# SABINE COUNTYWIDE ROAD/ BRIDGE DRAINAGE ANALYSIS STUDY

**Community Development & Revitalization:**
**General Land Office Harvey Infrastructure Project**

FEMA Disaster Declaration DR-4332

SABINE COUNTY, TEXAS


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Vol 3-I Page 48

# TABLE OF CONTENTS





Vol 3·T Page 49

## EXECUTIVE SUMMARY

LJA Engineering, Inc. (LJA) was contracted by Sabine County for engineering services to prepare a drainage analysis on 21 county road and bridge crossings of various creeks and streams for FEMA Disaster Declaration DR-4332. The study included selected crossings in Precincts 1, 2, 3, and 4.

Culvert and roadway improvements were proposed to be filled above the water surface elevation (WSEL) for 100-year storm event. Bridge improvements were proposed for improvement for wider crossing spans. The summary of improvements and estimated costs are shown below with assumptions and exclusions stated within the report.

| PRECINCT | CROSSING NO. | PROPOSED CULVERT 1% (100-YR) QTY, W x H FT | ESTIMATED COST | TOTALS |
|---|---|---|---|---|
| 1 | 1 | 80' BRIDGE | $761,764 | |
| 1 | 2 | 1 - 5 x 2 | $179,276 | |
| 1 | 3 | 2 - 9 x 6 | $383,768 | |
| 1 | 4 | 3 - 10 x 8 | $569,136 | |
| 1 | 5 | 1 - 5 x 3 | $58,331 | |
| **PRECINCT 1** | | | | $1,953,000 |
| 2 | 6 | N/A | $- | |
| 2 | 7 | N/A | $- | |
| 2 | 8 | 2 - 7 x 7 | $329,998 | |
| 2 | 9 | 1 - 8 x 8 | $161,491 | |
| 2 | 10 | 1 - 4 x 2 | $48,061 | |
| **PRECINCT 2** | | | | $540,000 |
| 3 | 11 | 2 - 8 x 6 | $290,816 | |
| 3 | 12 | 1 - 12 x 5 | $271,761 | |
| 3 | 13 | 1 - 8 x 8 | $207,206 | |
| 3 | 14 | 110' BRIDGE | $868,568 | |
| 3 | 15 | 110' BRIDGE | $1,072,116 | |
| 3 | 16 | 4 - 10 x 6 | $829,263 | |
| **PRECINCT 3** | | | | $3,249,000 |
| 4 | 17 | 3 - 6 x 3 | $172,571 | |
| 4 | 18 | 1 - 8 x 5 | $129,330 | |
| 4 | 19 | 6 - 5 x 2 | $216,869 | |
| 4 | 20 | 4 - 5 x 4 | $260,752 | |
| 4 | 21 | 60' BRIDGE | $588,905 | |
| **PRECINCT 4** | | | | $1,369,000 |
| **COUNTY TOTAL** | | | | **$7,111,000** |

## INTRODUCTION

LJA Engineering, Inc. (LJA) was contracted by Sabine County for engineering services to prepare a drainage analysis and study report on twenty-one (21) county road and bridge crossings of various creeks and streams across Sabine County in support of a Drainage Project Geographically partially eligible for FEMA Disaster Declaration DR-4332.

The study area includes locations in Precincts 1, 2, 3, and 4 and summarized on **Table 1. Existing Conditions** in **Appendix A1**. The **Vicinity Map** and **Crossing Exhibits** are available in **Appendix A2** for the following:

**Precinct 1**

1. Springhill Road & Pace Creek
2. Dorsey Road & Unnamed Drainage Channel
3. Blossom Lane & Dry Branch
4. Cole Drive & Boyd Creek
5. Old Milam Street & Unnamed Drainage Channel

**Precinct 2**

6. Clarktown Road & Unnamed Drainage Channel 1
7. Clarktown Road & Unnamed Drainage Channel 2
8. CCC Road West. & Rice Creek
9. CCC Road West & Sandy Branch
10. Willard James Drive & Unnamed Drainage Channel

**Precinct 3**

11. Drawhorn Road & Clear Creek
12. Little Flock Road & Steep Mile Creek
13. Housen Hollow & Lick Branch
14. Centerview Road & Shady Creek
15. Bear Creek Road & Bear Creek
16. M. Williams Drive & Unnamed Drainage Channel

**Precinct 4**

17. Davidson Road & Beaver Creek
18. Lickskillet Road & Sulphur Creek
19. Ceasar Smith Drive & El Lobanillo Creek
20. Boyd Road & Boyd Creek
21. Henson Road & Carrice Creek

Crossings no. 14 and 15 are existing bridges. Other crossings are roadways over culverts. Most roadways are unpaved gravel roads.

Sabine County, Texas is approximately 470 $mi^2$ of rural hilly areas on the border with Louisiana. The county is divided up into four (4) precincts, and each precinct identified crossings that cause problems for this study.

The county road bridges have been subjected to several flooding events with the most recent notable storm events during Hurricane Harvey (August 2017) and the Tax Day Flood (April 2016). During these storms, rainfall exceeded the capacity of the channels and culverts and overflowed over the roadways. Overtopping stormwater can erode the roadways and blocks access for residents, leaving them stranded until waters subside and may impede evacuation or emergency access.

## METHODLOGY

Data was collected from entities including the Texas Department of Transportation – Lufkin, the National Land Cover Database, and the National Bridge Index database.

Detailed field surveys and geotechnical investigations were not included in the scope of this study.

FEMA Flood Hazard Boundary Maps (FHBM) and Flood Insurance Rate Map (FIRM) are available for Bronson 4815480001A, effective on 04/01/1980; Hemphill 4809970001A, effective on 09/18/1979; and Pineland 480998A, effective on 06/01/1988.

No crossings are shown within regulated Flood Insurance Study, floodway or 100-year floodplain in Special Flood Hazard Areas Zone A or AE.

Hydrology and hydraulics were analyzed for 2-yr, 10-yr, 25-yr, 50-yr, 100-yr storm events.

### Hydrology

Each bridge scenario had a drainage area calculated with Arc Hydro, an extension of Arc GIS utilizing LiDAR for Sabine County. The calculated drainage areas were used to evaluate the rainfall runoff at each bridge.

The rainfall data used in the models was obtained using the EBDLKUP-2019 excel sheet provided by TxDOT. This data was updated to include Atlas 14 rainfall and other various characteristics of the region. Data from the EBDLKUP-2019 spreadsheet was then used in both the Rational Method and Omega EM Method. The Rational Method was used for areas less than 640 acres (1 sq. mi) and Omega EM Regression was used for larger areas.

The calculated flows were determined for 2-yr, 10-yr, 25-yr, 50-yr, 100-yr storm events and available on **Table 2. Existing Peak Flows and Subbasin Data** in **Appendix A1**.

### Hydraulics

The peak flows developed were used in modeling of the streams and bridges in GeoHEC-RAS, using HEC-RAS version 5.0.7. The modeled cross sections and output summary from HEC-RAS are available in the **Appendix A3. Data HEC-RAS Output**. Electronic model data is available by request for the final report.

Field reconnaissance was conducted on June 9th, 2020 to confirm the geometry of each bridge and surrounding roughness coefficients. Based on field visit observations and referring to the National Land Cover Database (NLCD), the average roughness coefficients were assigned to each channel and its surrounding area. Measurements taken on site were used for the dimensions of the bridges and culverts.

An individual model was created for each crossing including the road and culvert or bridge and elevation profiles for several thousand feet upstream and downstream in the model. The geometry of the channels was taken as a cross section cuts from 2018 LiDAR.

Most of the crossings have a well-defined upstream and downstream section of the channel, and no nearby streams that would cause drainage boundary issues. Upstream of crossing no. 16 is a low-lying area allowing for cross flow with another channel.

Crossing no. 16 at M. Williams Drive over Unnamed Drainage Channel, was found to run parallel to the crossing on M. Williams Drive over Devil's Ford Creek. Crossing no. 16 has an upstream watershed area of 230 acres and the Devil's Ford Creek bridge has an upstream watershed area of 4,611 acres.

To address this area, 1D models were created for each of the two channels separately, and a third model was created that considered both channels. From the 1D models of the bridges it was determined that many of the trouble areas involved the roads leading up to the crossings.

The roadside ditch system reaches capacity during a flood event with excess runoff seeking an overland flow path. To determine these paths, inundation locations, and discharges, were updated rainfall from NOAA Atlas 14 (NOAA ATLAS 14 POINT PRECIPITATION FREQUENCY ESTIMATES: TX, - EBDKLUP-2019) and applied to a steady, 1D hydraulic model (GeoHEC-RAS utilizing HEC-RAS 5.0.7).

The 1D, unsteady GeoHEC-RAS model was developed to determine the extreme event capacity of the channels with their bridges and culverts resulting from Atlas 14 rainfall flow data. These models were used to determine culvert capacity, roadway capacity and level of serviceability of the crossing according to modern standards.

An unsteady, 2D hydraulic model was used to evaluate the overland flow paths of the underserviced bridge sections, where the county roads were being overtopped using GeoHEC-RAS with HEC-RAS version 5.0.7. The 2D models were reviewed for changes in topography that could not be determined through the forested area and help identify overland flow not within the main channels.

## EXISTING CONDITIONS

Drainage problems within Sabine County result from three primary issues:

1. Crossings often incorporate single or multiple small culverts as the primary means for water to pass through the roadway. This may have been sufficient in the past for smaller storm events, but the adoption of Atlas 14 and more stringent guideline requirements require the bridges to be able to handle a larger storm event.

2. Entrances to the culverts were often overgrown and silted up, rendering the pipes less effective.

3. Elevation changes along the roads will often cause water to back up at one road crossing and heading downhill to overwhelm the next closest road crossing or potentially flow over the road at low points, rendering the roads impassable.

Several of the crossings that were studied exist along roads that lead to a dead end where residents live. If the bridge or road leading up to the bridge goes under water, the residents will lose access to/from their homes until the water subsides. This was taken into consideration and each crossing and leading roadways were evaluated.

Flooding of other roads and bridges and the loss of accessibility due to flooding of larger areas are beyond the scope of this study.

### Existing Level of Service

The computed water surface elevations were compared with roadway and bridge low elevations to determine inundation levels for storm events. The level of service for the storm events and maximum depth for 100-year storm are summarized as follows.

- Crossings 1, 4, 18, and 21 indicate no service during most storm events.
- Crossing 15 has a bridge above the 100-year WSEL but the roadway is restricted to 2-year service.
- Most crossings 3, 8, 11, 12, 13, 14, 15, 16, 17, 19, 20 support service for 25-year storm event or lower with less than 1.0 foot of inundation.
- Some crossings for 2, 5, 6, 7, 9, 10, 11 can provide 50-year and 100-year level of service with less than 1.0 foot of inundation.

## Existing Level of Service and Depth

| PRECINCT | CROSSING NO. | ELEV ROAD FT | ELEV BRIDGE FT | Existing Level of Service EVENT | U/S WSEL 1% (100-YR) FT | MAX DEPTH 1% (100-YR) FT |
|---|---|---|---|---|---|---|
| **1** | **1** | **227.73** | | **No Service** | **231.72** | **3.99** |
| 1 | 2 | 226.27 | | 1% (100-yr) | 227.00 | 0.73 |
| 1 | 3 | 196.64 | | 20% (5-yr) | 198.13 | 1.49 |
| **1** | **4** | **190.68** | | **No Service** | **195.07** | **4.39** |
| 1 | 5 | 205.12 | | 1% (100-yr) | 205.99 | 0.87 |
| 2 | 6 | 228.52 | | 1% (100-yr) | 228.24 | -0.28 |
| 2 | 7 | 221.99 | | 1% (100-yr) | 221.81 | -0.18 |
| 2 | 8 | 182.33 | | 10% (10-yr) | 183.67 | 1.34 |
| 2 | 9 | 205.31 | | 1% (100-yr) | 205.87 | 0.56 |
| 2 | 10 | 282.23 | | 1% (100-yr) | 282.99 | 0.76 |
| 3 | 11 | 278.44 | | 2% (50-yr) | 279.48 | 1.04 |
| 3 | 12 | 294.45 | | 50% (2-yr) | 296.23 | 1.78 |
| 3 | 13 | 265.73 | | 50% (2-yr) | 267.28 | 1.55 |
| 3 | 14 | 233.41 | 236.93 | 20% (5-yr) | 235.70 | 2.29 |
| 3 | 15 | 209.72 | 211.80 | 50% (2-yr) | 212.96 | 3.24 |
| 3 | 16 | 179.98 | | 4% (25-yr) | 181.08 | 1.10 |
| 4 | 17 | 206.09 | | 20% (5-yr) | 207.53 | 1.44 |
| **4** | **18** | **312.12** | | **No Service** | **314.00** | **1.88** |
| 4 | 19 | 354.16 | | 50% (2-yr) | 355.67 | 1.51 |
| 4 | 20 | 244.58 | | 20% (5-yr) | 246.15 | 1.57 |
| **4** | **21** | **199.84** | | **No Service** | **202.13** | **2.29** |

### Existing Flood Risk Evaluation

A comparison of the water surface elevation with the lowest road or bridge elevations and depth are shown on **Table 3. Water Surface Elevations** in **Appendix A1**.

Crossing locations were evaluated for flood depths and impact to number of properties serviced. In addition, impact considerations included locations without alternate access routes when inundated.

- Crossings 2, 4, 7, 16, 19 have no access when flooded
- Crossings 8/9 have no access when both are flooded

## PROPOSED IMPROVEMENTS

To improve access and level of service, culverts or bridges were proposed for replacement and roadway improvements were proposed to be filled above the water surface elevation (WSEL).

As shown on **Table 4. Proposed Summary** in **Appendix A1**, proposed culverts were sized to provide conveyance for the proposed storm frequency. The following improvements are proposed for crossings for the 100-year event.

- For crossings 1 and 21, bridge openings are proposed instead of culverts due to the wider span required. If the width of proposed openings exceeds 60 feet, a bridge was proposed instead of replacing culverts.
- Crossings 6 and 7 require no improvements as WSEL show no overtopping for the 100-year event.
- For crossing 14, the existing bridge is above the 100-year WSEL but the roadway is inundated thus restricting access. The road elevation is proposed to be filled but the bridge may be replaced as needed for complete improvements.
- For crossing 15, bridge replacement is needed to be above the 100-year WSEL along with some road improvements.
- Because some crossings already service up to the 100-year event with minor flood levels, proposed culvert and road improvements for the 100-year WSEL will reduce inundation for improved access.

The calculated length of culverts includes 24-ft road crossing and 4:1 side slope for culvert headers. The road length is the estimated length for road fill and asphalt pavement improvement for the distance of roadway elevated above the 100-year WSEL and tied into the existing roadway.

Right-of-way (ROW) width assumed a typical section with 24-ft roadway pavement, 2-ft berms and 4:1 and 3:1 side slope roadside ditches. The width is dependent on the amount of proposed fill placed above WSEL to keep improvements within the ROW.

## Summary of Proposed Improvements

| PRECINCT | CROSSING NO. | U/S WSEL 1% (100-YR) FT | PROPOSED CULVERT 1% (100-YR) QTY, W x H FT | PROPOSED CULVERT LENGTH FT | PROPOSED ROAD LENGTH FT | PROPOSED ROW REQUIRED FT |
|---|---|---|---|---|---|---|
| 1 | 1 | 231.72 | 80' BRIDGE | 80 | 2,300 | 60 |
| 1 | 2 | 227.00 | 1 - 5 x 2 | 40 | 300 | 60 |
| 1 | 3 | 198.13 | 2 - 9 x 6 | 72 | 700 | 60 |
| 1 | 4 | 195.07 | 3 - 10 x 8 | 72 | 700 | 100 |
| 1 | 5 | 205.99 | 1 - 5 x 3 | 48 | 200 | 60 |
| | | | | | | |
| 2 | 6 | 228.24 | N/A | 0 | 0 | N/A |
| 2 | 7 | 221.81 | N/A | 0 | 0 | N/A |
| 2 | 8 | 183.67 | 2 - 7 x 7 | 80 | 400 | 60 |
| 2 | 9 | 205.87 | 1 - 8 x 8 | 88 | 200 | 60 |
| 2 | 10 | 282.99 | 1 - 4 x 2 | 40 | 200 | 60 |
| | | | | | | |
| 3 | 11 | 279.48 | 2 - 8 x 6 | 72 | 500 | 60 |
| 3 | 12 | 296.23 | 1 - 12 x 5 | 64 | 800 | 80 |
| 3 | 13 | 267.28 | 1 - 8 x 8 | 88 | 600 | 80 |
| 3 | 14 | 235.70 | 110' BRIDGE | 110 | 1,500 | 80 |
| 3 | 15 | 212.96 | 110' BRIDGE | 110 | 3,400 | 90 |
| 3 | 16 | 181.08 | 4 - 10 x 6 | 72 | 1,500 | 80 |
| | | | | | | |
| 4 | 17 | 207.53 | 3 - 6 x 3 | 48 | 400 | 60 |
| 4 | 18 | 314.00 | 1 - 8 x 5 | 56 | 300 | 80 |
| 4 | 19 | 355.67 | 6 - 5 x 2 | 40 | 300 | 80 |
| 4 | 20 | 246.15 | 4 - 5 x 4 | 56 | 300 | 80 |
| 4 | 21 | 202.13 | 60' BRIDGE | 60 | 1,900 | 80 |
| | | | | | | |

## COST ESTIMATE

The preliminary opinion of probable estimated costs is shown on **Table 4. Proposed Summary** in **Appendix A1.** Preliminary construction costs were estimated as follows for the replacements of culverts or bridges, fill to elevate roadways above WSEL, two-lane asphalt roadways at crossings, and other miscellaneous construction items:

- Culverts pricing per TXDOT 3-month or 12-month construction average for District 11 or State-wide as available
- Fill at $12.00 per CY (cubic yard)
- Asphalt 24-ft roadway at $23 per SY (square yard) with roadside ditches
- Bridge at $100 per SF (square feet) over crossing span
- 30% for other incidental construction items
- 20% for professional services including survey, geotechnical investigations, engineering, and design
- 50% contingency

Incidental construction items were not quantified but 30% was included for other pay items, such as mobilization, clearing and grading, guard rails, erosion control, and hydro-mulching, etc. to be determined during engineering and design of construction plans.

Costs for right-of-way and maintenance and other costs such as, escalation and financing were not included.

## Summary of Proposed Costs

| PRECINCT | CROSSING NO. | PROPOSED CULVERT 1% (100-YR) QTY, W x H FT | ESTIMATED COST | TOTALS |
|---|---|---|---|---|
| 1 | 1 | 80' BRIDGE | $761,764 | |
| 1 | 2 | 1 - 5 x 2 | $179,276 | |
| 1 | 3 | 2 - 9 x 6 | $383,768 | |
| 1 | 4 | 3 - 10 x 8 | $569,136 | |
| 1 | 5 | 1 - 5 x 3 | $58,331 | |
| **PRECINCT 1** | | | | $1,953,000 |
| 2 | 6 | N/A | $- | |
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| **PRECINCT 2** | | | | $540,000 |
| 3 | 11 | 2 - 8 x 6 | $290,816 | |
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| 3 | 13 | 1 - 8 x 8 | $207,206 | |
| 3 | 14 | 110' BRIDGE | $868,568 | |
| 3 | 15 | 110' BRIDGE | $1,072,116 | |
| 3 | 16 | 4 - 10 x 6 | $829,263 | |
| **PRECINCT 3** | | | | $3,249,000 |
| 4 | 17 | 3 - 6 x 3 | $172,571 | |
| 4 | 18 | 1 - 8 x 5 | $129,330 | |
| 4 | 19 | 6 - 5 x 2 | $216,869 | |
| 4 | 20 | 4 - 5 x 4 | $260,752 | |
| 4 | 21 | 60' BRIDGE | $588,905 | |
| **PRECINCT 4** | | | | $1,369,000 |
| **COUNTY TOTAL** | | | | **$7,111,000** |

## APPENDICES

### A1. Tables

1. Existing Crossings Summary
2. Existing Peak Flows and Sub-Basis Data
3. Existing Water Surface Elevations
4. Proposed Improvements and Estimated Costs Summary

### A2. Exhibits

1. Vicinity Map
2. Existing Crossings (21)

### A3. Data

HEC-RAS Output:

1. HEC-RAS Crossing Sections
2. HEC-RAS Output Summary