Lower Colorado-Lavaca
REGIONAL FLOOD
PLANNING GROUP
REGION 10

Flood Management Evaluation Memorandum

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DATE: May 8, 2023

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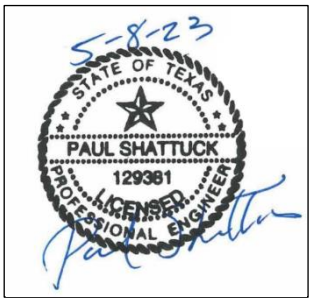

PROJECT: LCRA Contract No. 5809
Halff AVO 43796.001
HDR PN 10304676

SUBJECT: **FME ID: 101000189**
Project Sponsor: City of Edna (Municipality)
Project Name: Wastewater Treatment Plant Floodproofing

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

Introduction

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

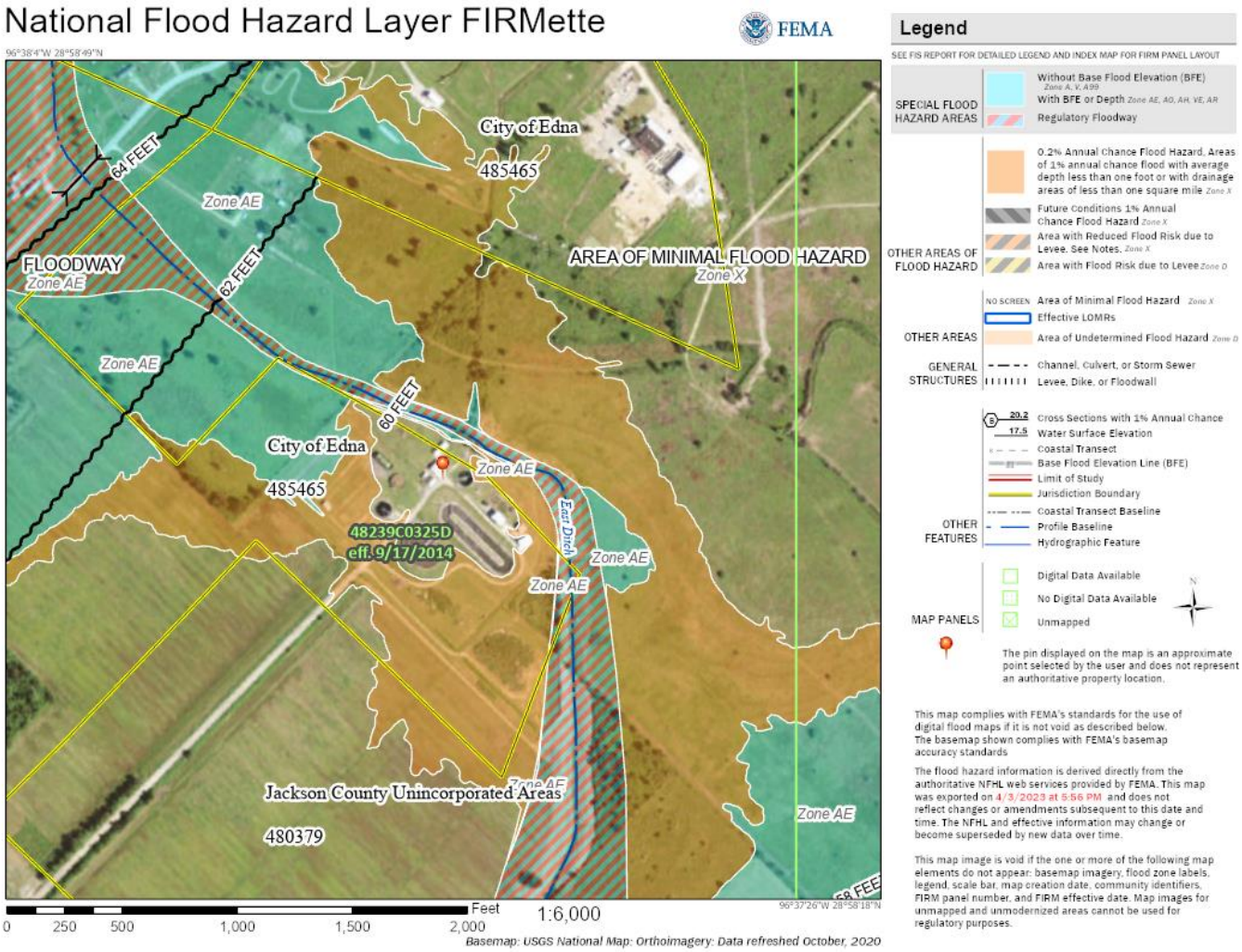

Figure 1: FEMA National Flood Hazard Layer FIRMette (effective 09/17/2014)

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

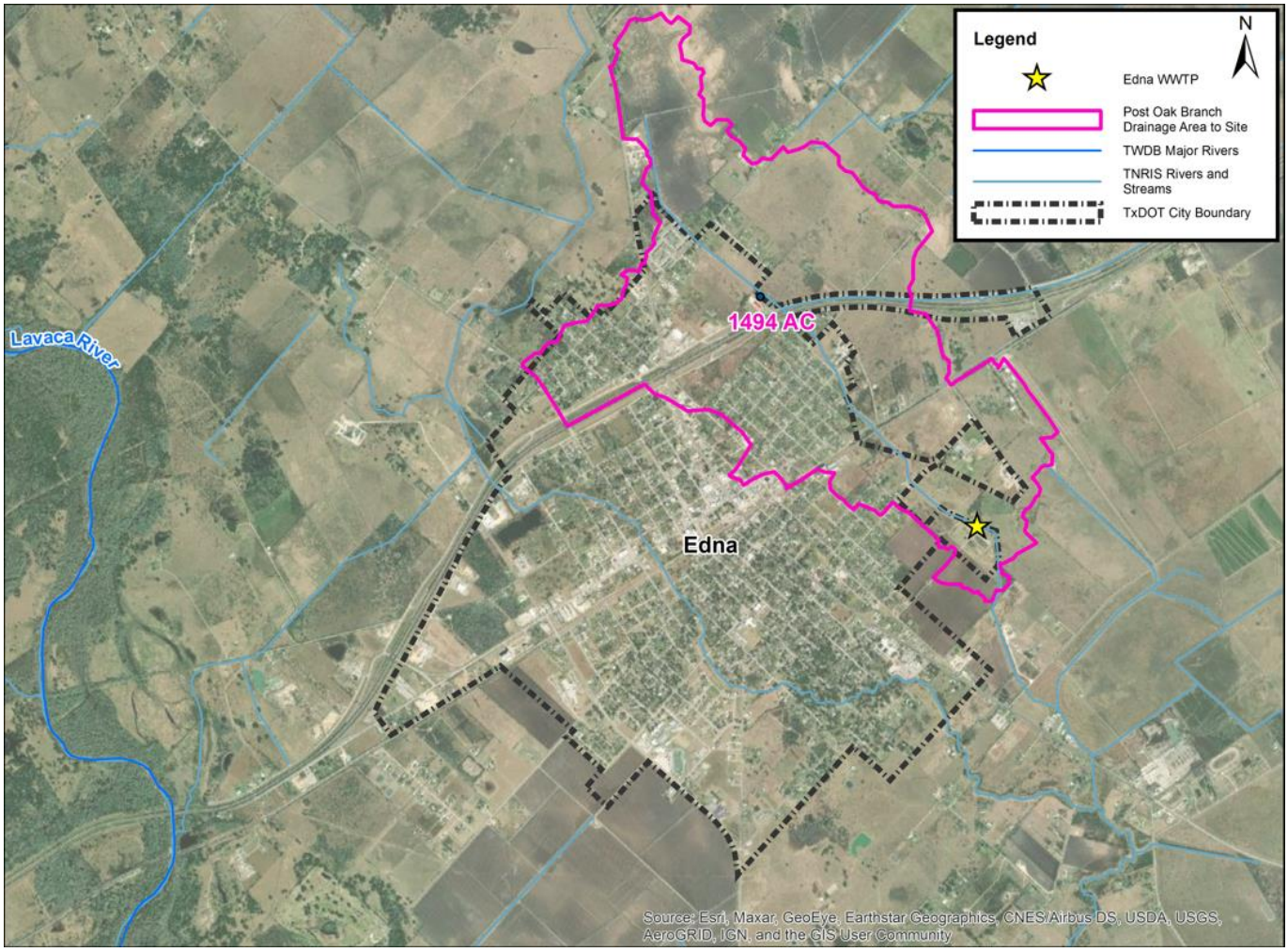

Figure 2: Study Area Location

Modeling Analysis

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

Data Collection and Site Visits

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

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

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

Figure 3: Reported HWM along fence near WWTP outlet

HDR gathered and compiled the following geospatial data:

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

Hydrology

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

Rainfall

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

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

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

[1]All precipitation frequency estimates in inches

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

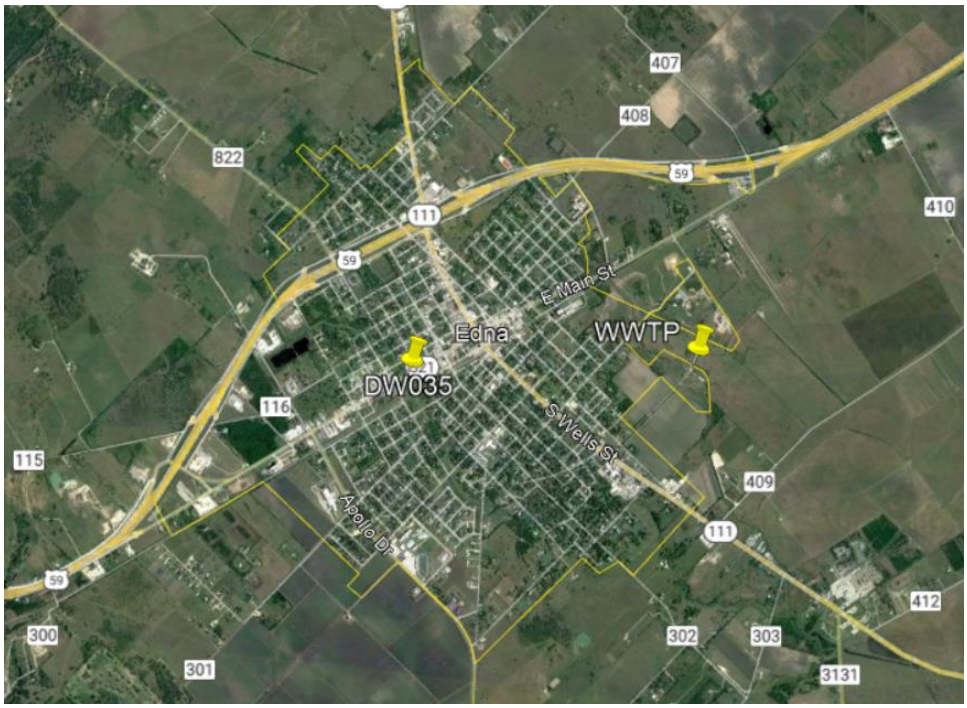

Figure 4: DataWise Environmental Monitoring Inc. Gage DW035 Location

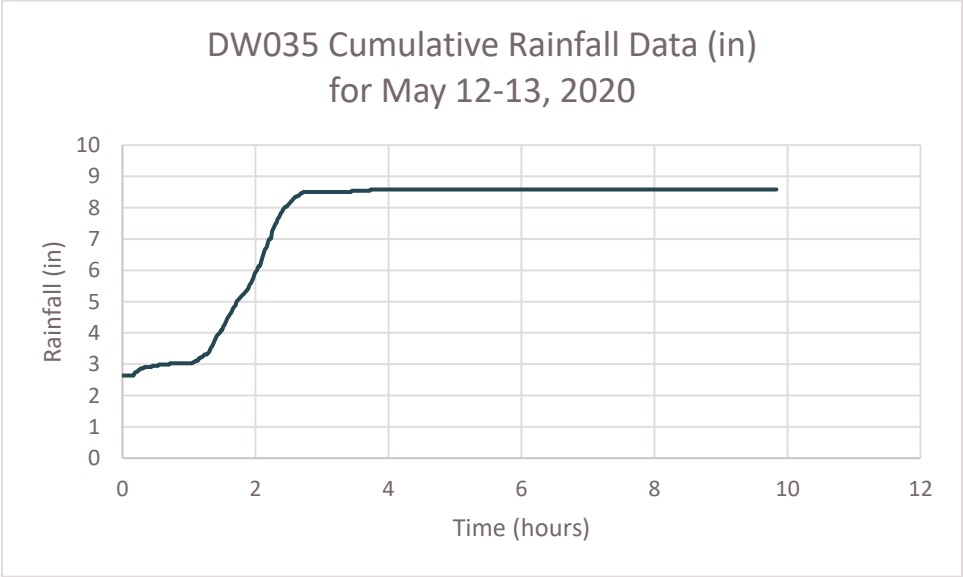

Figure 5: May 2020 Cumulative Rainfall Data Gauge DW035 at Dry Creek

Loss

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

Table 2: Calculated Loss Data

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

Transform

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

Results

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

Table 3: HEC-HMS Peak Flow Results

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

Hydraulics

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

Record Event Recreation

High Water Mark Points

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

- This elevation and location are based on recollection from an event over 2 years ago and may not be accurate.

- The approximate critical elevation of the UV system that would impact operations is between 62.3 and 62.7 ft-msl.

Model Ground Truthing and Verification

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

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

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

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

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

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

Table 5: HEC-RAS version 6.2 Model Runs

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

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

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

Table 6: 2D Water Surface Elevation Modeling Results

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

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

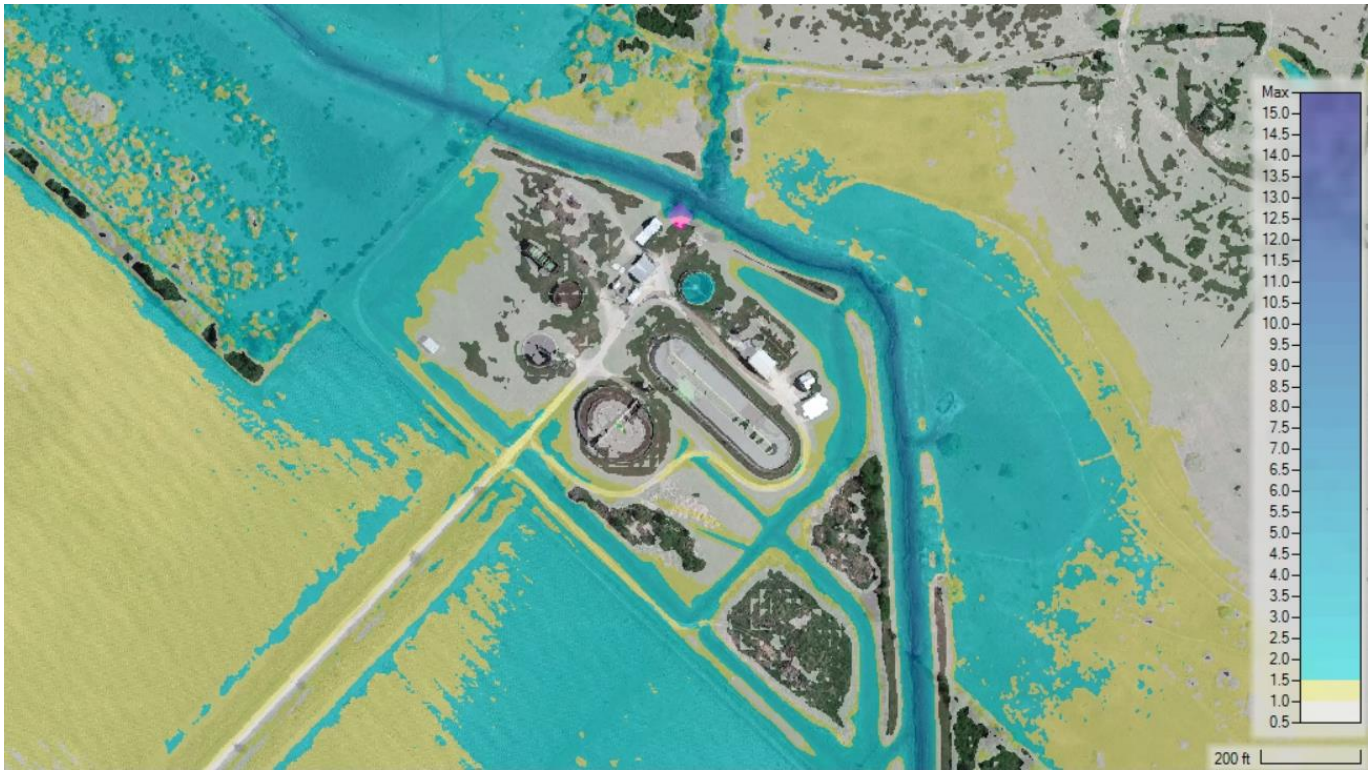

Figure 6: May 2020 Historical Event Combined Creek and Local Flood Depth (includes ROM)

Hydraulic Analysis

Riverine Flooding

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

Local Flooding

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

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

Rain on Mesh Analysis

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

Existing Condition Flood Risk

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

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

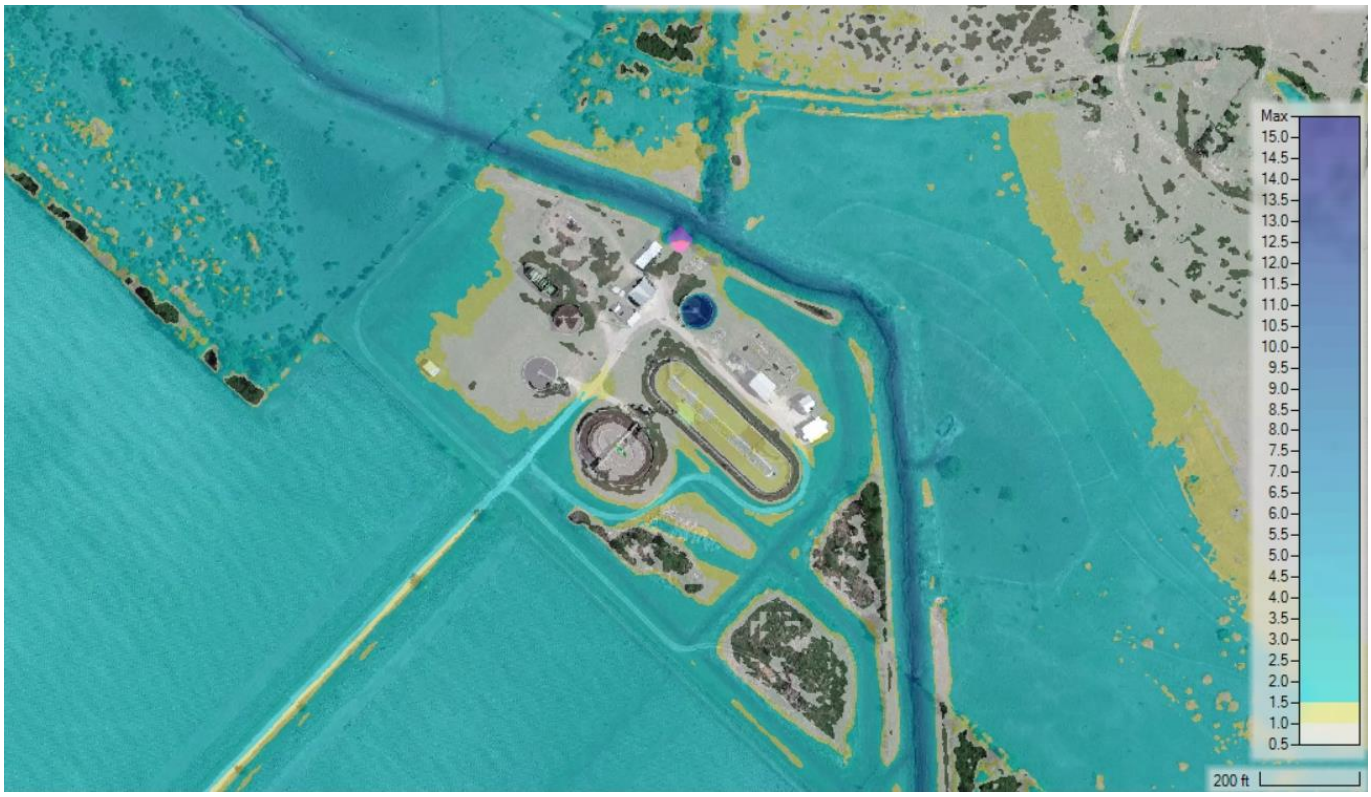

Figure 7: Existing Condition 100-year Combined Creek and Local Flood Depth

Recommendation

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

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

Technical Memorandum Attachments

Attachment 1. TWDB-Required Tables

- Table 16: Recommended Flood Mitigation Projects
- Geodatabase Table: Project Details

Attachment 2. Flood Mitigation Project

- FMP Summary Sheet
- Cost Estimate
- Benefit Cost Ratio

Attachment 1

TWDB-Required Tables

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Attachment 2

Flood Mitigation Project