most significant impact on the benefit cost ratio (BCR). Low Water Crossing benefits are calculated by comparing the damages at the crossing between the existing baseline conditions and the proposed project conditions for each evaluated flood event. This project evaluated the 10, 25, and 100 year flood events. The calculated damages are a function of the depth of flooding over the crossing and the traffic count. A sensitivity analysis was performed on the existing conditions depth of flooding over the crossing to observe the change in the BCR value. It was observed that the calculated damages and the resulting BCR value significantly increase when the existing flooding depth is reduced below 48-inches. This issue is illustrated in Tables 4a and 4b. By adjusting the existing depth of flooding over the crossing from 48-inches to 42-inches the BCR value passes the 1.0 threshold. However, the existing flooding depth on Broadway Street bridge is estimated to be more than 48-inches (see Figure 2).

Table 4a: BCR with 48-inch Existing Flood Depth

Input Into BCA Toolkit		
Project Useful Life	30	
Event Damages	**Baseline**	**Project**
100 - year storm	**$4,781,872**	**$0**
25 - year storm	**$3,245,828**	**$0**
10 - year storm	**$2,052,509**	**$0**
Total Benefits from BCA Toolkit	$3,981,751	
Other Benefits (Not Recreation)	$52,113	
Recreation Benefits	-	
Total Costs	$5,596,579	
Net Benefits	-$1,562,715	
Net Benefits with Recreation	-$1,562,715	
Final BCR	**0.7**	
Final BCR with Recreation	**0.7**	

Table 4b: BCR with 42-inch Existing Flood Depth

Input Into BCA Toolkit		
Project Useful Life	30	
Event Damages	**Baseline**	**Project**
100 - year storm	**$9,142,204**	**$0**
25 - year storm	**$6,366,908**	**$0**
10 - year storm	**$4,026,133**	**$0**
Total Benefits from BCA Toolkit	$7,744,272	
Other Benefits (Not Recreation)	$52,113	
Recreation Benefits	-	
Total Costs	$5,596,579	
Net Benefits	$2,199,806	
Net Benefits with Recreation	$2,199,806	
Final BCR	**1.4**	
Final BCR with Recreation	**1.4**	

Given this significant change in BCR result, both methods were presented for consideration. It is recommended that the Low Water Crossing BCA methodology and results be reviewed with TWDB and Marble Falls to determine the most appropriate inputs for the proposed project.

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 maximum water surface elevation results in HEC-RAS were extracted for the cross sections within the entire model domain during Existing and Proposed Conditions. Results are presented in Table 4 and indicate no rise throughout the model domain. It should be noted that as part of this evaluation the hydrologic routing impacts of increased velocities through the cross sections due to the proposed channel modifications. As part of detailed design, any future channel modifications will require considerations for potential increased velocities and sheer stresses.

Table 4: HEC-RAS Maximum Water Surface Elevation Existing and Proposed Condition for 100-Year Event

River Station Cross Section	W.S. Elev (ft)		Proposed - Existing (ft)	River Station Cross Section	W.S. Elev (ft)		Proposed - Existing (ft)
	Existing	Proposed			Existing	Proposed	
13725	784.81	784.81	0.00	8144	766.82	766.82	0.00
13507	784.62	784.61	-0.01	7783	766.64	766.64	0.00
13183	784.1	784.08	-0.02	7241	766.09	766.09	0.00
12785	782.99	782.95	-0.04	7120	766.05	766.05	0.00
12448	782.6	782.01	-0.59	7067	765.95	765.95	0.00
12132	782.06	782.01	-0.05	6834	765.1	765.1	0.00
11777	781.78	781.73	-0.05	6481	764.51	764.51	0.00
11391	781.52	781.46	-0.06	6119	764.22	764.22	0.00
11069	780.93	780.86	-0.07	5918	764.14	764.14	0.00
10938	780.79	780.71	-0.08	5824	762.77	762.77	0.00
10828	778.37	778.22	-0.15	5366	761.79	761.79	0.00
10643	777.12	776.85	-0.27	4835	760.87	760.87	0.00
10520	776.71	775.86	-0.85	4336	760.36	760.36	0.00
10452	776.64	776.04	-0.60	4250	759.95	759.95	0.00
10319	775.53	770.4	-5.13	4163	759.81	759.81	0.00
10188	775.79	771.88	-3.91	3960	759.74	759.74	0.00
10088	774.09	772.42	-1.67	3426	757.98	757.98	0.00
9965	774.41	771.31	-3.10	2548	757.11	757.11	0.00
9748	773.09	770.9	-2.19	2397	755.65	755.65	0.00
9430	771.49	770.5	-0.99	2311	755.69	755.69	0.00
9314	770.68	770.39	-0.29	1933	754.75	754.75	0.00
9068	769.67	769.67	0.00	838	752.78	752.78	0.00
8627	768.99	768.99	0.00	197	747.89	747.89	0.00

Mitigation Measures

The preliminary modeling confirms the following:

- The proposed project increases the level of service for the crossing Backbone Creek within Marble Falls to approximately the 25-year event.
- The proposed project does not increase inundation in areas beyond the public right-of-way, project property, or easement.
- Meets the maximum increase criteria of 1D Water Surface Elevation rounds to 0.0 feet (< 0.05ft) measured along the hydraulic cross-section within the right-of-way.
- The BCR value is primarily dependent on Low Water Crossing benefit calculations. Results fluctuate and it is recommended for further discussion with TWDB.

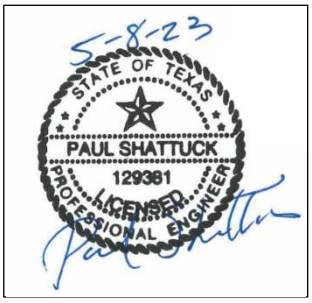
As the projects are advanced, the impact analysis should be updated to reflect final design and confirm no negative impacts.

Recommendation

Based on the findings presented in this Technical Memorandum it is recommended that Flood Management Evaluation No. 101000167 be reclassified as a Flood Mitigation Project. The City of Marble Falls concurs with this recommendation and requests that it be considered by the Regional Flood Planning Group for inclusion in in the amended Regional Flood Plan for the Lower Colorado-Lavaca Region.

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, 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



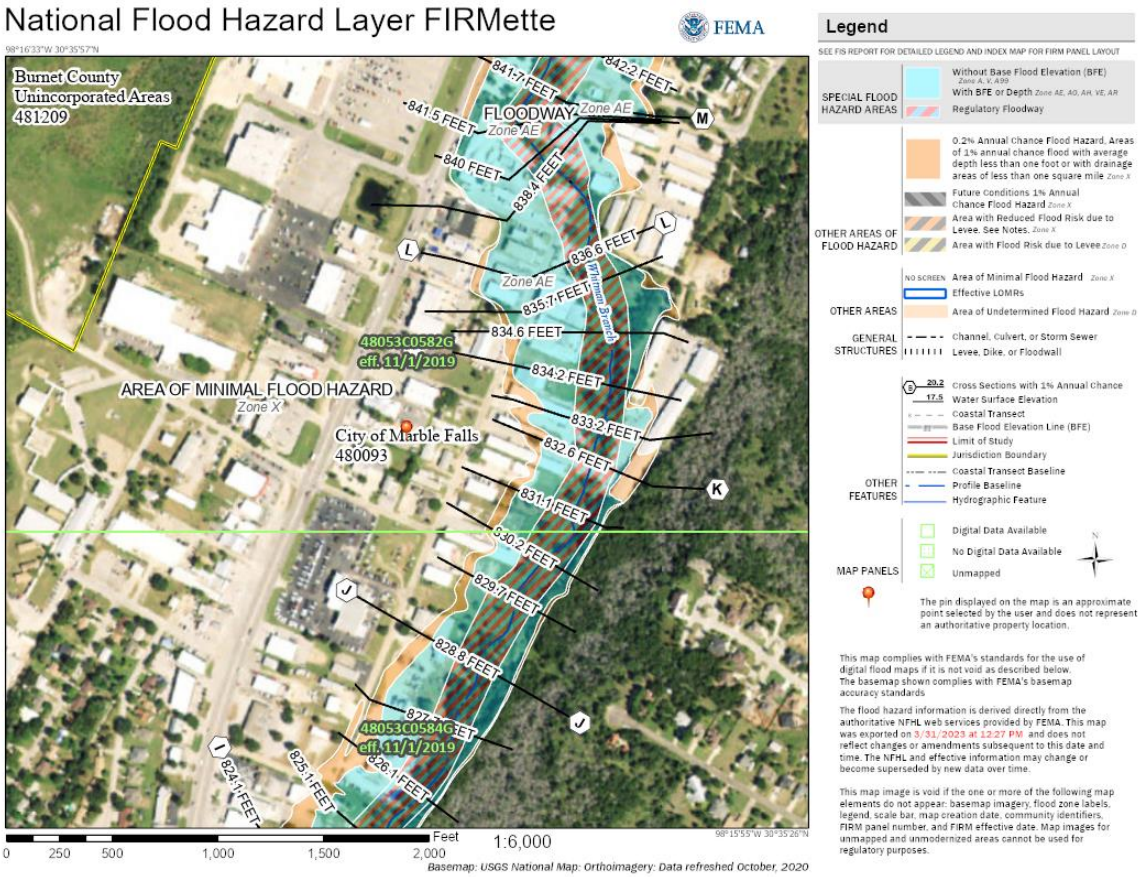
SUBJECT: **FME ID: 101000116/165**
Project Sponsor: City of Marble Falls (Municipality)
Project Name: Whitman Branch Regional Stormwater Detention FMP

On September 15, 2022, the Lower Colorado-Lavaca Regional Flood Planning Group (RFPG) approved the execution of this Flood Management Evaluation (FME) to identify, evaluate and recommend additional potentially feasible Flood Mitigation Projects (FMP). This alternatives analysis is produced to inform The City of Marble Falls (Marble Falls or Project Sponsor) of possible flood risk reduction solutions, their feasibility, impacts, costs, and benefits. The alternatives analysis recommends a regional stormwater detention solution to be adopted by Marble Falls and sponsored in the Regional Flood Plan.

Introduction

This FME evaluates multiple potential flood mitigation alternatives for the chronic flood problems associated with Whitman Branch in or near the industrial area along Commerce Street between US 281 and the Nature Heights area within the City of Marble Falls. These areas are located directly adjacent to Whitman Branch which has a designated Zone AE special flood area with a floodway as shown in Figure 0-1. These areas sustained heavy flood damages in 2007. Potential alternatives evaluated include regional stormwater detention, channel modifications of the existing Whitman Branch natural channel, two flood bypass concepts, and property acquisitions.

Figure 0-1: Study Area Location – FEMA Map



Modeling Analysis

Data Collection and Site Visits

The following data was collected and leveraged in the analysis process:

- Terrain Data: USGS 2019 – 1 meter, Hurricane Lidar, Stratmap 2020 – North & Central Texas Lidar
- Soils Data: 2019 Natural Resource Conservation Service (NRCS) Web Soil Survey
- Land Use Data: Determined from Aerial Imagery – CAPCOG 2022
- Relative Finished Floor Height: Site Visit March 10, 2023

Hydrology

A HEC-HMS hydrologic model of Backbone Creek, which includes Whitman Branch, was provided to HDR from Halff and Associates and is the best available model at the time of the analysis. This model was developed circa 2014 as part of a flood study by Halff and Associates for the City of Marble Falls. This HEC-HMS model is believed to match the regulatory model for Backbone Creek because the model output matches the regulatory HEC-RAS hydraulic model flow inputs. The model includes basin models representing both existing and fully developed conditions of Backbone Creek. Only the fully developed basin model was used for this FMP. The provided HMS model was updated to include Atlas 14 rainfall.

- Modeling Software: HEC-HMS version 3.5

- Rainfall Data: NOAA Atlas 14, 24-hour duration, frequency storm temporal distribution
- Initial Losses: NCRS Curve Number Method. Loss statistics were not revised or verified for this study. Basin model representing ultimate / fully developed conditions was used.
- Hydrograph Approach: SCS unit hydrograph. This methodology was not revised or verified for this study.
- Routing: Provided model utilizes Modified Puls and Muskingum Cunge reach routing methodologies. These values were not revised or verified for this study.
- Areal Reduction: No areal reduction was applied for this FMP. Total contributing area to proposed flood reduction areas is below the 10 square mile threshold for applying TP40 areal reduction factors.

Hydrologic analysis using Atlas 14 precipitation produces expected flows substantially higher than those in regulatory models. The Atlas 14 100-year event for instance has an expected rainfall of 11.4 inches compared to 8.34 inches in the pre-Atlas 14 best available model.

Hydraulics

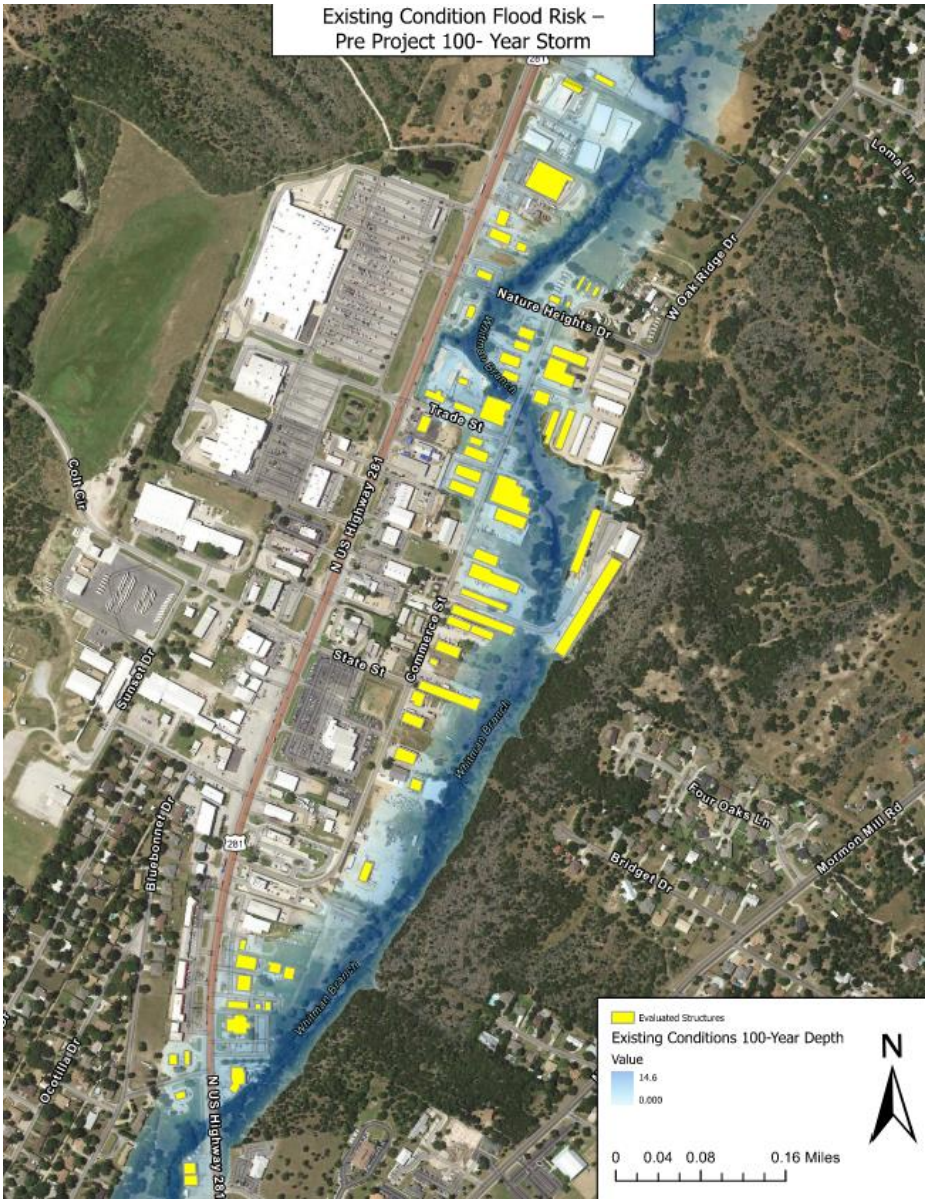
A 2D model was created for evaluation of pre-project (existing flooding conditions), and post-project (FMP proposed) conditions. The regulatory 1D model was evaluated with Atlas 14 flows and was used for informative purposes when creating the 2D model.

- Modeling Software: HEC-RAS version 4.3.1 – 2D unsteady
- Hydrologic Data: Hydrologic model output is applied directly to boundary condition lines on the 2D mesh
- Boundary Conditions: Downstream normal depth. Located at approximate regulatory model river station 5642 where profiles appear to consistently be normal depth.

Existing Condition Flood Risk

The Commerce Street area development is well within the riverine floodplain of Whitman Branch tributary. Existing flood risk to the Commerce Street area is extensive; however, when considering new design storm rainfall estimates, the flooding is deeper and more widespread compared to the effective floodplain mapping. There are approximately 49 commercial and residential buildings that face expected flood risk in the 100-year event, and two existing public roadway low water crossings that will overtop in most day-to-day rainfall events.

Figure 0-2: Existing Condition Flood Risk – Pre Project 100- Year Storm

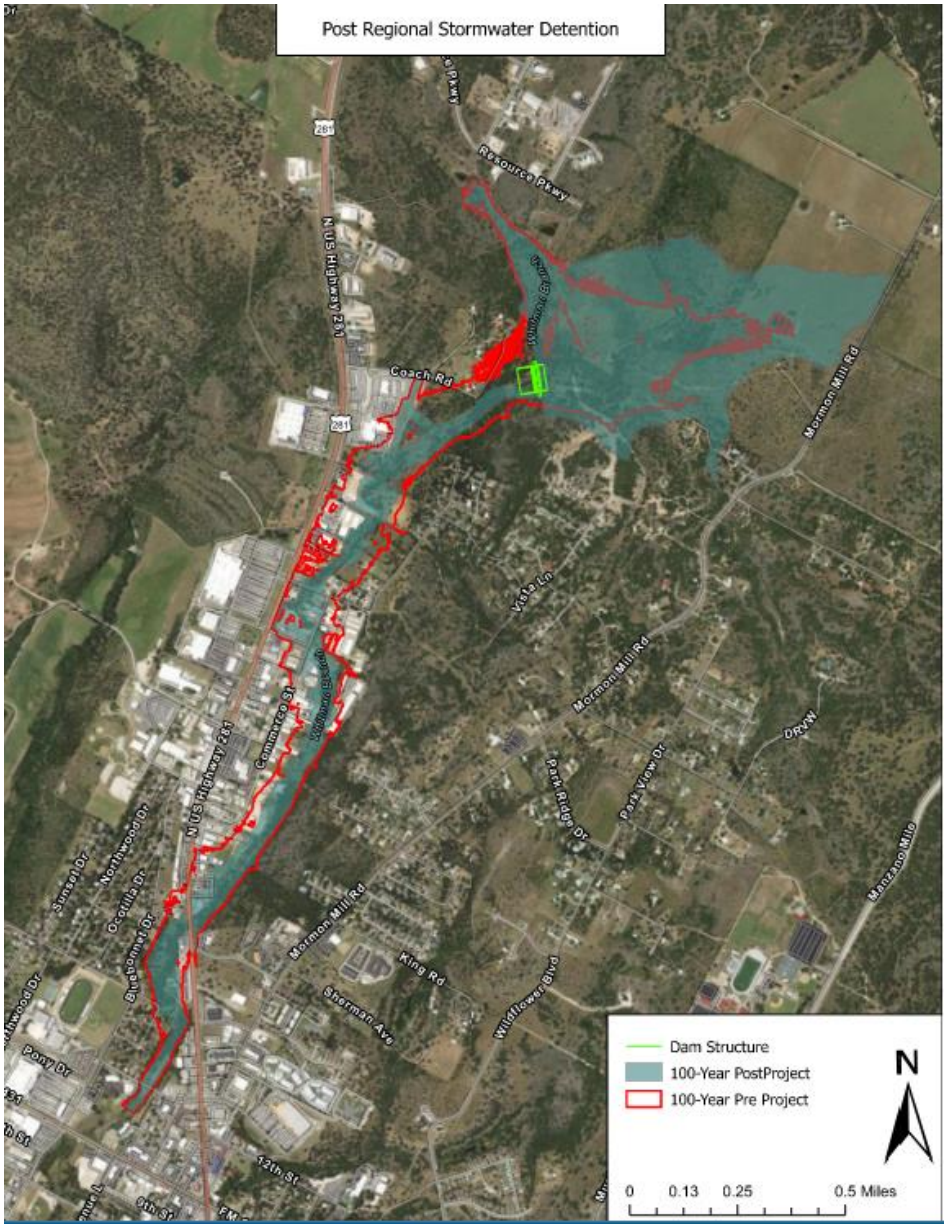


Alternatives Analysis

Alternative 1—Regional Stormwater Detention

This FMP proposes a regional stormwater detention solution to control flows upstream of the Commerce Street area. The solution includes an approximately 36 ft maximum height earthen embankment dam approximately 1750 feet long on Whitman Branch near Coach Drive as shown on Figure 1-1. The reservoir storage volume and outlet works configuration were chosen to provide an approximate 100-year level of protection to the Commerce Street area. The outlet works and any service or auxiliary spillway have not been formally designed or analyzed at this phase, and the modeled reservoir outlet is approximated only with outlet conduit spanning the proposed earthen embankment. The proposed top of dam is set at 890' msl; providing over 10' of freeboard in a 100-year event which approximates expected additional storage requirements for dam safety. Without a geotechnical evaluation, the earthen embankment and dam configuration are approximated.

Figure 1-1: Proposed Improvements – Pre and Post Project Inundation Boundaries



Project Benefits

This detention project would significantly attenuate flows within Whitman Branch upstream of the Commerce Street area resulting in major flood risk reduction benefits downstream. In a 100-year event, expected runoff approaching the flood prone area near the proposed dam outlet would be reduced from an estimated 7,000 cfs to approximately 400 cfs. This reduction in upstream flows would have the net effect of limiting flood risk to occur only from local runoff. There are two local low water crossings and approximately 49 residential and commercial structures that would have significantly reduced flood risk. This FMP would also have the effect of reducing flows at US 281 bridge over Whitman Branch which would no longer overtop in the 10-, 25-, and 100- Year events. US 281 has an average daily traffic of 31,416 vehicles.

Table 1-1: Risk Reduction Benefits

Flood Risk Condition	Number of At-Risk Buildings	Number of At-Risk Roadway Crossings (low water crossings)
Existing Condition 1% Annual Chance (100-year)	49	3
Post-Project Condition 1% Annual Chance (100-year)	11	2

Estimate of Probable Cost

The proposed project total capital cost is estimated to be $28,000,000 in 2023 dollars. Adjusted for 2020 dollars, the cost of the project would be approximately $24,000,000. Cost of the project includes construction costs, land acquisition, design and permitting (20%), and contingency (35%). Expected O&M costs are not itemized with capital costs in the cost estimate, but are included in the BCR calculations. The expected annual O&M cost is $50,000

Table 1-2: Cost Estimate

2023 Lower Colorado Regional Flood Plan: Project Cost Estimate						
Applicant/Subrecipient:	City of Marble Falls					
Site/Activity Title:	Regional Detention Improvements					
Consultant:	HDR Engineering, Inc. TBPE Registration No. F-754					
Date:	4/25/2023					
Eligible Activity:	Flood control and drainage improvements					
Materials/Facilities/Services	**$/Unit**	**Unit**	**Quantity**	**Construction**	**2023 Cost**	**2020 Cost (adjusted using ENR CCI)**
Mobilization	11%	LS	1	$ 1,246,300.00	$ 1,250,000.00	$ 1,087,754.92
Preparing the Right of Way	$ 20,000.00	LS	1	$ 20,000.00	$ 20,000.00	$ 17,455.75
Excavation	$ 30.00	CY	29000	$ 870,000.00	$ 870,000.00	$ 759,325.03
Class C (Topsoil), Plan Quantity	$ 100.00	CY	8000	$ 800,000.00	$ 800,000.00	$ 698,229.91
Embankment	$ 50.00	CY	76184	$ 3,809,200.00	$ 3,810,000.00	$ 3,325,319.94
Concrete Spillway Structures	$ 4,000,000.00	LS	1	$ 4,000,000.00	$ 4,000,000.00	$ 3,491,149.55
6'x6' Culvert (all depths), including excavation and backfill	$ 750.00	LF	200	$ 150,000.00	$ 150,000.00	$ 130,918.11
Concrete Riprap	$ 750.00	CY	1800	$ 1,350,000.00	$ 1,350,000.00	$ 1,178,262.97
Soil Retention Blanket Class A; Type G	$ 5.00	SY	25000	$ 125,000.00	$ 130,000.00	$ 113,462.36
Rock Berm	$ 31.50	LF	500	$ 15,750.00	$ 20,000.00	$ 17,455.75
Silt Fence for Erosion Control	$ 6.00	LF	2000	$ 12,000.00	$ 10,000.00	$ 8,727.87
Care of Surface Water	$ 120,000.00	LS	1	$ 120,000.00	$ 120,000.00	$ 104,734.49
Traffic Control	$ 50,000.00	LS	1	$ 50,000.00	$ 50,000.00	$ 43,639.37
TOTAL CONSTRUCTION COST					**$ 12,600,000.00**	**$ 11,000,000.00**
Design and Permitting (20% construction cost)	20%				$ 2,520,000.00	$ 2,199,424.21
Environmental; archaeological & historical resources	$ 1,000,000.00	LS	1		$ 1,000,000.00	$ 872,787.39
CLOMR / LOMR Preparation	$ 60,000.00	LS			$ 60,000.00	$ 52,367.24
Legal assistance; fiscal services & costs (bond counsel); outreach (3% construction cost)	3%				$ 378,000.00	$ 329,913.63
Interest during construction (*assume 1Yr)	3.5%				$ 441,000.00	$ 384,899.24
Inspection; pilot testing; warranty; manuals	6%				$ 756,000.00	$ 659,827.26
Contingency(s) (35% construction cost)	35%				$ 4,410,000.00	$ 3,848,992.37
Property Acquisition	$5,300,000.00	LS	1		$ 5,300,000.00	$ 4,625,773.15
TOTAL ADDITIONAL COST					**$ 14,900,000.00**	**$ 13,000,000.00**
TOTAL COST					**$ 28,000,000.00**	**$ 24,000,000.00**

Project Constraints

This proposed project would have many challenges in potential design and permitting phases. Upstream of the dam is expected to be inundated regularly and private property would need to be purchased to construct, maintain access for service, and contain the expected flood pool elevation. Land acquisition is expected to be approximately 5.3 million dollars.

Permitting would be a major challenge for this project.

- This project would require a USACE Section 404 permit and associated wetland mitigation costs due to construction impacts to regulatory waters of the U.S..

- TCEQ must review and approve the design of the dam which is anticipated to be a high hazard potential dam.
- Local permitting would be required; this dam may fall in jurisdiction of both the City of Marble Falls and Burnet County.
- FEMA compliance and coordination would be required for floodplain mapping and re-modeling.

Operation and maintenance (O&M) activities related to dam safety will be required to remain compliant with TCEQ Dam Safety Program requirements.

Benefit Cost Analysis

Table 1-3: Benefit Cost Analysis

Input Into BCA Toolkit

Project Useful Life	**30**

Event Damages	**Baseline**	**Project**
2 - year storm	**$704,806**	**$0**
10 - year storm	**$7,062,816**	**$704,806**
100 - year storm	**$27,280,686**	**$1,626,163**

Total Benefits from BCA Toolkit	$28,564,608
Other Benefits (Not Recreation)	$1,347,297
Recreation Benefits	$962,163
Total Costs	$24,162,786
Net Benefits	$5,749,119
Net Benefits with Recreation	$6,711,281
Final BCR	**1.2**
Final BCR with Recreation	**1.3**

No Negative Impact

The project is expected to have only a net reductive effect on maximum discharges and water surface elevations between the proposed reservoir itself and Lake Marble Falls.

The preliminary modeling confirms the following:

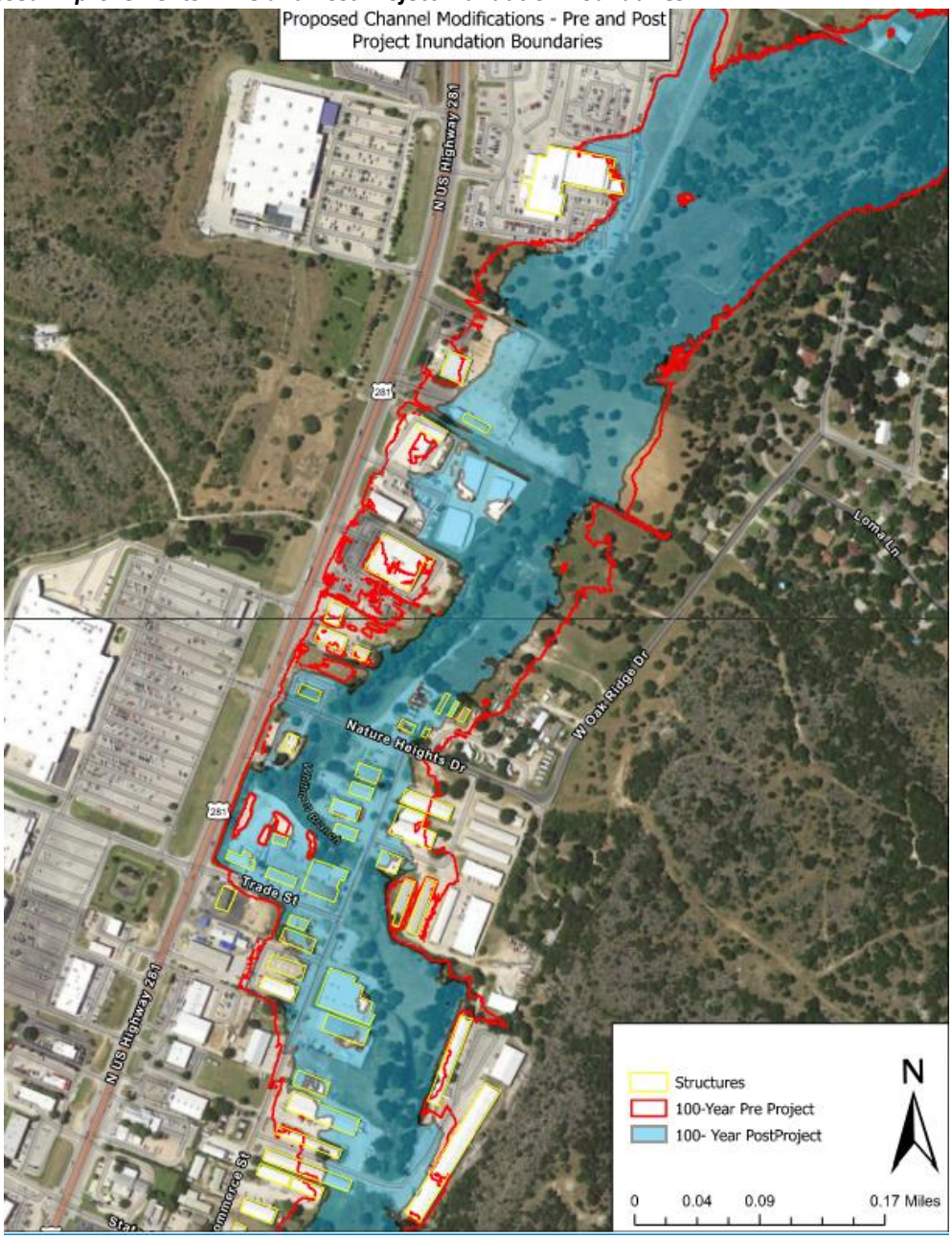
- Stormwater would not increase inundation in areas beyond the public right-of-way, project property, or easement.
- Stormwater would not increase inundation of storm drainage networks, channels, and roadways beyond design capacity.
- In no cases is there an increase of water surface elevation downstream of the proposed regional detention facility. Differences in water surface elevations round to 0.0 feet (< 0.05ft) measured along the hydraulic cross-section within the right-of-way.

As the projects are advanced, the impact analysis should be updated to reflect final design and confirm no negative impacts.

Alternative 2 – Channel Modifications

This FMP proposes a channelization solution to lower floodwaters within the flood prone Commerce Street area. The project would modify the existing natural channel into a trapezoidal engineered channel. Improvements would begin just upstream of US 281 and will end upstream of the Commerce Street industrial area near 3105 N. US 281. The project would flatten the longitudinal slope of the channel, deepening the channel through the Commerce Street area by up to 10 feet. Channel widening would vary depending on space availability and in locations would increase the bottom width from around 50 feet to over 200 feet. The channel is assumed to have earthen 4:1 side slopes except for select narrow areas in the heart of the Commerce Street area where limited sections are assumed to have vertical concrete retaining walls.

Figure 2-1: Proposed Improvements – Pre and Post Project Inundation Boundaries



Project Benefits

This channel modification concept would significantly lower flood elevations within Whitman Branch within the project area. Approximately 26 of 49 structures in the area would be removed from the floodplain while reducing depth of flood inundation for the remainder of the structures. Because of the nature of the conveyance improvements, the existing low water crossings at Commerce Street and Nature Heights Road would need to be replaced with bridge structures. New bridge crossings at Commerce Street and Nature Heights Street would still have some risk of overtopping in a 100-Year event but would not overtop in more frequent events.

Table 2-1: Risk Reduction Benefits

Flood Risk Condition	Number of At-Risk Buildings	Number of At-Risk Roadway Crossings (low water crossings)
Existing Condition 1% Annual Chance (100-year)	49	2 (less than 2-year level of service)
Post-Project Condition 1% Annual Chance (100-year)	23	2 (improved to 25 year level of service)

Estimate of Probable Cost

The proposed project total capital cost is estimated to be $,79,600,000 in 2023 dollars. Adjusted for 2020 dollars the cost of the project would be approximately $,69,500,000. Cost of the project include construction costs, land acquisition, design and permitting (20%), and contingency (35%).

Table 2-2: Cost Estimate

2023 Lower Colorado Regional Flood Plan: Project Cost Estimate							
Cost Verification Controls must be in place to assure that construction costs are reasonable and consistent with market costs at the time and place of construction.							
Applicant/Subrecipient:	City of Marble Falls						
Site/Activity Title:	Channel Improvements						
Consultant:	HDR Engineering, Inc. TBPE Registration No. F-754						
Date:	3/24/2023						
Eligible Activity:	Flood control and drainage improvements						
Materials/Facilities/Services	**$/Unit**	**Unit**	**Quantity**	**Construction**	**Acquisition**	**2023 Cost**	**2020 Cost (adjusted using ENR CCI)**
Mobilization	11%	LS	1	$ 2,085,105.00		$ 2,085,105.00	$ 1,819,853.34
Preparing the Right of Way	$ 20,000.00	LS	1	$ 20,000.00		$ 20,000.00	$ 17,455.75
Channel Excavation	$ 55.00	CY	265000	$ 14,575,000.00		$ 14,575,000.00	$ 12,720,876.16
Class C (Topsoil), Plan Quantity	$ 30.00	CY	18500	$ 555,000.00		$ 555,000.00	$ 484,397.00
Embankment	$ 50.00	CY	1000	$ 50,000.00		$ 50,000.00	$ 43,639.37
Concrete Structures	$ 1,000.00	CY	550	$ 550,000.00		$ 550,000.00	$ 480,033.06
Bridges	$ 150.00	SF	12500	$ 1,875,000.00		$ 1,875,000.00	$ 1,636,476.35
Concrete Riprap	$ 500.00	CY	200.00	$ 100,000.00		$ 100,000.00	$ 87,278.74
Soil Retention Blanket Class A; Type G	$ 7.50	SY	110000	$ 825,000.00		$ 825,000.00	$ 720,049.59
Rock Berm	$ 31.50	LF	5000	$ 157,500.00		$ 157,500.00	$ 137,464.01
Silt Fence for Erosion Control	$ 6.00	LF	13000	$ 78,000.00		$ 78,000.00	$ 68,077.42
Care of Surface Water	$ 120,000.00	LS	1	$ 120,000.00		$ 120,000.00	$ 104,734.49
Traffic Control	$ 50,000.00	LS	1	$ 50,000.00	$ -	$ 50,000.00	$ 43,639.37
TOTAL CONSTRUCTION COST				$ 18,955,500.00	$ -	**$ 21,000,000.00**	**$ 18,300,000.00**
Design and Permitting (20% construction cost)	20%					$ 4,200,000.00	$ 3,665,707.02
Environmental; archaeological & historical resources	$ 250,000.00	LS	1			$ 250,000.00	$ 218,196.85
CLOMR / LOMR Preparation	$ 50,000.00	LS	1			$ 50,000.00	$ 43,639.37
Mitigation; utility relocation	$ 20,000,000.00	LS				$ 20,000,000.00	$ 17,455,747.73
Interest during construction (*assume 1Yr)	3.5%					$ 735,000.00	$ 641,498.73
Inspection; pilot testing; warranty; manuals	$ 5,000.00	LS	1			$ 5,000.00	$ 4,363.94
Contingency(s) (35% construction cost)	35%					$ 7,350,000.00	$ 6,414,987.29
Property Acquisition	$10,000,000.00	LS	1			$ 10,000,000.00	$ 8,727,873.86
TOTAL ADDITIONAL COST						**$ 42,600,000.00**	**$ 37,200,000.00**
TOTAL COST						**$ 63,600,000.00**	**$ 55,500,000.00**
Value of Adversely Impacted Parcels	$17,000,000	LS	1			$ 17,000,000.00	$ 14,837,385.57
TOTAL COST						**$ 79,600,000.00**	**$ 69,500,000.00**

Project Constraints

For acquisition estimates, a cost of 3 times the reported market value in the TWDB database is assumed.

- Nearly the entirety of FMP improvements would be located on private property.
    - The estimated value of property containing the improvements footprint is $10,000,000. Partial buyout is assumed for properties not adversely affected hydraulically.

Permitting will be a major challenge for this project.

- This project would likely require an individual USACE Section 404 permit because of permanent impacts to jurisdictional waters of the U.S.
    - Mitigation costs for this Channel Improvements Alternative are estimated based on mitigation costs for the Regional Detention Alternative outlined in the Environmental Memorandum (Attachment 1). Because the proposed mitigation cost would be approximately $1,000,000 for

each 300 linear feet, a total cost of $20,000,000 is assumed for this project of approximately 6,000 linear feet.

- Local permitting would be required; this project is entirely within the City of Marble Falls.
- FEMA compliance and coordination is required for floodplain mapping and re-modeling.

Benefit Cost Analysis

Table 2-3: Benefit Cost Analysis

Input Into BCA Toolkit

Project Useful Life	**30**

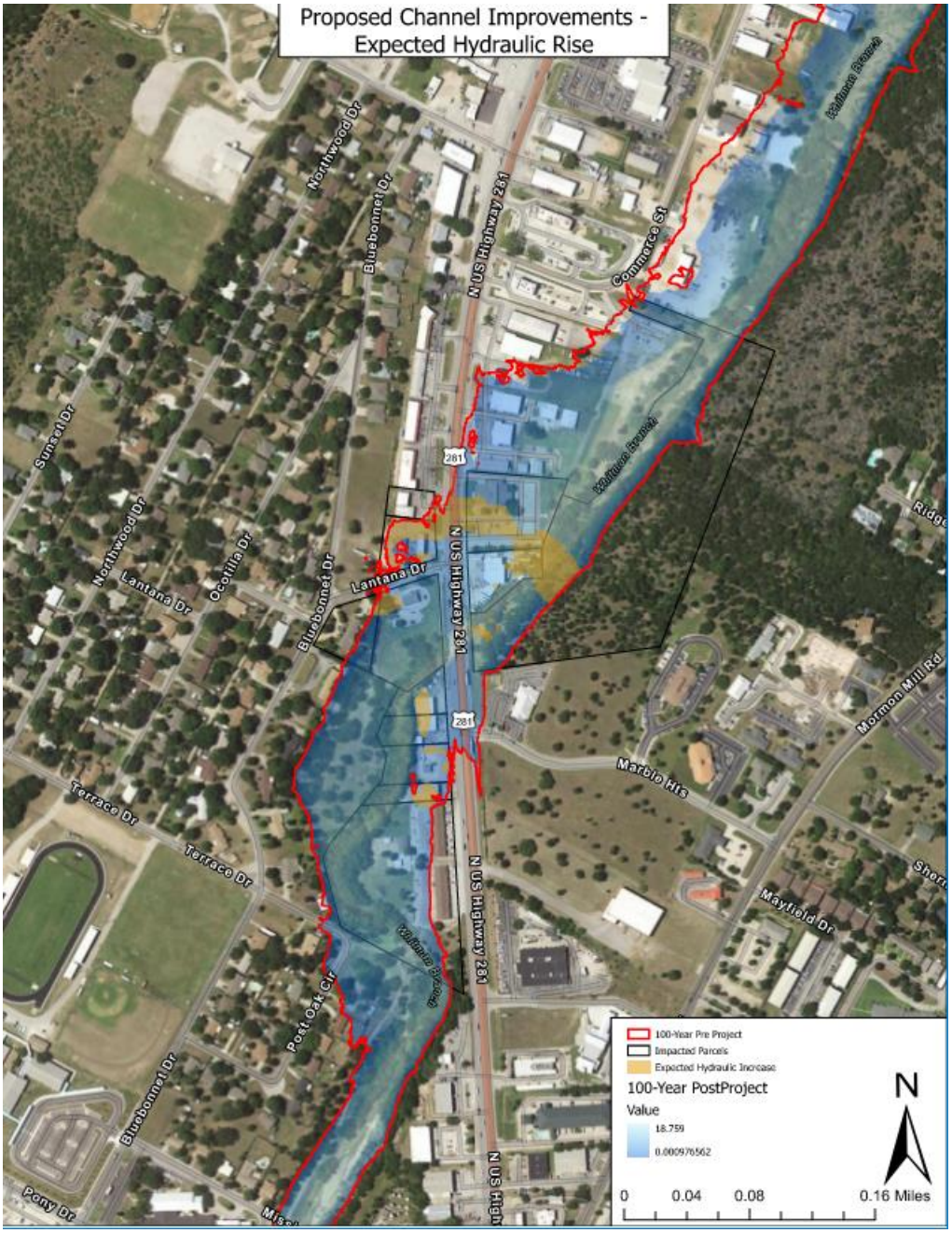
Event Damages	**Baseline**	**Project**
2 - year storm	**$1,151,205**	**$0**
10 - year storm	**$4,324,096**	**$1,135,864**
100 - year storm	**$13,739,117**	**$4,271,931**

Total Benefits from BCA Toolkit	$18,397,223
Other Benefits (Not Recreation)	$2,895,337
Recreation Benefits	-
Total Costs	$67,251,517
Net Benefits	-$45,958,957
Net Benefits with Recreation	-$45,958,957
Final BCR	**0.3**
Final BCR with Recreation	**0.3**

No Negative Impact

- This project as it is proposed would have some effects hydraulically and hydrologically.
    - Hydraulic impacts could be offset with property buyouts. These value of hydraulically affected parcels is assumed to be $17,000,000, the majority of which are expected to have increased structural flooding.
- Hydrologic impacts are minimal and are assumed to be within an acceptable range.

Figure 2-3: Expected Hydraulic Rise

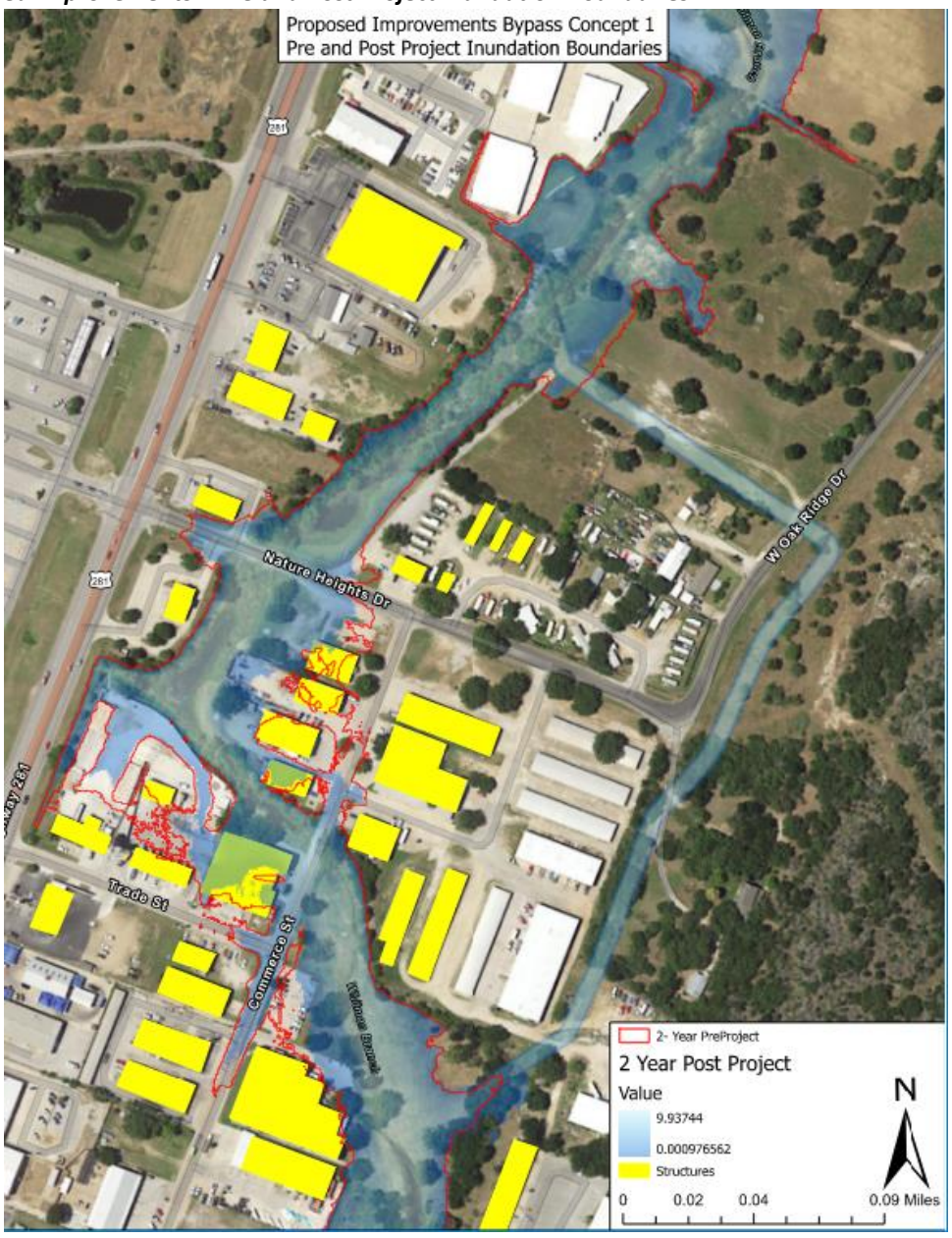


As the projects are advanced, the impact analysis should be updated to reflect final design and confirm no negative impacts.

Alternative 3 – Flood Bypass Concept 1

Flood Bypass Concept 1 proposes a hydraulic bypass that would reroute some flood waters around the Nature Heights Drive and Commerce Street low water crossings on Whitman Branch as conceptualized in the 2014 Flood Protection Planning Study. The proposed bypass concept would take flow from Whitman branch near 2904 Nature Heights Drive to Nature Heights Drive, then along Nature Heights drive in private property back to Whitman Branch near 2706 Commerce Street. This flood bypass would have the effect of reducing discharge and flood levels, to some extent, within the bypassed reach of Whitman Branch.

Figure 3-1: Proposed Improvements – Pre and Post Project Inundation Boundaries



Project Benefits

Between the upstream bypass location and the downstream re-entry of the bypass, the total peak flows in Whitman Branch are expected to be marginally reduced. This bypass project is expected to provide some limited flood risk reduction, particularly in lower frequency storm events where bypassed flow is a larger proportion of the total simulated flooding.

Table 3-1: Flow Reduction Benefits (measured upstream of proposed bypass)

Return event	Bypassed Flow (cfs)	Flow in Whitman Branch (cfs)	% Flow Bypassed (cfs)
2- Year	330	1220	21
10- Year	840	3550	19
25- Year	1020	5030	17
100- Year	1250	7150	15

This project would reduce flood depths but does not remove any structures from the 100-year floodplain and would have the net effect of adding 1 structure.

Table 3-2: Risk Reduction Benefits

Flood Risk Condition	Number of At-Risk Buildings	Number of At-Risk Roadway Crossings (low water crossings)
Existing Condition 1% Annual Chance (100-year)	49	3
Post-Project Condition 1% Annual Chance (100-year)	48	3

Estimate of Probable Cost

The proposed project total capital cost is estimated to be $5,500,000 in 2023 dollars. Adjusted for 2020 dollars the cost of the project would be approximately $4,600,000. The cost of the project includes construction costs, design and permitting (20%), and contingency (35%). Land acquisition costs for the flood bypass channel are estimated to be $1,300,000. There are multiple parcels downstream of the proposed improvements that would have negative hydraulic impacts. If this project were to be coupled with the Regional Detention Alternative, no hydraulic impacts would be expected. If these additional parcels are required to be acquired because of hydraulic impacts, then the total expected land acquisition costs would increase by approximately $28.7M and $25M in 2023 and 2020 dollars, respectively. These costs, with and without impacted properties are subtotaled separately.

Table 3-3: Cost Estimate

2023 Lower Colorado Regional Flood Plan: Project Cost Estimate							
Cost Verification Controls must be in place to assure that construction costs are reasonable and consistent with market costs at the time and place of construction.							
Applicant/Subrecipient:	City of Marble Falls						
Site/Activity Title:	Bypass Improvements - A						
Consultant:	HDR Engineering, Inc. TBPE Registration No. F-754						
Date:	3/24/2023						
Eligible Activity:	Flood control and drainage improvements						
Materials/Facilities/Services	**$/Unit**	**Unit**	**Quantity**	**Construction**	**Acquisition**	**2023 Cost**	**2020 Cost (adjusted using ENR CCI)**
Mobilization	11%	LS	1	$ 262,505.83		$ 262,505.83	$ 229,111.78
Preparing the Right of Way	$ 20,000.00	LS	1	$ 20,000.00		$ 20,000.00	$ 17,455.75
Excavation	$ 30.00	CY	60000	$ 1,800,000.00		$ 1,800,000.00	$ 1,571,017.30
Channel Excavation	$ 100.00	CY	700	$ 70,000.00		$ 70,000.00	$ 61,095.12
Class C (Topsoil), Plan Quantity	$ 30.00	CY	4389	$ 131,666.67		$ 131,666.67	$ 114,917.01
Embankment	$ 50.00	CY	500	$ 25,000.00		$ 25,000.00	$ 21,819.68
Concrete Structures	$ 1,000.00	CY	50	$ 50,000.00		$ 50,000.00	$ 43,639.37
Concrete Riprap	$ 500.00	CY	100.00	$ 50,000.00		$ 50,000.00	$ 43,639.37
Soil Retention Blanket Class A; Type G	$ 5.00	SY	30000	$ 150,000.00		$ 150,000.00	$ 130,918.11
Rock Berm	$ 31.50	LF	500	$ 15,750.00		$ 15,750.00	$ 13,746.40
Silt Fence for Erosion Control	$ 6.00	LF	4000	$ 24,000.00		$ 24,000.00	$ 20,946.90
Traffic Control	$ 50,000.00	LS	1	$ 50,000.00	$ -	$ 50,000.00	$ 43,639.37
TOTAL CONSTRUCTION COST				$ 2,386,416.67	$ -	**$ 2,600,000.00**	**$ 2,300,000.00**
Design and Permitting (20% construction cost)	20%					$ 520,000.00	$ 453,849.44
Environmental; archaeological & historical resources	$ 25,000.00	LS	1			$ 25,000.00	$ 21,819.68
CLOMR / LOMR Preparation	$ 60,000.00	LS	1			$ 60,000.00	$ 52,367.24
Interest during construction (*assume 1Yr)	3.5%					$ 91,000.00	$ 79,423.65
Inspection; pilot testing; warranty; manuals	$ 5,000.00	LS	1			$ 5,000.00	$ 4,363.94
Contingency(s) (35% construction cost)	35%					$ 910,000.00	$ 794,236.52
Property Acquisition	$1,300,000	LS	1			$ 1,300,000.00	$ 1,134,623.60
TOTAL ADDITIONAL COST						**$ 2,900,000.00**	**$ 2,500,000.00**
TOTAL COST						**$ 5,500,000.00**	**$ 4,800,000.00**
Value of Adversely Impacted Parcels	$28,700,000	LS	1			$ 28,700,000.00	$ 25,048,997.99
TOTAL COST						**$ 34,200,000.00**	**$ 29,800,000.00**

Project Constraints

This proposed project would have many challenges in design and permitting phases. The value to acquire property is assumed as three times the reported market value of affected property value as reported in TWDB database.

- Nearly the entirety of proposed project improvements are located on private property. Multiple parcels would be affected, so property or easement acquisition would be a major component of the FMP.
    - The estimated value of property containing the flood bypass channel is $1,300,000.
    - The downstream end of the project at Whitman Branch somewhat is hydraulically sensitive and the project may have the potential to marginally impact several properties in the floodplain. The value of these properties is estimated at $28,700,000 to acquire.

Permitting would be less of a challenge for this project compared to the regional detention and channel modifications alternatives because there would be less impact to jurisdictional waters of the United States.

- This project may require a Nationwide USACE Section 404 permit if improvements are required to encroach into waters of the United States.
- Local permitting will be required; this project is believed to be entirely within the City of Marble Falls.
- FEMA compliance and coordination is required for floodplain mapping and re-modeling.

Benefit Cost Analysis

Table 3-4: Benefit Cost Analysis

Input Into BCA Toolkit

Project Useful Life	**30**

Event Damages	**Baseline**	**Project**
2 - year storm	**$704,806**	**$574,723**
10 - year storm	**$3,877,696**	**$3,371,883**
100 - year storm	**$13,345,785**	**$12,346,437**

Total Benefits from BCA Toolkit	$2,337,727
Other Benefits (Not Recreation)	$3,217,041
Recreation Benefits	-
Total Costs	$28,894,496
	-
Net Benefits	$23,339,728
	-
Net Benefits with Recreation	$23,339,728
Final BCR	**0.2**
Final BCR with Recreation	**0.2**

No Negative Impact

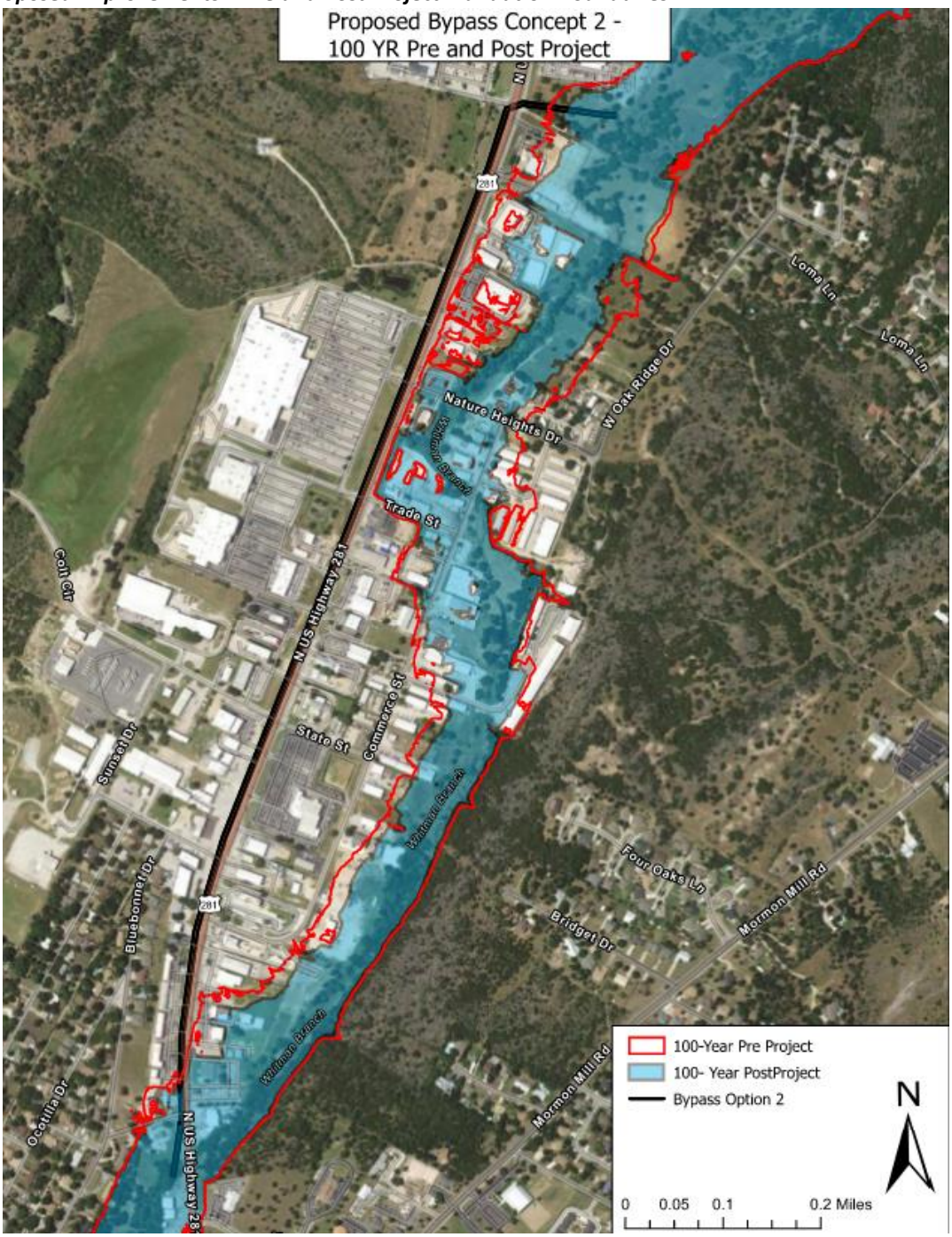
- This project as it is proposed as a standalone project would have some effects hydraulically and marginal effects hydrologically.

  - Hydraulic impacts can be offset with property buyouts. These value of hydraulically affected parcels is assumed to be $28,700,000, the majority of which are expected to have increased structural flooding. Hydraulic impact would also be offset by coupling this project with the Regional Detention Alternative. The expected project BCR if coupled with Regional Detention is 0.5.
- Hydrologic impacts are minimal and are assumed to be within an acceptable range.

Alternative 4 – Flood Bypass Concept 2

Flood Bypass Concept 2 proposes a longer hydraulic bypass that would reroute flood waters around the flood prone Commerce Street area of Whitman Branch. The proposed project would bypass runoff from Whitman Branch near 3105 North US 281 Drive, to near 1300 Lantana Drive. This bypass would have the effect of reducing discharge and flood levels within the bypassed reach of Whitman Branch to a greater extent than Flood Bypass Concept 1. The project proposes 2-16-foot circular conduits that would be constructed primarily within the US 281 right of way. The length of the proposed bypass is approximately 6,700 linear feet.

Figure 4-1: Proposed Improvements – Pre and Post Project Inundation Boundaries



Project Benefits

For the bypassed reach of Whitman Branch, the total expected peak flows in Whitman Branch are expected to be reduced. This bypass project would provide a significant degree of flood risk reduction, particularly in lower frequency storm events where bypassed flow is a larger proportion of the total simulated flood flows.

Table 4-1: Flow Reduction Benefits (measured upstream of proposed bypass)

Return event	Bypassed Flow (cfs)	Flow in Whitman Branch (cfs)	% Flow Bypassed (cfs)
2- Year	1200	370	76
10- Year	3090	1360	69
25- Year	3640	2500	59
100- Year	4230	4470	49

Approximately 20 of 49 structures in the area would be removed from the floodplain while reducing the flood risk for the remainder of the structures.

Table 4-2: Risk Reduction Benefits

Flood Risk Condition	Number of At-Risk Buildings	Number of At-Risk Roadway Crossings (low water crossings)
Existing Condition 1% Annual Chance (100-year)	49	3
Post-Project Condition 1% Annual Chance (100-year)	29	3

Estimate of Probable Cost

The proposed project total capital cost is estimated to be $65,000,000 in 2023 dollars. Adjusted for 2020 dollars the cost of the project would be approximately $57,000,000. Cost of the project include construction costs, land acquisition, design and permitting (20%), and contingency (35%).

Table 4-3: Cost Estimate

2023 Lower Colorado Regional Flood Plan:
Project Cost Estimate

Cost Verification Controls must be in place to assure that construction costs are reasonable and consistent with market costs at the time and place of construction.

Applicant/Subrecipient:	City of Marble Falls
Site/Activity Title:	Tunnel Bypass Improvements - D
Consultant:	HDR Engineering, Inc. TBPE Registration No. F-754
Date:	3/24/2023
Eligible Activity:	Flood control and drainage improvements

Materials/Facilities/Services	$/Unit	Unit	Quantity	Construction	Acquisition	2023 Cost	2020 Cost (adjusted using ENR CCI)
Mobilization	11%	LS	1	$ 4,000,673.31		$ 4,000,673.31	$ 3,491,737.21
Preparing the Right of Way	$ 200,000.00	LS	1	$ 200,000.00		$ 200,000.00	$ 174,557.48
Excavation	$ 30.00	CY	12000	$ 360,000.00		$ 360,000.00	$ 314,203.46
Channel Excavation	$ 100.00	CY	700	$ 70,000.00		$ 70,000.00	$ 61,095.12
Class C (Topsoil), Plan Quantity	$ 30.00	CY	1852	$ 55,555.56		$ 55,555.56	$ 48,488.19
Embankment	$ 10.00	CY	1200	$ 12,000.00		$ 12,000.00	$ 10,473.45
Concrete Structures	$ 1,000.00	CY	371	$ 371,111.11		$ 371,111.11	$ 323,901.10
Standard Pre-cast Manhole w/Pre-cast Base, 48" Dia.	$ 20,000.00	EA	15	$ 300,000.00		$ 300,000.00	$ 261,836.22
Trench Excavation Safety Protective Systems (all depths)	$ 10.00	LF	6700	$ 67,000.00		$ 67,000.00	$ 58,476.75
Pipe, 192" Dia. (all depths), including excavation and backfill	$ 2,500.00	LF	13400	$ 33,500,000.00		$ 33,500,000.00	$ 29,238,377.45
Concrete Riprap	$ 500.00	CY	462.96	$ 231,481.48		$ 231,481.48	$ 202,034.12
Soil Retention Blanket Class A; Type G	$ 5.00	SY	1852	$ 9,259.26		$ 9,259.26	$ 8,081.36
Rock Berm	$ 31.50	LF	500	$ 15,750.00		$ 15,750.00	$ 13,746.40
Silt Fence for Erosion Control	$ 6.00	LF	9600	$ 57,600.00		$ 57,600.00	$ 50,272.55
Care of Surface Water	$ 120,000.00	LS	1	$ 120,000.00		$ 120,000.00	$ 104,734.49
Traffic Control	$ 1,000,000.00	LS	1	$ 1,000,000.00	$ -	$ 1,000,000.00	$ 872,787.39
TOTAL CONSTRUCTION COST				$ 36,369,757.41	$ -	**$ 40,000,000.00**	**$ 34,911,495.46**
Design and Permitting (20% construction cost)	20%					$ 8,000,000.00	$ 6,982,299.09
Environmental; archaeological & historical resources	$ 10,000.00	LS	1			$ 10,000.00	$ 8,727.87
CLOMR / LOMR Preparation	$ 60,000.00	LS	1			$ 60,000.00	$ 52,367.24
Interest during construction (*assume 1Yr)	3.5%					$ 1,400,000.00	$ 1,221,902.34
Inspection; pilot testing; warranty; manuals	$ 5,000.00	LS	1			$ 5,000.00	$ 4,363.94
Contingency(s) (35% construction cost)	35%					$ 14,000,000.00	$ 12,219,023.41
Property Acquisition	$1,500,000	LS	1			$ 1,500,000.00	$ 1,309,181.08
TOTAL ADDITIONAL COST						**$ 25,000,000.00**	**$ 21,819,684.66**
TOTAL COST						**$ 65,000,000.00**	**$ 56,731,180.12**

Project Constraints

This proposed project would have many challenges in design and permitting phases. The value to acquire property is assumed as three times the reported market value of affected property value as reported in TWDB database.

- Nearly the entirety of proposed project improvements is located on private property. Multiple parcels would be affected, so property or easement acquisition will be a major component of the FMP.

Permitting would be less of a challenge for this project compared to the regional detention and channel modifications alternatives because there would be less impact to jurisdictional waters of the United States.

- This project may require a Nationwide USACE Section 404 permit if improvements are required to encroach into waters of the United States.
- Local permitting will be required; this project is believed to be entirely within the City of Marble Falls.
- FEMA compliance and coordination is required for floodplain mapping and re-modeling.

- The project will exist somewhat on multiple private properties. Property acquisition can be time consuming and expensive. Multiple properties are hydraulically impacted in this configuration as well and may have to be acquired, at least partially.
- The project is primarily within the US 281 right of way and will likely require advanced funding agreements and permitting by TxDOT.
- Local permitting will be required; portions of this project are within the City of Marble Falls.
- FEMA compliance and coordination is required for floodplain mapping and re-modeling.

Benefit Cost Analysis

Table 4-3: Benefit Cost Analysis

Input Into BCA Toolkit

Project Useful Life	**30**

Event Damages	**Baseline**	**Project**
2 - year storm	**$704,806**	**$787,202**
10 - year storm	**$3,877,696**	**$1,728,901**
100 - year storm	**$13,338,417**	**$5,406,884**

Total Benefits from BCA Toolkit	$7,995,406
Other Benefits (Not Recreation)	$160,852
Recreation Benefits	-
Total Costs	$54,916,440
Net Benefits	-$46,760,182
Net Benefits with Recreation	-$46,760,182
Final BCR	**0.1**
Final BCR with Recreation	**0.1**

No Negative Impact

This project is expected to have unacceptable hydraulic and hydrologic impacts.

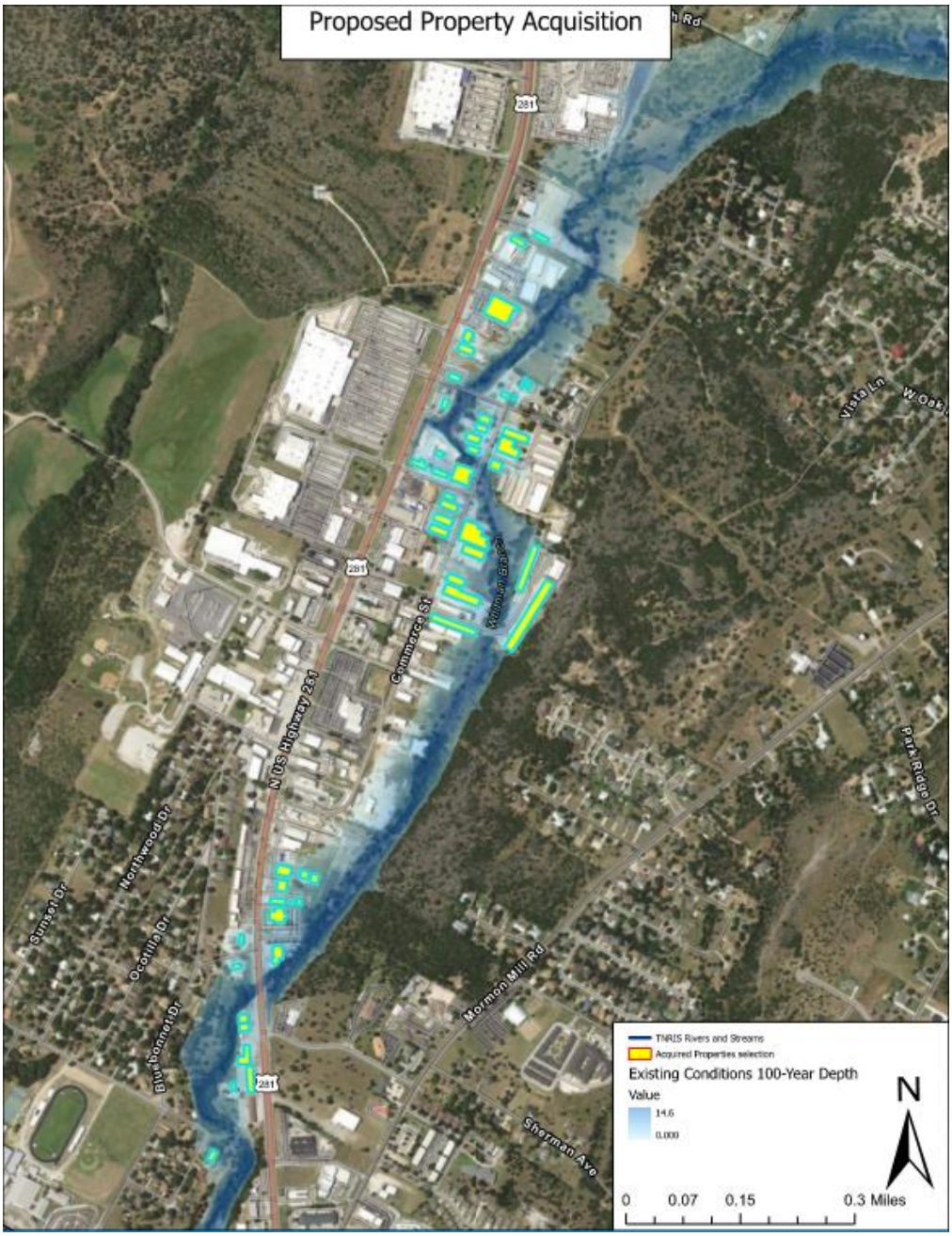
Alternative 5 – Property Buyouts

This alternative proposes a floodplain buyout program to acquire properties with expected structural flooding in the 100- Year flood event.

Project Benefits

Flood prone properties will no longer experience damage due to flooding if population is removed and existing improvements are removed, thereby eliminating all flood risk. The City of Marble Falls would purchase and own these flood prone properties and could convert them to park land or open green space.

Figure 5-1: Proposed Property Acquisition



Estimate of Probable Cost

The total buyout program is estimated to cost $52,800,000 in 2023 dollars. Buyout costs are estimated as 3 times the market value of the parcel in 2020.

Table 5-1: Proposed Property Acquisition Values / Cost Estimate

Parcel ID	TNRIS Parcels Value (2020)	Buyout Value	Structure Removal	Site Restoration
19550	$ 239,948.00	$ 719,844.00	$50,000.00	$5,000.00
19551	$ 362,010.00	$ 1,086,030.00	$50,000.00	$5,000.00
19552	$ 169,500.00	$ 508,500.00	$50,000.00	$5,000.00
19553	$ 173,851.00	$ 521,553.00	$50,000.00	$5,000.00
19584	$ 89,640.00	$ 268,920.00	$50,000.00	$5,000.00
19579	$ 222,402.00	$ 667,206.00	$50,000.00	$5,000.00
19580	$ 199,651.00	$ 598,953.00	$50,000.00	$5,000.00
55367	$ 2,137,756.00	$ 6,413,268.00	$50,000.00	$5,000.00
55372	$ 1,819,590.00	$ 5,458,770.00	$50,000.00	$5,000.00
20576	$ 1,193,781.00	$ 3,581,343.00	$50,000.00	$5,000.00
20574	$ 187,085.00	$ 561,255.00	$50,000.00	$5,000.00
57168	$ 501,932.00	$ 1,505,796.00	$50,000.00	$5,000.00
57277	$ 448,433.00	$ 1,345,299.00	$50,000.00	$5,000.00
57224	$ 245,560.00	$ 736,680.00	$50,000.00	$5,000.00
57276	$ 189,426.00	$ 568,278.00	$50,000.00	$5,000.00
57278	$ 372,536.00	$ 1,117,608.00	$50,000.00	$5,000.00
57223	$ 1,086,754.00	$ 3,260,262.00	$50,000.00	$5,000.00
33133	$ 213,316.00	$ 639,948.00	$50,000.00	$5,000.00
19586	$ 1,538,936.00	$ 4,616,808.00	$50,000.00	$5,000.00
19477	$ 154,086.00	$ 462,258.00	$50,000.00	$5,000.00
19484	$ 143,334.00	$ 430,002.00	$50,000.00	$5,000.00
19485	$ 206,925.00	$ 620,775.00	$50,000.00	$5,000.00
19473	$ 767,790.00	$ 2,303,370.00	$50,000.00	$5,000.00
19489	$ 340,096.00	$ 1,020,288.00	$50,000.00	$5,000.00
19472	$ 570,955.00	$ 1,712,865.00	$50,000.00	$5,000.00
19593	$ 631,859.00	$ 1,895,577.00	$50,000.00	$5,000.00
19598	$ 258,525.00	$ 775,575.00	$50,000.00	$5,000.00
115890	$ 97,515.00	$ 292,545.00	$50,000.00	$5,000.00
19594	$ 216,412.00	$ 649,236.00	$50,000.00	$5,000.00
19591	$ 1,239,880.00	$ 3,719,640.00	$50,000.00	$5,000.00
19480	$ 308,265.00	$ 924,795.00	$50,000.00	$5,000.00
19481	$ 42,696.00	$ 128,088.00	$50,000.00	$5,000.00
19480	$ 308,265.00	$ 924,795.00	$50,000.00	$5,000.00
19479	$ 185,690.00	$ 557,070.00	$50,000.00	$5,000.00
19483	$ 101,592.00	$ 304,776.00	$50,000.00	$5,000.00
SUM	$ 16,965,992.00	$ 50,897,976.00	$ 1,750,000.00	$ 175,000.00
		Total Buyout Alternative Cost		$ 52,822,976.00

Project Constraints

A buyout program that would acquire these properties would take multiple years and would likely involve multiple phases. Initially buyouts could be done as a sale between willing parties and the City. More than likely, ultimate phases of buyouts would be forceful and would require use of imminent domain or a similar legal apparatus to acquire holdout properties.

A buyout program such as this one is extensive and would disaffect many businesses and residents. Many residents and businesses could be expected to relocate within the city, however, many could be expected to leave and not return. These buyouts could have long term to permanent damage to the city's tax base and would likely face political and public opposition.

Benefit Cost Analysis

Table 5-2: Benefit Cost Analysis

Input Into BCA Toolkit

Project Useful Life	**30**

Event Damages	**Baseline**	**Project**
2 - year storm	**$704,806**	**$0**
10 - year storm	**$3,877,696**	**$0**
100 - year storm	**$13,345,785**	**$0**

Total Benefits from BCA Toolkit	$17,632,478
Other Benefits (Not Recreation)	$5,664,456
Recreation Benefits	-
Total Costs	$44,628,458
Net Benefits	-$21,331,524
Net Benefits with Recreation	-$21,331,524
Final BCR	**0.5**
Final BCR with Recreation	**0.5**

No Negative Impact

Buying out flood prone properties in and of itself will have no effect on hydrology or hydraulics of Whitman Branch. Removal and clearing of bought out structures may have minor effects on overbank conveyance and storage of the creek, and would reduce the impervious cover in the basin. These minor effects of building removal have not been evaluated, but no adverse impacts are expected

Recommendation

Based on the findings of this alternatives analysis, Alternative 1, Regional Stormwater Detention is the most potentially feasible FMP to reduce flood risk to the chronic flood problems associated with floodwaters from Whitman Branch in or near the industrial area along Commerce Street between US 281 and the Nature Heights area. The City of Marble falls is agreeable to sponsoring this FMP to be considered for future project funding through the TWDB. It is therefore recommended that Flood Management Evaluation No. 101000116 be reclassified as a Flood Mitigation Project.

The Regional Stormwater Detention alternative has the highest benefit-cost ratio of all alternatives evaluated at 1.3. This FMP is estimated to remove 38 out of 49 structures from the 100-year floodplain and greatly reduce flood risk at US 281 by eliminating flood overtopping for floods up to the 100-year event.

HDR has performed a preliminary desktop environmental and permitting constraints analyses in support of the recommended Regional Stormwater Detention alternative. These analyses are outlined in Attachment 1. There are anticipated permitting and environmental challenges and costs (include in the cost estimate) but nothing is currently identified that is prohibitive.

Alternatives 2, 3, 4, and 5 are not recommended as they all are more costly, provide less flood risk reduction benefits, and have lower benefit-cost ratios than the Regional Stormwater Detention alternative.

Technical Memorandum Attachments

Lower Colorado-Lavaca
REGIONAL FLOOD
PLANNING GROUP
REGION 10

Attachment 1

Environmental Memorandum

Memo

Date:	April 7, 2023
Project:	Marble Falls Potential Detention Pond Dam
To:	Paul Shattuck, P.E. – HDR and Cris Parker, P.E. – HDR
From:	James Thomas, SPWS; Ben Patterson; Kelsea Radican, HDR
Subject:	Preliminary Environmental and Cultural Resources Evaluation for Potential Detention Pond, Marble Falls, TX

HDR Environmental and Cultural Resource professionals conducted a preliminary constraints evaluation of the proposed detention pond located on Whitman Branch north of Marble Falls. The study area consisted of the proposed location of a dam and the dry basin flood pool area of a detention pond being evaluated to provide flood risk reduction benefits in portions of Marble Falls along Whitman Branch. HDR evaluated potential for regulated water resources, cultural resources, and federally protected threatened or endangered species. The objective of this evaluation and memorandum is to provide an overview of potential constraints and preliminary cost considerations for regulatory permitting and mitigation for the project. This evaluation is a preliminary assessment and should be updated with on-site investigations if the project advances.

Clean Water Act

The study area includes two potential stream channels or tributaries to Whitman Branch, which have a confluence at the approximately location of the proposed earthen dam and culvert. The eastern tributary has a more distinct channel which appears to vary between 8- to 15-feet wide and is presumed to be intermittent based on aerial imagery. It includes two on-channel impoundments constructed for livestock use, and is anticipated to be a water of the U.S. under current and potential future definitions / guidance. It is worth noting the USACE and U.S. Environmental Protection Agency (EPA) have proposed new definitions to waters of the U.S. that could affect federal jurisdiction of ephemeral stream, and the U.S. Supreme Court is considering a case (*EPA v. Sackett*) that may result in additional regulatory guidance changes in 2023.

The western branch is less defined and appears to be ephemeral. There appears to be some segments with a well-defined scoured bed and other reaches which may be better described as vegetated swales. While it may not be considered a stream with a consistent ordinary high-water mark (OHWM), for the purposes of this preliminary evaluation it is considered a potential water of the U.S.

Exhibit 1. USGS topographic map of the proposed detention pond area with the blue outline depicting the approximate centerline of dam.

The construction of the dam is anticipated to require placement of fill within one or more stream channels likely to be considered waters of the U.S. Based on the preliminary location of the dam, there is the potential to impact approximately 600 linear feet (LF) of stream, or 300 LF of intermittent stream and 300 LF of ephemeral stream. The estimated acreage of impacts using an average OHWM width of 12 feet is approximately 0.165 acre. A Clean Water Act Section 404 permit would be required, and it is anticipated the project could meet the conditions of a Nationwide Permit (NWP) 43 for Stormwater Management Facilities, which allows permanent loss of up to 0.5 acre of non-tidal waters. However, NWP 43 does require pre-construction notification to the U.S. Army Corps of Engineers (USACE) and typically requires compensatory mitigation for permanent loss of stream of greater than 0.03 acre.

The site is located within the tertiary service area of the Cottonwood Creek Mitigation Bank located east of Pflugerville, Texas. While credit availability can fluctuate unpredictably, the bank currently has approximately 500 stream credits; however, with a tertiary service area multiplication factor of 3, there currently would not be enough credits to mitigate for all of the potential impacts to ephemeral and intermittent stream. The credit availability should continue to be monitored and pre-purchase of credits should be considered if available. However, for the purposes of this preliminary evaluation it is assumed that no mitigation credits are available or that permittee-responsible mitigation (PRM) in the project vicinity is determined to be ecologically preferable and most cost-effective mitigation alternative. The existing impoundments along the upstream segments of the Whitman Branch tributaries have modified

and retained flow which has likely impaired stream condition and aquatic habitat. The USACE may consider removal of one or more of the on-channel ponds along with stream restoration methods (i.e., native species plantings, invasive vegetation control, natural channel design / stabilization) as potential mitigation methods. One important factor to consider is that the USACE Fort Worth District Regulatory Division typically will only grant stream mitigation credit if the stream reach is permanently protected by a conservation easement and grazing is eliminated or only conducted under a very limited and strictly monitored pre-approved rotational grazing plan.

Cultural Resources

The project is anticipated to require a review of potential impacts to protected state and federal historical and archeological resources in accordance with the Texas Antiquities Code and National Historic Preservation Act, Section 106 coordination requirements associated with the Clean Water Act, Section 404 Permit review. An HDR professional archeologist evaluated the site for known or potential archeological resources and historic sites utilizing the Texas Historic Site Atlas and the Texas Department of Transportation's Potential Archeological Liability Mapping (PALM).

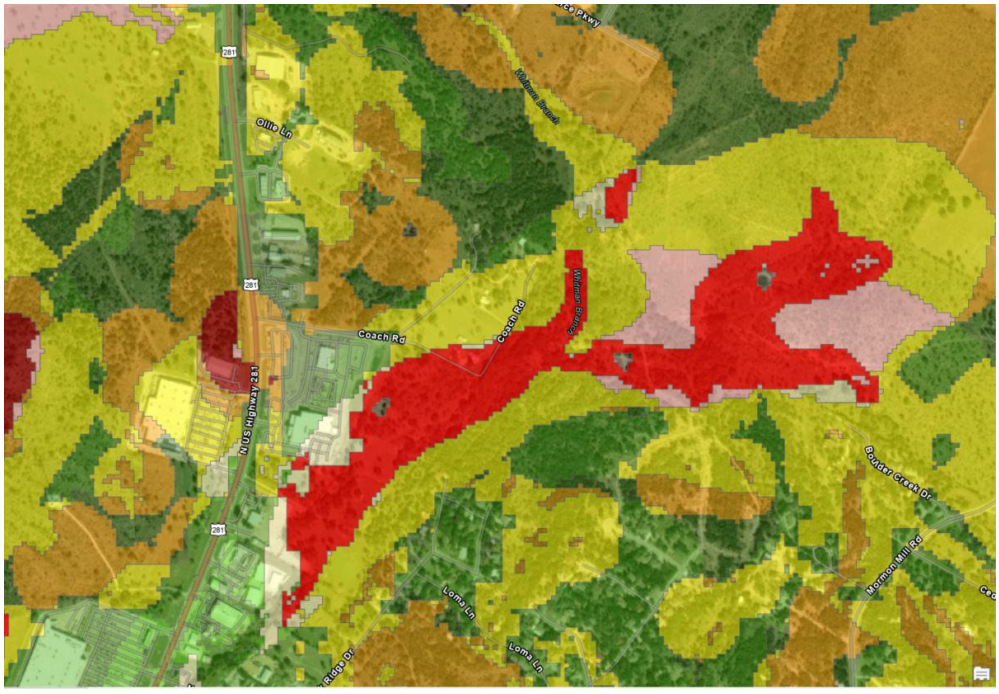


Exhibit 2. Potential Archeological Liability Map results of the site. Areas designated in red and yellow indicate high and moderate potential for archeological deposits, respectively. Published by Texas Dept. of Transportation.

Based on their Site Atlas, the Texas Historical Commission (THC) has no record of previous cultural resource surveys of the project area. The closest archaeological site is about 0.8 mi

southwest of the site on the west side of US Highway 281. The PALM data indicates that the project area does contain moderate and high probability areas for buried archaeological deposits. Also, a review of aerial photography indicates a historic-aged homestead structure present within the proposed flood pool of the detention basin. The structure appears to be associated with early 20th Century ranching activities on the site, but more thorough investigations of the site and Burnet Country archives will be needed to assess the potential eligibility for listing on the National Register of Historic Places (NRHP).

Endangered Species Act

HDR obtained a current Trust Resources List of threatened and endangered species list for the study area, from the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation (IPaC) System (see **Attachment 1**). Federally listed threatened and endangered species that could potentially occur in the study area are listed in **Table 1**. A Trust Resources List is not an official list, which requires notification to USFWS. Once an official list is requested, additional species may be included for the area due to species status changes.

Table 1. Threatened and Endangered Species Potentially Occurring in the Study Area

Species Name	Status	Potential Habitat
Red knot (*Calidris canutus rufa*)	Threatened	NA
Piping plover (*Charadrius melodus*)	Threatened	NA
Monarch Butterfly (*Danaus plexippus*)	Candidate	Possible
Texas fatmucket (*Lampsilis bracteata*)	Proposed Endangered	Unlikely
Tricolored bat (*Perimyotis subflavus*)	Proposed Endangered	Yes
Golden-cheeked warbler (*Setophaga chrysoparia*)	Endangered	Yes
Bee Creek Cave Harvestman (*Texella reddelli*)	Endangered	Possible

The red knot (*Calidris canutus rufa*) and piping plover (*Charadrius melodus*) are federally-threatened shorebirds that have the potential to migrate through the study area. These species only require consideration for wind related projects within the migratory route (see **Attachment 1**). Therefore, the project would not be required to consult with USFWS for the red knot and piping plover.

The monarch butterfly (*Danaus plexippus*) is a candidate species and not yet proposed for listing. During the breeding season, monarchs lay their eggs on their obligate milkweed host plant (primarily *Asclepias* spp.), and larvae emerge after two to five days. In many regions where monarchs are present, monarchs breed year-round. Depending on the land use and habitat that occurs in the study area, monarch habitat may occur. However, the potential for the project to adversely impact this species is unlikely. It is expected that the monarch butterfly would become listed in 2024 and the status of this species should be closely monitored.

The Texas fatmucket (*Lampsilis bracteata*) is a freshwater mussel that has been proposed to list as endangered by the USFWS. Habitat includes small perennial streams to medium-sized rivers. The Texas fatmucket occurs in tributaries of the Colorado River drainage. Based on the aerial review, the two tributaries to Whitman Branch appear to be ephemeral or intermittent streams, and no other perennial water body appears in the study area. Therefore, it is unlikely that suitable habitat for the Texas fatmucket occurs in the study area.

The tricolored bat (*Perimyotis subflavus*), which occurs throughout much of the United States, east of the Rocky Mountains, is proposed to be listed as endangered by the USFWS. During the winter, tricolored bats hibernate in caves, abandoned mines, and other cave-like structures or even culverts in the southern United States where caves are sparse. During the spring, summer, and fall, tricolored bats are found in forested habitats where they roost in trees, primarily among leaves of live or recently dead deciduous hardwood trees, as well as in Spanish moss, clusters of pine needles, and occasionally built structures. Based on the preliminary desktop review, potential habitat for the tricolored bat does occur in the study area. It is expected that the final listing for the tricolored bat would become effective in 2024 and the status of this species should be closely monitored.

The golden-cheeked warbler (*Setophaga chrysoparia*) is an endangered neo-tropical songbird that nests in portions of the Texas hill country, including Burnet County. Typical nesting habitat is found in tall, dense, mature stands of Ashe juniper (*Juniperus ashei*) mixed with a variety of oaks (*Quercus* spp.) and other native trees and shrubs. Within a ten-mile radius of the study area, there have been five confirmed golden-cheeked warbler observations. The observation in closest proximity to the study area occurred in 1994 approximately 5.6 miles southeast of the study area. Based on the preliminary desktop review, potential habitat for the golden-cheeked warbler does occur in the study area.

The Bee Creek Cave harvestman (*Texella reddelli*) is a troglobitic harvestman listed as endangered by the USFWS. This species is endemic to a restricted range in the Balcones Canyonlands ecoregion of Texas, specifically portions of Burnet and Travis County. It is unlikely that karst features occur in the study area; however, the potential for karst features that provide habitat to the Bee Creek Cave harvestman cannot be discounted in the desktop review.

Preliminary Regulatory Cost Summary

Activity	**Preliminary Estimate**
On-site Natural & Cultural Resource Surveys	$100,000 - $200,000
Historic Structure Archival / NRHP-eligibility Evaluation	$50,000 - $75,000
Agency Consultation / Permitting (including USACE, THC, & USFWS informal consultation)	$150,000 - $250,000
CWA – Section 404 Mitigation planning / construction costs	$250,000 - $500,000
Section 106 – Site Testing / Mitigation	$100,000 - $500,000
Real Estate / Legal support for mitigation site protection	$50,000 - $150,000
Cumulative Total (range)	**$700,000 - $1,675,000**

Recommendations

If the detention pond is advanced as a potential flood risk reduction strategy for the Marble Falls area, it is recommended to perform onsite surveys to delineate potential waters of the U.S., evaluate protected species habitat occurrence, and identify potential cultural resources as soon as is practicable. This will allow input on the dam location and alignment to avoid and minimize impacts to protected state and federal resources to the extent practicable. Following those activities the evaluation of unavoidable impacts, initiation of the permitting process and more project-specific mitigation planning can commence.

Attachment I

USFWS Information for Planning and Consultation (IPaC) Database Report

IPaC **U.S. Fish & Wildlife Service**

IPaC resource list

IPaC will be down for a maintenance event the week of April 10th. We apologize for any inconvenience this may cause. ×

This [illegible]cal habitat[illegible]'s (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

Burnet County, Texas

Local office

Austin Ecological Services Field Office

(512) 490-0057
(512) 490-0974

10711 Burnet Road, Suite 200

Austin, TX 78758-4460

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species[1] and their critical habitats are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service (USFWS) and the fisheries division of the National Oceanic and Atmospheric Administration (NOAA Fisheries[2]).

Species and critical habitats under the sole responsibility of NOAA Fisheries are **not** shown on this list. Please contact NOAA Fisheries for species under their jurisdiction.

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1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information. IPaC only shows species that are regulated by USFWS (see FAQ).

2. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following species are potentially affected by activities in this location:

Mammals

NAME	STATUS
Tricolored Bat *Perimyotis subflavus* Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/10515	Proposed Endangered

Birds

NAME	STATUS
Golden-cheeked Warbler *Setophaga chrysoparia* Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/33	Endangered
Piping Plover *Charadrius melodus* This species only needs to be considered if the following condition applies: • Wind Energy Projects There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/6039	Threatened
Red Knot *Calidris canutus rufa* Wherever found This species only needs to be considered if the following condition applies: • Wind Energy Projects There is **proposed** critical habitat for this species. https://ecos.fws.gov/ecp/species/1864	Threatened

Clams

NAME	STATUS

Texas Fatmucket Lampsilis bracteata Wherever found There is **proposed** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/9041	Proposed Endangered

Insects

NAME	STATUS
Monarch Butterfly Danaus plexippus Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/9743	Candidate

Arachnids

NAME	STATUS
Bee Creek Cave Harvestman Texella reddelli Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/2464	Endangered

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

There are no critical habitats at this location.

Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats should follow appropriate regulations and consider implementing appropriate conservation measures, as described below.

1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.

Additional information can be found using the following links:

- Birds of Conservation Concern https://www.fws.gov/program/migratory-birds/species
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide conservation measures for birds https://www.fws.gov/sites/default/files/documents/nationwide-standard-conservation-measures.pdf

The birds listed below are birds of particular concern either because they occur on the USFWS Birds of Conservation Concern (BCC) list or warrant special attention in your project location. To learn more about the levels of concern for birds on your list and how this list is generated, see the FAQ below. This is not a list of every bird you may find in this location, nor a guarantee that every bird on this list will be found in your project area. To see exact locations of where birders and the general public have sighted birds in and around your project area, visit the E-bird data mapping tool (Tip: enter your location, desired date range and a species on your list). For projects that occur off the Atlantic Coast, additional maps and models detailing the relative occurrence and abundance of bird species on your list are available. Links to additional information about Atlantic Coast birds, and other important information about your migratory bird list, including how to properly interpret and use your migratory bird report, can be found below.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, click on the PROBABILITY OF PRESENCE SUMMARY at the top of your list to see when these birds are most likely to be present and breeding in your project area.

NAME	BREEDING SEASON
Bald Eagle Haliaeetus leucocephalus This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.	Breeds Oct 15 to Jul 31
Black-capped Vireo Vireo atricapilla This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/5716	Breeds Apr 1 to Sep 15
Chimney Swift Chaetura pelagica This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds Mar 15 to Aug 25

Eastern Meadowlark Sturnella magna — Breeds Apr 25 to Aug 31
This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA

Field Sparrow Spizella pusilla — Breeds Mar 1 to Aug 15
This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA

Lesser Yellowlegs Tringa flavipes — Breeds elsewhere
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9679

Painted Bunting Passerina ciris — Breeds Apr 25 to Aug 15
This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA

Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read and understand the FAQ "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence (■)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence

at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.

3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

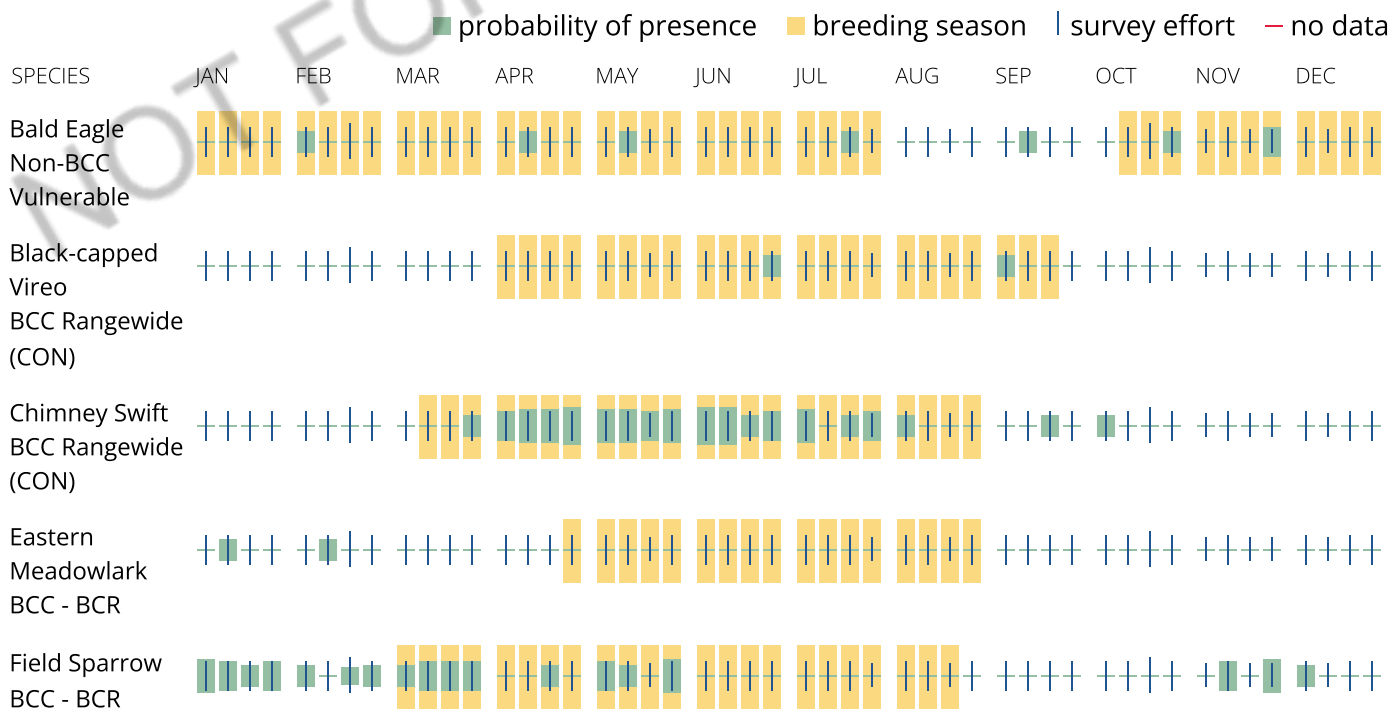
Breeding Season (▪)
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

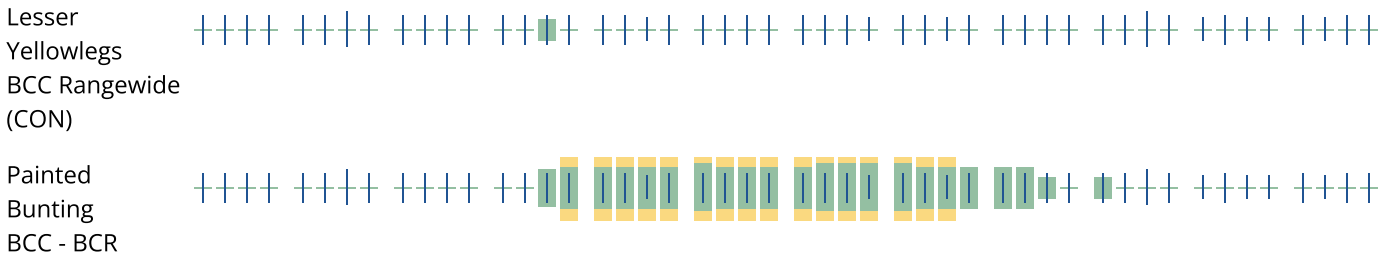
Survey Effort (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

To see a bar's survey effort range, simply hover your mouse cursor over the bar.

No Data (–)
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.





Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Conservation Measures describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. Additional measures or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the list of migratory birds that potentially occur in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the Rapid Avian Information Locator (RAIL) Tool.

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets.

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering or migrating in my area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may query your location using the RAIL Tool and look at the range maps provided for birds in your area at the bottom of the profiles provided for each bird in your results. If a bird on your migratory bird species list has a breeding season associated with it, if that bird does occur in your project area, there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Eagle Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the Diving Bird Study and the nanotag studies or contact Caleb Spiegel or Pam Loring.

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur.

Proper Interpretation and Use of Your Migratory Bird Report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated, and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability

of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please also look carefully at the survey effort (indicated by the black vertical bar) and for the existence of the "no data" indicator (a red horizontal bar). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list helps you know what to look for to confirm presence, and helps guide you in knowing when to implement conservation measures to avoid or minimize potential impacts from your project activities, should presence be confirmed. To learn more about conservation measures, visit the FAQ "Tell me about conservation measures I can implement to avoid or minimize impacts to migratory birds" at the bottom of your migratory bird trust resources page.

Facilities

National Wildlife Refuge lands

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

There are no refuge lands at this location.

Fish hatcheries

There are no fish hatcheries at this location.

Wetlands in the National Wetlands Inventory (NWI)

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Please note that the NWI data being shown may be out of date. We are currently working to update our NWI data set. We recommend you verify these results with a site visit to determine the actual extent of wetlands on site.

This location overlaps the following wetlands:

FRESHWATER FORESTED/SHRUB WETLAND

PFO1A

RIVERINE

R4SBC

A full description for each wetland code can be found at the National Wetlands Inventory website

NOTE: This initial screening does **not** replace an on-site delineation to determine whether wetlands occur. Additional information on the NWI data is provided below.

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or

products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate Federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.