Appendix D Investigation and Analysis Report

Kickapoo Creek Watershed
Floodwater Retarding Structure No. 4 & 5
Investigation and Analysis Report

D.1 INTRODUCTION

D.1.1 Overview

Appendix D provides supplementary information regarding the investigations and analyses for the Supplemental Watershed Planning for Floodwater Retarding Structure (FRS) No. 4 and FRS No. 5 located in Coke County, TX. The dams are located on Middle Kickapoo Creek (a tributary to Kickapoo Creek, a tributary to the Colorado River), north of Bronte, Texas in Coke County. FRS No. 4 is located upstream of FRS No. 5 on Middle Kickapoo Creek and there are four other dams located within the Kickapoo Creek Watershed. Kickapoo Creek FRS No. 3 and FRS No. 6 are located on tributaries to Middle Kickapoo Creek, prior to the confluence of Middle Kickapoo Creek and West Kickapoo Creek (the downstream extent of the model for the project area). Kickapoo Creek FRS No. 1 and FRS No. 2 are located on West Kickapoo Creek. Analyses were completed for four project alternatives. Discussion of the following topics is presented in Section D.2.0 through Section D.4.0:

- Alternative development;
- Economics evaluation procedures, assumptions, analysis methods, and results; and
- Hydrology and hydraulics.

D.1.2 Background

FRS No. 4 and FRS No. 5 were constructed as "Significant Hazard Potential" dams in 1962 and 1963, respectively. Three years after construction of FRS No. 4, large cracks began forming in the crest of the dam and since that time, additional cracks and holes have developed in the dam crest resulting in concerns about the condition/safety of the dam. A number of investigations have been performed and it is suspected that collapsible foundation materials are responsible for the cracking and holes. In addition, over the ensuing decades since the dams were constructed, development has occurred downstream of the dams, increasing the hazard classifications from "significant hazard potential" to "high hazard potential." The NRCS studied the feasibility of project alternatives that would reduce the risk of life loss and maintain the flood damage reduction benefits of FRS No. 4 and FRS No, 5. This report provides information on the methods and details of the analyses that were conducted for the *Draft Supplemental Watershed Plan No. I and Environmental Assessment for the Rehabilitation of Floodwater Retarding Structures No. 4 and 5 of the Kickapoo Creek Watershed* (*Supplemental Watershed Plan No. I and EA*).

Historically, the land in the study area was undeveloped, minimizing potential flood impacts from a dam breach. However, potential damages from a dam breach are larger today than when the dams were constructed, necessitating increased safety standards to accommodate the increased hazard rating of the dams. As part of the Supplemental Watershed Plan, a without-project (No Action) alternative and three with-project (Action) alternatives underwent a detailed study for the rehabilitation study of FRS No. 4 and FRS No. 5. The alternatives are summarized in the ensuing sections.

D.2 ALTERNATIVES CONSIDERED

Several alternatives were eliminated from detailed evaluation in the Plan-EA as a result of high (relative) implementation costs or logistics issues. Complete descriptions of the alternatives eliminated from detailed consideration and the alternatives considered in the development and identification of the selected alternative for FRS No. 4 and FRS No. 5 are provided in Section 4 of the Supplemental Watershed Plan No. I and EA. Summaries of the alternatives considered for detailed analysis and supplementary information related to the development of the alternatives are provided in the following sections

D.2.1 No Action Alternative

The No Action alternative is the without-project alternative and documents baseline conditions against which all other alternatives are analyzed. It does not involve federal action or federal investment and assumes that the existing dams would remain in place without any action that would improve the dams from their original designs or correct safety deficiencies beyond maintenance or replacements performed in accordance with the operations and maintenance plans for the dams. It is assumed that the dams will catastrophically fail in the future from the highest probability failure mode and that they will not be subsequently rebuilt or rehabilitated.

<u>No Action Alternative for FRS No. 4</u>

The two most likely failure modes for FRS No. 4 are hydrologic failure (overtopping) and spillway integrity failure (breach of the auxiliary spillway). The probability of failure of these events was estimated by reducing the Probable Maximum Precipitation (PMP) values until they were at the minimum values that would cause each type of failure. Frequency rainfall events were plotted and a power function trendline equation was used to estimate the return interval for the rainfall events that would result in each failure type. Hydrologic failure is estimated to occur as a result of the 94% PMP event, which is estimated to have a return interval of 25,295-years. Integrity failure is estimated to occur as a result of the 52% PMP event, which is estimated to have a return interval of 2,136-years. **Exhibit D-1** below shows the plotted rainfall values and corresponding rainfall values used to estimate the probability of failure. Note that the critical storm duration was determined to be the 24-hour event.

<u>No Action Alternative for FRS No. 5</u>

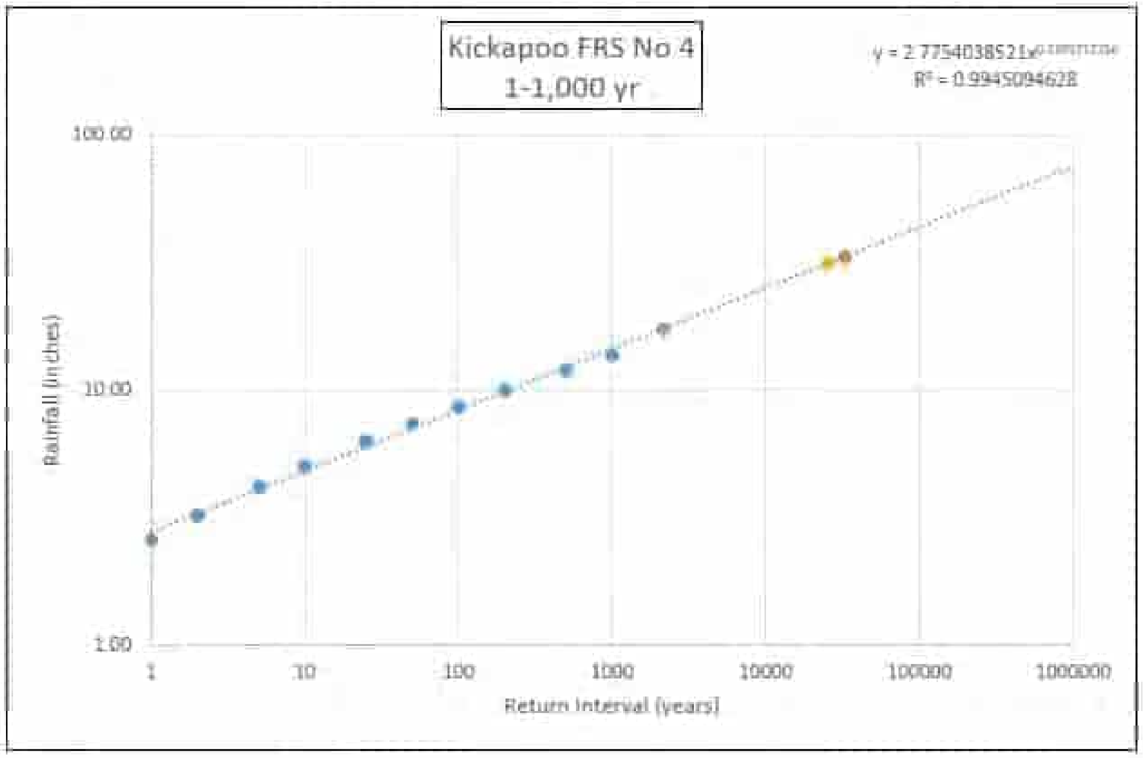
The two most likely failure modes for FRS No. 5 are hydrologic failure (overtopping) and spillway integrity failure (breach of the auxiliary spillway). The probability of failure of these events was estimated by reducing the PMP values until they were at the minimum values that would cause each type of failure. Frequency rainfall evented were plotted and a power function trendline equation was used to estimate the return interval for the rainfall events that would result in each failure type. Hydrologic failure is estimated to occur as a result of the 80% PMP event, which is estimated to have a return interval of 12,118-years. Integrity failure would not occur until the 90% PMP event and the dam would have overtopped at the 80% PMP event, so integrity failure was not included in the No Action alternative for FRS No. 5. **Exhibit D-2** below shows the plotted rainfall values and corresponding rainfall values used to estimate the probability of failure. Note that the critical storm duration was determined to be the 24-hour event.

Exhibit D-1: Kickapoo FRS No. 4 Probability of Failure Estimation

Project: Kickapoo Creek FRS 4
Purpose: Estimate PMP Probability, Failure Probability
Trendline: Power Function
Rainfall Sources: 1 through 1000 years = NOAA Atlas 14
PMP = Texas PMP Rainfall (24-hours)

Return (years)	24-HR Precipitation (inches) Kickapoo 4
1	2.58
2	3.21
5	4.16
10	5.02
25	6.30
50	7.37
100	8.56
200	9.93
500	12.00
1000	13.70
52% PMP	17.42
94% PMP	31.49
PMP	33.50

A	2.7754038521
b	0.2395717256
52% PMP	2136.90
94% PMP	25295.94
PMF	32750.52



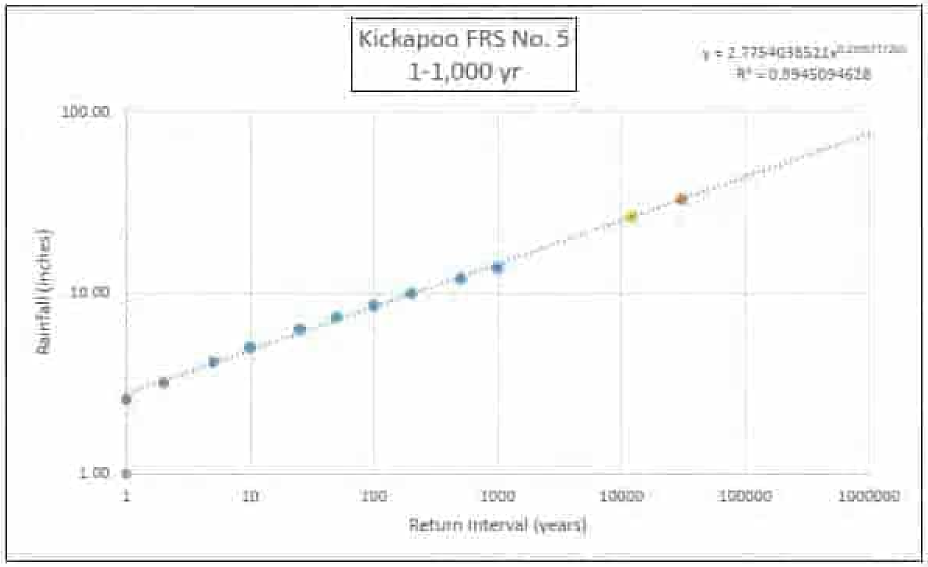
Note:
The 94% PMP event results in a "barely overtopping" event of the existing Kickapoo FRS No.4
The 52% PMP event results the spillway to breach in SITES integrity analysis in the existing Kickapoo FRS No.4

Exhibit D-2: Kickapoo FRS No. 5 Probability of Failure Estimation

Project: Kickapoo Creek FRS 5
Purpose: Estimate PMP Probability, Failure Probability
Trendline: Power Function
Rainfall Sources: 1 through 1000 years = NOAA Atlas 14
PMP = Texas PMP Rainfall (24-hours)

Return (years)	24-HR Precipitation (inches) Kickapoo 5
1	2.58
2	3.21
5	4.16
10	5.02
25	6.30
50	7.37
100	8.56
200	9.93
500	12.00
1000	13.70
80% PMP	26.40
PMP	33.00

A	2.7754038521
b	0.2395717256
80% PMP	12118.37
PMF	30757.97



Note:
The 90% PMP event results the spillway to breach in SITES Integrity analysis in the existing Kickapoo FRS No.5. This was not included in analysis as the dam overtopps at the 80% PMP.
The 80% PMP event results in a "barely overtopping" event of the existing Kickapoo FRS No.5

D.2.2 Alternative 3: Federal Decommission of FRS No. 4 and High Hazard Potential Rehabilitation of FRS No. 5

Decommission of FRS No 4

Decommissioning consists of removing the storage function of the dam and reconnecting, restoring, and stabilizing the stream and floodplain functions. Although complete removal of the embankment is sometimes required for decommissioning, only partial removal of the embankment was evaluated in this alternative. It includes excavating a breach in the dam of sufficient size to safely pass the 1% AEP flood through the dam and the construction of a grade stabilization structure. This breach would be a minimum size opening in the dam from top of dam to the valley floor which would eliminate the structure's ability to store water and would have a bottom width of approximately 84 feet. To not impede flows through the breached embankment and to reduce certain safety and health factors, the principal spillway components would also be removed. The estimated cost is $2,012,000 and includes three flood warning systems to reduce the risk of loss of life on three downstream roadways that would be impacted by the decommissioning.

High Hazard Potential Rehabilitation of FRS No 5

The high hazard potential rehabilitation of FRS No. 5 included in Alternative 3 consisted of the following:

- Replace principal spillway riser with new crest at 1894.5 feet (4.5 feet lower than existing crest at 1899.0 feet and at same elevation of existing low-level ports);
- Install a 48-inch-diameter RCP conduit;
- Regrade auxiliary spillway crest to 1909.7 feet (0.1 foot raise);
- Line upper 355 feet of existing auxiliary spillway slope with articulated concrete blocks;
- Install 100-foot wide RCC step overtopping spillway at elevation on 1909.7; and
- Raise the top of dam crest from the as-built elevation of 1915.9 feet to 1918.7 feet (2.8 feet raise).
- Estimated Cost: $23,690,000

D.2.3 Alternative 9: High Hazard Potential Rehabilitation of FRS No. 4 and High Hazard Potential Rehabilitation of FRS No. 5

High Hazard Potential Rehabilitation of FRS No. 4

The high hazard potential rehabilitation of FRS No. 4 included in alternative 9 consisted of the following:

- Lower crest elevation of vegetated auxiliary spillway to 1994.3 feet (2.1 feet lower than as-built);
- Line upper section of existing auxiliary spillway slope with articulated concrete blocks;
- Construct 200-foot wide RCC overtopping spillway at elevation of 1994.3;
- Excavate all existing rock blanket and a minimum 5-feet of existing embankment material;
- Construct a new chimney filter/toe drain at a 2:1 slope on the downstream embankment;
- Add new embankment fill on the upstream and downstream embankment at a 3:1 slope with minimum 5 feet cover over filter; and
- Add rock riprap over geotextile over new fill on the upstream slope.
- Estimated Cost: $22,897,000

This alternative assumes that the existing principal spillway riser, conduit, and impact basin remain in place. Exterior inspection of the riser and impact basin showed these structures to be in good condition, but an inspection of the conduit would be recommended before any action associated with this alternative is undertaken.

High Hazard Potential Rehabilitation of FRS No. 5

The high hazard potential rehabilitation of FRS No. 5 included in alternative 9 consisted of the following:

- Replace principal spillway riser with new crest at 1894.5 feet (4.5 feet lower than existing crest at 1899.0 feet and at same elevation of existing low-level ports);
- Lower crest elevation of vegetated auxiliary spillway to 1908.4 feet (1.2 feet lower than as-built);
- Line upper 350 feet of existing auxiliary spillway slope with articulated concrete blocks;
- Over-excavation of the downstream slope of the embankment to a depth of approximately 3 feet and replacement of new fill material as well as flattening the upstream and downstream embankments to 3:1 slopes; and
- Raise the top of dam crest from the as-built elevation of 1915.9 feet to 1916.9 feet (1.0 foot raise).
- Estimated Cost: $15,708,000

D.2.4 Alternative 10: Federal Decommission of FRS No. 4 and Rehabilitation of FRS No. 5 to TCEQ Standards.

Decommission of FRS No 4

Decommissioning consists of removing the storage function of the dam and reconnecting, restoring, and stabilizing the stream and floodplain functions. Although complete removal of the embankment is sometimes required for decommissioning, only partial removal of the embankment was evaluated in this alternative. It includes excavating a breach in the dam of sufficient size to safely pass the 1% AEP flood through the dam and the construction of a grade stabilization structure. This breach would be a minimum size opening in the dam from top of dam to the valley floor which would eliminate the structure's ability to store water and would have a bottom width of approximately 84 feet. To not impede flows through the breached embankment and to reduce certain safety and health factors, the principal spillway components would also be removed. The estimated cost is $2,012,000 and includes three flood warning systems to reduce the risk of loss of life on three downstream roadways that would be impacted by the decommissioning.

SLO Sponsored Rehab of FRS No. 5 to TCEQ Standards

The SLO Sponsored Rehab of FRS No. 5 to TCEQ Standards would consist of determining the TCEQ size and hazard classification, determining the required criteria associated with the applicable size and hazard classification, and making improvements to FRS No. 5, if necessary, to meet those criteria.

According to Texas Administrative Code (TAC) Title 30 Part 1 Chapter 299 Subchapter B Rule 299.12 – Classification of Dams:

> “The executive director shall classify all proposed and existing dams based on size (small, intermediate, or large) and downstream hazard (low, significant, or high) and not on the physical condition of the dam.”

Exhibit D-3 below from TAC 299.13 provides the size classification criteria that would apply to a rehabilitation to TCEQ standards.

Exhibit D-3: TCEQ Size Classification Table (Figure 30 from TAC 299.13)

SIZE CLASSIFICATION		
Category	Impoundment Maximum Storage (Acre-Foot)	Height (Ft.)
Small	Equal to or Greater than 15 and Less than 1,000 Equal to or Greater than 50 and Less than 1,000	Equal to or Greater than 25 and Less than 40 Greater than 6 & Less than 40
Intermediate	Equal to or Greater than 1,000 and Less than 50,000	Equal to or Greater than 40 and Less than 100
Large	Equal to or Greater than 50,000	Equal to or Greater than 100

According to **Exhibit D-3**, FRS No. 5 would be classified as an intermediate size dam, as it has a maximum impoundment storage capacity of approximately 4,220 ac-ft.

The dam would be classified as high hazard potential by TCEQ as it meets the following criteria from TAC 299.14:

- Loss of life expected (seven or more lives or three or more habitable structures in the breach inundation area downstream of the dam); or

- Excessive economic loss, located primarily in or near urban areas where failure would be expected to cause extensive damage to:
    - public facilities;
    - agricultural, industrial, or commercial facilities;
    - public utilities, including the design purpose of the utility;
    - main highways as defined in §299.2(33); or
    - railroads used as a major transportation system.

FRS No. 5 would be classified as an intermediate size, high hazard dam by TCEQ. TAC 299.15 (a) (1) (A) specifies the hydrologic criteria **(Exhibit D-4)** that would be applied to dam.

Exhibit D-4: TCEQ Hydrologic Criteria Table (Figure 30 from TAC 299.15 (a)(1)(A))

HYDROLOGIC CRITERIA FOR DAMS		
Classification		
Hazard, as defined in §299.14 of this title (relating to Hazard Classification Criteria)	Size, as defined in §299.13 of this title (relating to Size Classification Criteria)	Minimum Design Flood Hydrograph (expressed as a percentage of the probable maximum flood (PMF)).
Low	Small	25% PMF
	Intermediate	25% PMF to 50% PMF
	Large	50% to 75% PMF
Significant	Small	50% PMF
	Intermediate	50% PMF to 75% PMF
	Large	75% to PMF
High	Small	75% PMF
	Intermediate	75% to PMF
	Large	PMF
When a range is given, the minimum flood hydrograph must be determined by straight-line interpolation within the given range. Interpolation must be based on either height of dam or maximum storage capacity, whichever results in the highest percentage of PMF. The interpolation for large, low-hazard dams for height must be between end points of 100 feet and 50% PMF and 200 feet and 75% PMF. The interpolation for large, low-hazard dams for maximum storage capacity must be between the end points of 50,000 acre-feet and 50% PMF and 300,000 acre-feet and 75% PMF. The interpolation for large, significant-hazard dams for height must be between end points of 100 feet and 75% PMF and 200 feet and PMF. The interpolation for large, significant-hazard for maximum storage capacity must be between the end points of 50,000 acre-feet and 75% PMF and 300,000 acre-feet and PMF		

As there is a range given for the design flood for an intermediate size high hazard dam, an interpolation was required to determine the minimum design flood hydrograph criterion for FRS No. 5. The height of FRS No. 5 is less than that of a dam that would be considered an intermediate size dam per **Exhibit D-4** and therefore would result in a minimum design flood hydrograph criterion of less than 75% of the PMF, so it was determined that that the capacity would dictate the minimum design flood criterion. **Table D.2-1** below shows the interpolation performed.

Table D.2-1. Interpolation of Minimum Design Flood for TCEQ Criteria

Bounding Criteria	Capacity (ac-ft)	Minimum Design Flood Hydrograph (percent of PMF)
Existing Condition		
Low Bounding Criteria - Intermediate Size High Hazard	1,000	75%
FRS No. 5 - Interpolation	**4,220**	**77%**
High Bounding Criteria - Intermediate Size High Hazard	10,000	100%
Proposed Rehabilitation to TCEQ Criteria		
Low Bounding Criteria - Intermediate Size High Hazard	1,000	75%
FRS No. 5 - Interpolation	**4,257**	**77%**
High Bounding Criteria - Intermediate Size High Hazard	10,000	100%

Based on modeling analysis, it was determined that the 12-hr duration of the 77% PMF was the critical duration for the minimum design flood hydrograph and the concept design for Alternative 10 was based on this storm event.

Without FRS No. 4 in place, minor modifications to FRS No. 5 would be required for the dam to meet TCEQ standards for an intermediate size high hazard potential dam. The crest of FRS No. 5 would need to be re-graded to fill in depressions and raise the effective dam crest by 0.29 foot to an elevation of 1916.19 feet. The raise would be to an elevation below the as-built top-of-dam elevation (1916.79). It should be noted that although the auxiliary spillway would not experience integrity issues (headcutting) in the TCEQ design storm, it would experience stability (erosion) issues, if engaged. According to modeling results, it is expected that the earthen auxiliary spillway would be engaged in the 44.5-year event. The estimated cost for the Sponsors to regrade the dam crest and raise the effective crest 0.29 foot is $147,000. Although not required to meet TCEQ hydrologic criteria (and not included in the above cost estimate), the Sponsors may want to make modifications to the auxiliary spillway to protect it against erosion.

D.3 ECONOMIC ANALYSIS

D.3.1 Economic Framework

In general, the national economic benefits presented in this supplemental plan were developed based on guidance contained in *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*[1] and the *Principles, Requirements and Guidelines for Federal Investments in Water Resources.*[2] The primary benefits evaluated were flood damage reduction to residential development, nonresidential development, and roads and bridges.

The economic analysis considers the No Federal Action (No Action) alternative as the baseline condition, which assumes the existing conditions with no major changes made to the dam or the floodplain, until catastrophic failure of the dams in the future. The analysis is formulated from the perspective that changes/impacts resulting from implementation of a with-project (Action) alternative in relation to the without-project (No Action) alternative were measured as a cost or a benefit (i.e., a zero benefit, zero cost approach was applied to the No Action alternative). Costs and benefits are reported in 2023 dollars (2023$) and were evaluated over a 103-year period of analysis (3 years for design and construction and 100-year evaluation period). The costs and benefits were annualized over the 100-year evaluation period using a 2.75 percent discount rate.

Damage to structures and contents typically form the majority of damages that result from a storm event, and therefore, form the foundation of the economic analysis when assessing alternatives. Damages to structures, contents, and automobiles were estimated through the Hydrologic Engineering Center's Flood Damage Analysis (HEC-FDA) program, and the results generated by the program were output in average annual terms based on damage estimates at each recurrence interval evaluated. Debris removal costs were assigned for every residential structure that incurred flood damages, based on the HEC-FDA results.

The hydrologic and hydraulic (H&H) analysis conducted for each alternative was used to estimate the depth of flooding throughout the study area. The economic analysis uses inundation models for eight flood recurrence intervals, which are the 100% (1-year), 50% (2-year), 20% (5-year), 10% (10-year), 4%

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[1] U.S. Water Resources Council, 1983. *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*, March.
[2] *Principles, Requirements and Guidelines for Federal Investments in Water Resources,* 2014.

(25-year), 2% (50-year), 1% (100-year), and 0.2% (500-year) AEP storm events) to estimate future damages from flooding within the study area.

Under the Action alternative, the dam would not be brought up to current federal or state standards and many of the underlying issues would remain. Therefore, there is still a chance for the dam to fail from a seismic, hydrologic, or static event. A hydrologic failure was estimated to have the highest probability of occurring. As a result, a one-time hydrologic failure (AS integrity failure) with a probability of 0.047 percent (2,136-year event) for FRS No. 4 and a one-time hydrologic failure (overtopping failure) probability of 0.0083 (12,118-year) for FRS No.5 were evaluated as part of the No Action alternative.

D.3.2 Benefit Analysis

The following describes the analyses used to evaluate the benefits of the Action alternatives. The benefits represent damage/cost reduction from future flooding and are evaluated in average annual terms. The benefit categories evaluated were:

- Residential and nonresidential structures
- Automobiles
- Debris removal
- Roads and bridges
- Agriculture

D.3.2.1 <u>Residential and Nonresidential Structures</u>

Knowledge of existing residential and nonresidential development located in a floodplain is essential when evaluating a flood-risk-management measure. A structure inventory was undertaken to identify the residential and nonresidential structures located in the study area, which serves as the base data for the economic analysis. The structure inventory comprised of residential and nonresidential structures that are within the breach area of inundation based on the H&H models. Data from the Coke County Tax Office were utilized to determine the characteristics of the structures in the inventory.

HEC-FDA was then used to estimate annual damages to residential and nonresidential structures for each alternative. The structure inventory imported into HEC-FDA included the following information for each structure:

- Unique identifier;
- Name of the river;
- Structure improvement value;
- Stream station number (based on H&H modeling cross sections);
- First floor elevation (FFE); and
- Structure category and occupancy types assigned to the structure based on type and use.

Local tax appraisal data from the Coke County Tax Assessor's office was reviewed and used to assign structure type and improvement value for each structure. Because the tax assessor data provided multiple valuation components (e.g., land, improvement) for each parcel, the value listed under the improvement component in the tax assessor data was used for the structure value.

The structures were assigned one of the structure types outlined in **Table D.3-1**. LiDAR data were used to determine ground surface elevation (GSE) at each structure, which was added to the foundation height to estimate the FFE. Structure types and their respective foundation heights are listed in **Table D.3-1**. Automobiles were assigned an elevation equal to the GSE.

Table D.3-1. Structure Type in Study Area

Structure Type	Structure Category	Structure Description	Foundation Height (FFE above GSE)
1ST-NB	Residential	Single Family-1 Story with no Basement	0.5
A1	Automobile	Automobile	0.0
ELEC_S	Utility	Electric substation	0.5
M_H	Residential	Mobile Home	1.0
WH_P	Commercial	Warehouse	0.5

To ensure that all potentially impacted structures were incorporated into the analysis, the study area was based on the floodplain from a catastrophic dam failure. The structure inventory collected information on 15 residential and nonresidential structures (**Table D.3-2)**. The inventory also included 13 automobiles, which were associated with the 13 residential structures.

Table D.3-2. Summary of Structure Inventory

Structure Type	Number of Structures	Total Value of Structures
Structures Below FRS No. 4		
1ST-NB	2	$129,000
M_H	2	$52,000
Structures Below FRS No. 5		
1ST-NB	9	$223,000
ELEC_S	1	$1,000,000
WH_P	1	$67,000

Exhibit D-5. Depth-Damage Functions

Structure Type	Parameter	Start_ Data																									
1ST-B	Stage	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	S	0	0	0.7	0.8	2.4	5.2	9	13.8	19.4	25.5	32	38.7	45.5	52.2	58.6	64.5	69.8	74.2	77.7	80.1	81.1	81.1	81.1	81.1	81.1	81.1
	SN	0	0	1.34	1.06	0.94	0.91	0.88	0.85	0.83	0.85	0.96	1.14	1.37	1.63	1.89	2.14	2.35	2.52	2.66	2.77	2.88	2.88	2.88	2.88	2.88	2.88
	C	0	0.1	0.8	2.1	3.7	5.7	8	10.5	13.2	16	18.9	21.8	24.7	27.4	30	32.4	34.5	36.3	37.7	38.6	39.1	39.1	39.1	39.1	39.1	39.1
	CN	0	1.6	1.16	0.92	0.81	0.78	0.76	0.74	0.72	0.74	0.83	0.98	1.17	1.39	1.6	1.81	1.99	2.13	2.25	2.35	2.45	2.45	2.45	2.45	2.45	2.45
	Struct	N		1							100																
1ST-NB	Stage	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16							
	S	0	2.5	13.4	23.3	32.1	40.1	47.1	53.2	58.6	63.2	67.2	70.5	73.2	75.4	77.2	78.5	79.5	80.2	80.7							
	SN	0	2.7	2	1.6	1.6	1.8	1.9	2	2.1	2.2	2.3	2.4	2.7	3	3.3	3.7	4.1	4.5	4.9							
	C	0	2.4	8.1	13.3	17.9	22	25.7	28.8	31.5	33.8	35.7	37.2	38.4	39.2	39.7	40	40	40	40							
	CN	0	2.1	1.5	1.2	1.2	1.4	1.5	1.6	1.6	1.7	1.8	1.9	2.1	2.3	2.6	2.9	3.2	3.5	3.8							
	Struct	N		1							100																
A1	Stage	-1.5	-1	0	0.5	1	2	3	4	5	6	7	8	9	10	11	12										
	S	0	0	0	7	28	46	62	76	87	97	100	100	100	100	100	100										
	Struct	N		1							0																
CONV_P	Stage	-2	-1	-0.5	0	0.5	1	1.5	2	3	4	5	6	7	8	9	10										
	S	0	0.4	0.4	1.1	11.1	16	21.6	25.3	34.1	41.9	45.4	51.4	57	60.6	62.8	63.6										
	STL	0	0	0	0	6.2	9.3	12.7	17	24.1	31.2	34.4	41.7	44.6	50.9	53.3	54.5										
	STU	0	1.3	1.3	2.7	17.6	22.1	29.2	34.2	42	49.8	52.5	60	63.8	66.4	68.5	69.5										
	C	0	0	0	0	11.6	23.1	32.1	39.9	52.9	70.7	79.3	88	94.1	95.7	97.1	98.6										
	CTL	0	-0.1	-0.1	0	5	12.7	20	30	40	60	70	80	90	92	95	97										
	CTU	0	0	0	0	15	28	38	45	60	78	85	95	100	100	100	100										
	Struct	N		1							41																
ELEC_S	Stage	-2	-1	-0.5	0	0.5	1	1.5	2	3	4	5	6	7	8	9	10										
	S	0	0	0	0	0	0	0	0	3.3	6.7	10	22.9	35.7	48.6	61.4	74.3										
FFR_P	Stage	-2	-1	-0.5	0	0.5	1	1.5	2	3	4	5	6	7	8	9	10										
	S	0	0.3	0.3	0.6	11.1	15.9	22.5	28.7	37.4	47.3	52.1	58.3	63.5	67	70.9	72.2										
	STL	0	0	0	0	6.1	9.3	13.9	20.9	26.9	37.5	44	50.9	54.6	59.7	64.2	64.9										
	STU	0	1.1	1.1	2.1	18.6	23.9	32	42.4	48.9	58.1	61.9	67.4	73.5	76.6	79	79.6										
	C	0	0	0	0	10.6	21.3	29.4	38.6	52.7	62.6	73	79.3	88.3	94.9	98.6	98.6										
	CTL	0	0	0	0	5	15	20	30	44	54	65	72.5	80	85	90	92										
	CTU	0	0	0	0	15	28	36	50	60	72.5	80	80	95	100	100	100										
	Struct	N		1							32				-901												
M_H	Stage	-2	-1	-0.5	0	0.5	1	1.5	2	3	4	5	6	7	8	9	10										
	S	0	7.3	11.2	32.2	48.5	54	56.1	58.9	60.3	64.3	67.5	68	69	80	81.7	82.8										
	C	0	0	0	0.1	15	30.1	45.6	58.8	69.2	78.3	82.4	84.3	84.4	84.4	84.4	84.4										
	Struct	N		1							139																
WH_P	Stage	-2	-1	-0.5	0	0.5	1	1.5	2	3	4	5	6	7	8	9	10										
	S	0	0.5	0.5	1.1	7.6	11.8	16.1	19.9	25.4	31.4	34.2	39	41.8	45.7	50.4	51.7										
	STL	0	0	0	0	3.5	5.1	7.6	11.7	16.4	21.2	22.3	28.3	29.9	34.5	37.6	38.7										
	STU	0	1.2	1.4	3.3	14	17.4	23.6	28.8	34.2	42.5	44.7	48.9	52.7	56.9	60.6	62.2										
	C	0	0	0	0	13.4	20.7	27.6	33.7	47.4	56.9	65.6	73.6	81.3	88.4	91.6	93.6										
	CTL	0	0	0	0	7	15	20	25	35	40	50	60	70	76	84	90										
	CTU	0	0	0	0	20	25	35	45	55	66	75	85	90	100	100	100										
	Struct	N		1							47																

Each structure was assigned a depth-damage function (DDF) based on the structure type that estimates an economic loss as a percentage of the value of the structure and depth of flooding. DDFs were sourced from the U.S. Army Corps of Engineers' (USACE's) Economic Guidance Memorandum (EGM) 04-01, *Generic Depth-Damage Relationships for Residential Buildings with Basements*.[3] DDFs for nonresidential buildings were sourced from FEMA's Benefit-Cost Analysis Toolkit.[4] The structure and content DDFs for the structure types are provided in **Exhibit D-5**.

To estimate the average annual damages from a catastrophic dam failure for the No Action alternative, the damages were estimated for the catastrophic dam failure events and then multiplied by the probability of failure for the failure type with the highest probability of occurring (0.047 percent for AS integrity failure of FRS No.4 and 0.0083 percent for overtopping failure of FRS No. 5). The average annual damages from a catastrophic dam failure were added to the estimated average annual damages resulting from the recurrence interval flood events for the dams in the without-project condition to estimate the total average annual damages for the No Action alternative.

D.3.2.2 Automobiles

The damages to automobiles were estimated using the U.S. Army Corps of Engineers' (USACE) Economic Guidance Memorandum, 09-04, *Generic Depth-Damage Relationships for Vehicles*. In accordance with the guidance, the ground elevation of the grade adjacent to each residential structure served as the elevation of each automobile, which was provided in the structure inventory. The damages to vehicles at residences is dependent on the average number of vehicles per household and the percentage of vehicles that are likely to be at the residence at the time the flood waters reach the property and the availability of safe evacuation routes.

In 2019, the most recent year in which U.S. Census data is available, the average number of vehicles per household in Coke County, Texas was 2.12.[5] As suggested by the guidance, the average vehicle value was obtained from Edmunds. According to the Edmunds Used Car Market Report, the average retail value for used vehicles was $28,381 in the first quarter of 2023.[6]

The length of potential warning time and the access to a safe evacuation route to a flood-free location was considered to estimate the percentage of vehicles that would likely remain in the flood prone location. For Coke County, it is assumed that the warning time would be less than 6 hours; therefore, 50.5% of the vehicles in the flood area would be evacuated according to USACE guidance and 49.5% would remain.

Since only those vehicles not used for evacuation can be included in the damage calculations, an adjusted average vehicle value of $29,783 ($28,381 x 2.12 x 0.495) was assigned to each individual residential building record. The automobile inventory and associated values were input into the HEC-FDA structure inventory to calculate the damages to automobiles.

3 USACE, 2003. *Generic Depth-Damage Relationships for Residential Buildings with Basements*, EGM 04-01. October 10. https://planning.erdc.dren.mil/toolbox/guidance.cfm?Option=BL&BL=OnlyInlandFlood&Type=None&Sort=Default.

4 FEMA, 2019. *Benefit-Cost Analysis Toolkit, Version 6.0*. https://www.fema.gov/media-library/assets/documents/179903.

5 United States Census Bureau, *Commuting Characteristics by Sex, American Community Survey 5-Year Estimates*, 2021.

6 Edmonds, *Used Vehicle Report, Q1 2023*. Retrieved https://static.ed.edmunds-media.com/unversioned/img/car-news/analysis/2023-q1-used-vehicle-report.pdf

D.3.2.3 Structure and Automobile Benefits

Data on structures and automobiles and H&H data were imported into HEC-FDA to estimate the average annual damages and benefits. The following sections describe the structure and automobile damage estimate for each alternative and the resulting benefits. HEC-FDA conducts a Monte Carlo simulation to estimate the impacts of uncertainty on the results. Uncertainty parameters are incorporated into both the H&H analysis and the structure data. The results provided in this section account for uncertainty.

Table D.3-3 provides the average annual damage for each alternative, by structure category, while **Table D.3-4** presents the number of structures flooded above the FFE for each recurrence interval.

Table D.3-3. Average Annual Damage by Structure Category

Alternative	AUTO	COM	RES	UTL	Dam Failure	Total
No Action	$7,590	$2,110	$27,190	$0	$470	$37,360
Alternative 3	$8,120	$2,360	$30,010	$0	$0	$40,490
Alternative 9	$7,680	$2,300	$27,340	$0	$0	$37,320
Alternative 10	$7,870	$2,170	$29,340	$0	$0	$39,380

Table D.3-4. Number of Structures Flooded Above the First Floor Elevation

Alternative	50% AEP	20% AEP	10% AEP	4% AEP	2% AEP	1% AEP	0.4% AEP	0.2% AEP	Dam Failure
No Action	**0**	**1**	**1**	**3**	**4**	**4**	**4**	**4**	**14**
1ST-NB	0	1	1	2	3	3	3	3	11
ELEC_S	0	0	0	0	0	0	0	0	0
M_H	0	0	0	0	0	0	0	0	2
WH_P	0	0	0	1	1	1	1	1	1
Alt 3	**0**	**1**	**1**	**3**	**3**	**4**	**4**	**6**	**N/A**
1ST-NB	0	1	1	2	2	3	3	5	N/A
N/AELEC_S	0	0	0	0	0	0	0	0	N/A
N/AM_H	0	0	0	0	0	0	0	0	N/A
WH_P	0	0	0	1	1	1	1	1	N/A
Alt 9	**0**	**1**	**1**	**3**	**4**	**4**	**4**	**4**	**N/A**
01123333N/A1ST-NB	0	0	0	0	0	0	0	0	N/A
00000000N/AELEC_S	0	0	0	1	1	1	1	1	N/A
01134444N/AM_H	0	1	1	2	3	3	3	3	N/A
WH_P	0	0	0	0	0	0	0	0	N/A
Alt 10	**0**	**1**	**1**	**3**	**4**	**4**	**4**	**6**	**N/A**
1ST-NB	0	1	1	2	3	3	3	5	N/A

Alternative	50% AEP	20% AEP	10% AEP	4% AEP	2% AEP	1% AEP	0.4% AEP	0.2% AEP	Dam Failure
ELEC_S	0	0	0	0	0	0	0	0	N/A
M_H	0	0	0	0	0	0	0	0	N/A
WH_P	0	0	0	1	1	1	1	1	N/A

Note: N/A is not applicable because dam is assumed not to fail

Table D.3-5 provides the average annual benefits and damage probability exceedance values for structures and automobiles, as reported from HEC-FDA. Damages and benefits include the dam failure scenario and the damages related to the eight recurrence intervals that were evaluated. The negative benefit values are a result of slight induced damages related to increased flow from the dams when compared to the without-project condition.

Table D.3-5. Average Annual Benefits

Alternative	Damages	Benefits
No Action	$37,360	N/A
Alternative 3	$40,490	-$3,130
Alternative 9	$37,320	$40
Alternative 10	$39,380	-$2,020

D.3.2.4 Debris Removal

When flooding occurs, debris can accumulate from flood damage, requiring effort to bring debris to the street for pickup and removal. The costs associated with debris removal were estimated based on guidance from the Federal Emergency Management Agency (FEMA) and were grouped with structure damages for the purposes of this analysis.

Debris costs were estimated for structures located in the reaches evaluated. Debris removal costs were assigned for every residential structure that incurred flood damages, based on the HEC-FDA results. The debris costs per structure include the hauling cost, tipping fee, and labor to remove debris and break it into pieces that could be hauled to the street for pickup.

FEMA has estimated there are 25 to 30 cubic yards of debris for a flooded residential structure without a basement and 45 to 50 cubic yards for a residential structure with a basement. The cost to load and haul away debris was estimated using the average cost per cubic yard of $22 from the Homewyse Debris Removal Cost Calculator (August 2021); in addition, the disposal cost of $4 per cubic yard results in a total debris removal cost of $26 per cubic yard. The FEMA Debris Estimation Field Guide conversion factor of four cubic yards of debris per ton was used to convert the total debris removal cost per cubic yard to debris removal cost per ton; resultantly, a debris removal cost of $104 per ton was incorporated into the analysis.

Using the Homewyse Debris Removal Cost Calculator (August 2021), the number of labor hours to break down debris and move it from the structure to the street was estimated to be 1.4 hours for every cubic yard of debris. Because homeowners are forgoing other activities to clean up debris, including work and leisure, the opportunity cost was applied to value this time. The value of time was estimated using the 2019 median household income for Coke County from the Census (adjusted to 2023 dollars) and dividing by 2,080 hours to get $22, representing the hourly opportunity cost of work per household. For leisure time, an opportunity cost of $15 was assigned based on the common practice used in economics literature to value recreation time as a fraction of the wage. In literature, this fraction ranges from one-third the wage to the full wage; therefore, a fraction of two-thirds was used to estimate the opportunity cost of leisure. During the flood aftermath, owners were assumed to forego recreation two-thirds of the time and forego work one-third of the time, for an average opportunity cost of time of $17 per hour. **Table D.3-6** presents the average cost of debris removal from a flooded residential structure with and without a basement.

Table D.3-6. Summary of Residential Debris Costs by Structure Type

Structure Description	Cubic Yards of Debris	Debris Removal Labor and Disposal Costs	Owner Opportunity Cost of Time	Total Debris Cost
With Basement	45 to 50	$1,200	$800	$2,000
Without Basement	25 to 30	$700	$500	$1,200

Note: 2023 price level

The "FDA_StrucDetail.Out" file from HEC-FDA was reviewed for each alternative to identify which structures would receive flood damages at each recurrence interval. If the structure received damages, the debris cleanup costs were applied and annualized. The average annual debris cleanup benefit for each with-project alternative was less than $100.

D.3.2.5 Roads and Bridges

Debris removal and damages were evaluated for two road segments for flooding downstream of FRS No. 4 and seven road segments were evaluated for flooding downstream of FRS No. 5 during the 100% to 0.2% AEP storm events and for the catastrophic breach events. Although it is believed that many of these roadways do flood frequently, it is assumed that the typical focus following a storm event that produces flooding of between 0.5 foot and 1 foot is debris removal with an estimated cost of $3,000 per event per road. The following criteria were used to apply debris removal and damage repair costs to both public and private roads:

- For roadways flooded at a depth of less than 0.5 foot, no debris removal or damage repairs costs were applied.
- For roadways flooded at depths between 0.5 foot and 1foot, debris removal costs at $3,000 per roadway were applied.
- For roadways flooded by a depth of 1 foot or more, floodwater damage repair estimates were applied. Repair costs include $15.00 per square yard of inundated asphalt (resurfacing, 12-inch sub base, 2-inch wearing surface), $30 per cubic yard for compacted earthfill for culvert crossings earthfill could be washed away, and $18.00 per linear foot of impacted guardrail (replacement).

Based on the H&H data from flood models and the assumptions above, damages were estimated for roads and bridges located downstream of each dam (**Table D.3-7**).

Table D.3-7. Road and Bridge Damages per Recurrence Interval

Alternative	100% AEP	50% AEP	20% AEP	10% AEP	4% AEP	2% AEP	1% AEP	0.2% AEP
FRS No. 4								
No Action	$0	$0	$9,830	$9,830	$16,984	$16,984	$21,964	$27,608
Alternative 3	8,090	$8,893	28,035	$28,593	$29,188	$31,242	$79,367	$92,169
Alternative 9	$0	$0	$0	$9,830	$16,986	$16,986	$24,962	$29,455
Alternative 10	$8,090	$8,893	$28,035	$28,593	$29,188	$31,242	$79,367	$92,169
No Action								
No Action - 52% PMP								$177,611
No Action - 94% PMP								$179,961
No Action - 100% PMP								$180,174
FRS No. 5								
No Action	$0	$0	$3,000	$21,463	$54,116	$62,833	$64,393	$103,642
Alternative 3	$0	$0	$3,000	$30,584	$54,260	$64,012	$65,515	$258,092
Alternative 9	$0	$0	$3,000	21,476	$63,373	$62,803	$64,388	$103,623
Alternative 10	$0	$0	$3,000	21,464	$54,119	$62,817	$68,175	$345,762
No Action								
No Action - 80% PMP								$389,716
No Action - 100% PMP								$485,020
Total								
No Action	$0	$0	$12,830	31,293	$71,100	$79,817	$86,358	$131,251
Alternative 3	$8,090	$8,893	$31,035	59,177	$83,448	$95,254	144,883	$350,260
Alternative 9	$0	$0	$3,000	$31,306	$80,359	$79,789	$89,350	$133,078
Alternative 10	8,090	$8,893	$31,035	$50,057	$83,307	$94,059	147,542	$437,931
No Action								
No Action - 52% PMP	Dam 4 Integrity Failure							$177,611
No Action - 80% PMP	Dam 4 Integrity Failure and Dam 5 Overtopping Failure							$567,327
No Action - 94% PMP	Dam 4 Overtopping Failure and Dam 5 Overtopping Failure							$569,677
No Action - 100% PMP	Dam 4 Overtopping Failure and Dam 5 Overtopping Failure							$665,195

A summary of damages avoided to roads and bridges is provided in **Table D.3-8**.

Table D.3-8. Damages Avoided to Roads and Bridges

Project Alternative	Average Annual Damages	Average Annual Benefits
No Action	$11,000	N/A
Alternative 3	$24,000	-$13,000
Alternative 9	$9,000	$2,000
Alternative 10	$24,000	-$13,000

Note: values rounded to the nearest $1,000

D.3.2.6 Agricultural Land Damages

Knowledge of existing agricultural land located in a floodplain is essential when evaluating flood-risk-management measures. The impacts of flooding can cause significant damage to crops, but there are a number of factors that need to be considered when estimating damages. When estimating the damage, the three primary factors to consider are timing of the flood (what season the flood occurs in), duration (how long the crops are flooded), and extent of flooding (how many acres are flooded).

As a preliminary analysis of potentially impacted agricultural land, the 2022 Cropscape Cropland Data Layer (USDA, 2022) and GIS were used to estimate the number of acres potentially flooded by land cover type for the 1% AEP storm event. From this information, the amount of agricultural land potentially flooded was estimated for each alternative. Based on the analysis, it was estimated that less than 210 acres of agricultural land would potentially be flooded for any of the alternatives, that all of the alternatives had similar results (less than a 50-acre maximum difference between the alternatives), and that the Action alternatives had similar results to the No Action alternative (less than a 50-acre maximum difference between the Action alternatives and No Action alternative).

Because the timing of the floods would be the same and the duration and extent of the potential flooding would be similar, there would be little difference in potential agricultural damages between the alternatives. In addition, considering the probability of the storm event that would result in the potential damage, in combination with the probability of the storm event occurring at a stage of crop growth that would result in damages, the economic significance of these potential impacts would be reduced further. As such, any agricultural damages considered in the economic analysis would be minimal, and any differences between the alternatives would not change the results of the overall economic analysis. Therefore, agricultural damages were not evaluated in detail for the economic analysis.

D.3.2.7 Benefit Summary

The following summarizes the benefits quantified for each project alternative. The benefits were estimated over the 100-year evaluation period following construction completion. A summary of economic benefits is provided in **Table D.3-9**.

Table D.3-9. Summary of Economic Benefits

Project Alternative	Road/Bridge Damages Avoided	Structure-Related Benefits	Total Benefits
Alternative 3	-$13,000	-$3,000	-$16,000
Alternative 9	$2,000	$0	$2,000
Alternative 10	-$13,000	-$2,000	-$15,000

Notes: 2023 price level; values rounded to the nearest $1,000; debris removal benefits and agricultural benefits were less than $500 and, therefore, not included in the table.

D.3.3 Cost Analysis

The costs of implementation for the with-project alternatives are summarized in **Table D.3-10**. To reduce the potential for loss of life resulting from the decommission of FRS No. 4 in alternatives 3 and 10, the total implementation cost of these alternatives includes the installation of flood warning systems on roads that would see a significant amount of increased flooding. Note that the costs presented in the table are not annualized.

Table D.3-10. Design and Construction Cost of Alternative Implementation

Project Alternative	Dam 4	Dam 5	Flood Warning System	Total
Alternative 3	$1,652,000	$23,690,000	$360,000	$25,702,000
Alternative 9	$22,897,000	$15,708,000	$0	$38,605,000
Alternative 10	$1,652,000	$147,000	$360,000	$2,159,000

Notes: 2023 price level; values rounded to the nearest $1,000.

Average annual costs associated with the alternatives include implementation costs and operation & maintenance (O&M) costs. Average annual project costs are shown in **Table D.3-11**. O&M costs are the net cost in relation to the No Action alternative (i.e., difference between existing O&M and the with-project alternative).

Table D.3-11. With-Project Average Annual Project Costs

Project Alternative	Implementation Costs	Annual O&M Costs	Average Annual Costs
Alternative 3	$788,000	-$2,000	$786,000
Alternative 9	$1,184,000	$0	$1,184,000
Alternative 10	$64,000	-$2,000	$62,000

Notes: 2023 price level; 2.75% discount rate; annualized over the 100-year evaluation period; implementation costs include interest during construction; values rounded to the nearest $1,000.

D.3.4 Results of the Economic Analysis

Average annual net benefits and benefit-cost ratios (BCR) for the with-project alternatives are shown in **Table D.3-12.** The alternative with the greatest annual benefit is Alternative 9 and the alternative with the lowest average annual cost and greatest (least negative) annual net benefits is Alternative 10.

Table D.3-12. Evaluation of With-Project Alternatives

Project Alternative	Average Annual Benefits	Average Annual Costs	BCR	Annual Net Benefits
Alternative 3	-$16,000	$786,000	0.0:1.0	-$802,000
Alternative 9	$2,000	$1,184,000	0.0:1.0	-$1,182,000
Alternative 10	-$15,000	$62,000	-0.2:1.0	-$77,000

Notes: 2023 price level; 2.75% discount rate; annualized over the 100-year period of evaluation, BCR rounded to nearest tenth

The impacts of the alternatives on flood risk management in relation to existing conditions was reviewed. There are also no known public utilities or water sources that would experience induced flooding compared to existing conditions with implementation of the with-project alternatives. While large-scale development of the watershed is not anticipated, low-density residential development is expected to continue both upstream and downstream of FRS No. 4 and FRS No. 5. This development is not anticipated to have an impact on the functioning of the FRS No. 5 or change the flooding conditions.

It should be noted that Kickapoo FRS No. 3 and FRS No. 6 also outfall to the study area considered as part of this project. While no modifications are currently planned for these structures, future modifications to them could have an effect of the impacts and benefits attributed to this project. The combined as-built capacity of FRS No. 3 (1485 ac-ft) and FRS No. 6 (1478 ac-ft) is approximately 42.4% of the combined capacity of FRS No. 4 (2606 ac-ft) and FRS No. 5 (4386 ac-ft) and only 67.6% of FRS No. 5. In addition, 5 of the 13 potentially impacted residential structures are located upstream of the confluence of the outfall from FRS No. 3 and Middle Kickapoo Creek and 9 of the 13 potentially impacted residential structures are located upstream of the confluence of East Kickapoo Creek (the outfall of FRS No. 6) and Middle Kickapoo Creek. Any modifications associated with these structures would not impact the current breach risks associated with FRS No. 4 or FRS No. 5 or the concerns associated with the FRS No. 4 embankment.

D.3.5 Regional Economic Analysis

A regional economic analysis was conducted by the NRCS economist. This calculated the regional impacts of the construction activities for the four alternatives, and the value-added flood damage reduction benefits using the IMPLAN model for the state of Texas. For the federally assisted alternatives (Alternative 3 and Alternative 9), most of the local cost-share dollars would be funded by a Texas State Government agency, not Coke County, so it made more sense to use the state as the economic impacted area. The IMPLAN model was used, using standard NRCS procedures. The analysis was conducted for the recommended Alternative 10, then the calculated multipliers were used for Alternatives 3 and 9. The No Action alternative (baseline) used the same flood damage benefits as Alternative 9. **Table D.3-13 to Table D.3-17** below show the results of the regional economic analysis.

Table D.3-13. Annual Flood Damage Benefits

IMPLAN Sectors	Benefits
6001 Proprietor Income	$6,000.00
10006 Households 70-100k	$25,000.00
10006 Households 70-100k	$31,000.00
10006 Households 70-100k	$1,000.00
Total	**$63,000.00**

Table D.3-14. Annual Flood Damage Impacts

Annual Flood Damage Impacts	Impact Type	Employment	Labor Income	Value Added	Output
	Direct Effect	0	$63,000	$63,000	$63,000
	Indirect Effect	0	$0	$0	$0
	Induced Effect	0.4	$24,108	$41,047	$71,790
	Total Effect	**0.4**	**$87,108**	**$104,047**	**$134,790**
Multipliers			**1.3827**	**1.6515**	**2.1395**
Baseline and Alternative 9 Benefits			$111,028	$132,618	$171,804

Table D.3-15. Construction Costs

Cost Item	PL-83-566	Other funds	Total	IMPLAN Sectors	
Construction	$7,077,000	$3,719,000	$10,796,000	62	construction of highways, streets, bridges
Engineering	$2,039,000	$-	$2,039,000	457	Architectural, engineering, and related services
Real Property2		$60,000	$60,000	447	Other real estate
Permits		$182,000	$182,000	540	State Local Gov
Project Administration	$1,077,000	$15,000	$1,092,000	544	Federal Admin for Fed Share
Mitigation	$156,000	$84,000	$240,000	62	construction of highways, streets, bridges
Total	**$10,349,000**	**$4,060,000**	**$14,409,000**		

Table D.3-16. Construction Impacts

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	69	$5,512,641	$6,910,294	$14,409,000
Indirect Effect	41.7	$3,018,271	$4,852,853	$8,932,326
Induced Effect	43.9	$2,395,521	$4,106,295	$7,201,325
Total Effect	154.6	$10,926,433	$15,869,441	$30,542,650
Multipliers	2.24		1.10	2.12
Mitigation	$93,201.81	per job		

Table D.3-17. Regional Economic Benefits

Regional Economic Benefits (Texas)	No Action	Alternative 3	Alternative 9	Alternative 10
Job-Years of Employment Created by Construction	-	155	265	14
Value Added to Texas Economy During Construction (One-time benefits)	$0 (Baseline)	$15,869,441	$27,238,741	$3,566,000
Total Benefits (Including annualized Value Added from construction) to Texas Economy	$132,619	$504,368	$819,741	$16,000

D.4 HYDROLOGY AND HYDRAULICS ANALYSES

D.4.1 Overview

FRS No. 4 and FRS No. 5 are located in Coke County, Texas on Middle Kickapoo Creek, a tributary to Kickapoo Creek, a tributary to the Colorado River, and are located approximately 8 and 5 miles north, respectively, of Bronte, Texas. New hydrologic (HEC-HMS, SITES) and hydraulic (HEC-RAS 1D, 2D) models were created for the area upstream of the confluence of Middle Kickapoo Creek and the West Kickapoo Creek, including FRS No. 4 and FRS No. 5.

D.4.2 Data Sources

- National Land Cover Database (NLCD) 2019
- SSURGO Soils (Accessed 10/23/2020)
- Field measurements of culverts and bridges collected 10/16/2020
- As-built plans for FRS No. 2, No. 3, No. 4, No. 5, No. 6
- USDA NRCS Dam Safety Inspections of FRS 4 and 5, 2019
- LiDAR (Texas Natural Resources Information System, 2019)
- NOAA Atlas-14 Point Precipitation Frequency Estimates, Volume 11, Version 2.0 for Texas

D.4.3 SITES Modeling

The dam hydraulic and hydrologic computer analysis program SITES was used to:

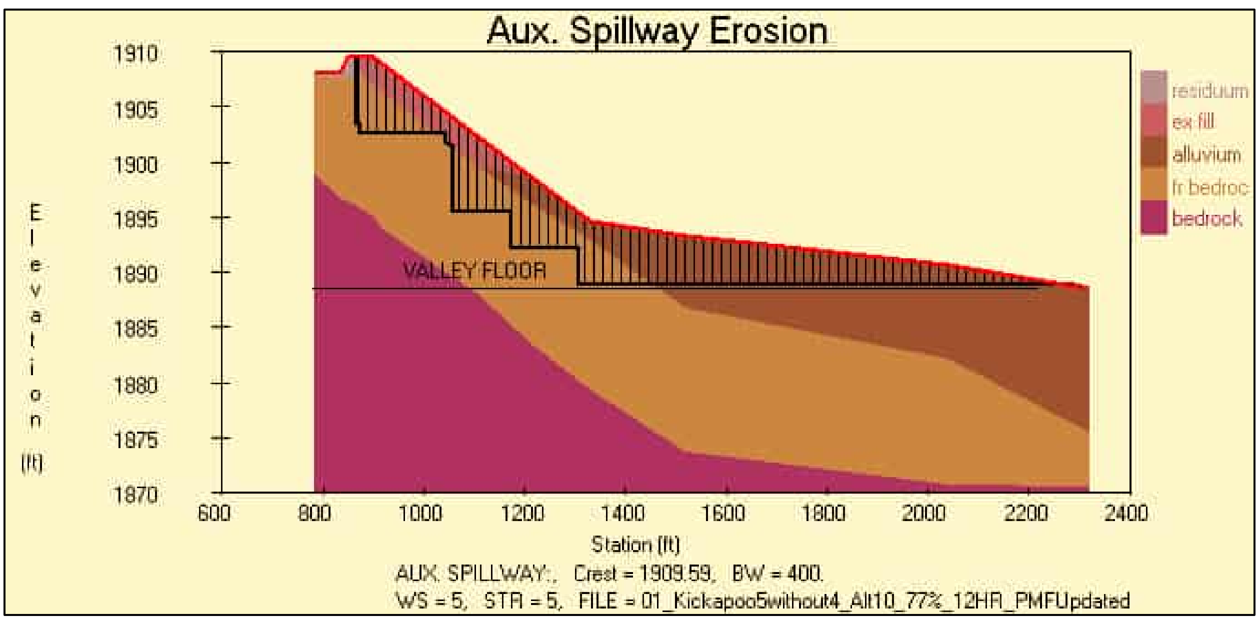
- Develop design inflow hydrographs;
- Develop storage-discharge relationships;
- Model the PSH to evaluate the existing conditions of the FRSs against current NRCS criteria and set the crest of the auxiliary spillway channels for proposed alternatives designed to meet NRCS criteria;
- Model the Stability Design Hydrograph (SDH) and the Freeboard Design Hydrograph (FBH) events to evaluate the existing conditions of the FRSs against current NRCS criteria and to develop proposed alternatives designed to meet NRCS criteria;
- Evaluate wave run up height above the SDH peak WSE for proposed alternatives designed to meet current NRCS criteria;
- Model the TCEQ design storm event to evaluate the existing condition of FRS No. 5 and develop a proposed alternative to meet TCEQ criteria; and
- Evaluate integrity/stability of the existing auxiliary spillways and auxiliary spillways in proposed alternatives.

D.4.3.1 Integrity Analysis

An integrity analysis of the existing FRS No. 4 vegetated auxiliary spillway was performed using estimated spillway parameters developed using the methods described in *Geotechnical Recommendations for Sites Parameters* technical memo provided in Appendix E. The result of the analysis was that the existing vegetated auxiliary spillway fails the NRCS integrity criteria. NRCS integrity criteria were evaluated for each alternative that included utilizing and/or modifying the existing spillway and that was developed to meet NRCS criteria. Because the preferred alternative, Alternative 10, involves decommissioning Site No. 4, an integrity analysis was not performed for the preferred alternative at Site No. 4 and soil samples were not collected at the auxiliary spillway to confirm assumptions regarding the spillway.

An integrity analysis of the existing FRS No. 5 vegetated auxiliary spillway was performed using data and estimated spillway parameters developed using the methods described in *Kickapoo Creek FRS No. 5 – Preliminary Geologic Investigation Report and Soil Mechanics Report* provided in Appendix E. Geotechnical soil borings were collected at four locations along the centerline of the auxiliary spillway of FRS No. 5. Data from sampling and lab testing of these borings were used to develop parameters and stratigraphic profiles, and SITES was used to evaluate the integrity of the spillway. The result of the analysis was that the existing vegetated auxiliary spillway fails the NRCS integrity criteria. NRCS integrity criteria were evaluated for each alternative that included utilizing and/or modifying the existing spillway and that was developed to meet NRCS criteria. Because the preferred alternative, Alternative 10, was not developed to meet NRCS criteria, a FBH integrity analysis (as would be required to meet NRCS standards) was not performed for the preferred alternative at FRS No. 5. TCEQ criteria does require that the dam pass the minimum design flood hydrograph without failing, either by overtopping or by integrity failure. An integrity analysis was performed for the existing vegetated auxiliary spillway during the 12-hour 77% PMF hydrograph. The results of the integrity analysis for Alternative 10 indicates that the existing vegetated auxiliary spillway does not breach during the 12-hour 77% PMF hydrograph using the estimated SITES parameters. The headcut extends to within 15 feet of the upstream spillway crest. A SITES integrity erosion graph from this analysis is provided in **Exhibit D-6**. The integrity analysis will need to be re-evaluated during final design if any aspects of the conceptual design are modified.

Exhibit D-6. Kickapoo FRS No. 5 12-HR 77% PMF Integrity Erosion Graph – Alternative 10



D.4.3.2 <u>Stability Analysis</u>

A stability evaluation was performed for the existing condition of both FRS No. 4 and FRS No. 5, and for each of the proposed alternatives for FRS No. 4 and FRS No. 5 that were developed to NRCS standards and included utilizing or modifying an existing vegetated auxiliary spillway. The evaluations were performed following the guidance of Agricultural Handbook #667, Stability Design of Grass-Lined Open Channels (USDA ARS 1987). The vegetated auxiliary spillways for both dams experienced stability issues in the existing condition and many of the proposed alternatives and other designs that were considered required measures, such as Articulated Concrete Block (ACB) to address the stability issues.

As FRS No. 4 would be decommissioned in the preferred alternative (Alternative 10), no stability analysis was performed for the FRS No. 4 preferred alternative.

The preferred alternative for FRS No. 5 included performing minor modifications to the effective dam crest so that the dam could meet TCEQ standards after the decommission of FRS No. 4. While there is not a specific TCEQ criteria for stability, it was determined the results of a stability analysis could be useful to the Sponsors, so an analysis was performed. As the alternative was not developed to NRCS standards, it was not appropriate to evaluate the stability of the auxiliary spillway with the NRCS Spillway Design Hydrograph (SDH). An equivalent storm event was identified to be the 1,000-year, 6-hour frequency storm event from NOAA Atas 14. Because there is a significant grade change approximately 430 ft downstream of the control section where the surface slope of the spillway changes from approximately 3.5% to approximately 0.5%, the stability analysis was performed for both the steep section (above the grade change) and the flat section (below the grade change). The evaluation was performed with a vegetal retardance curve index of 5.6.

Using the 1,000-year 6-hour rainfall value of 9.28 inches, the maximum SITES effective soil stress and total stress for the auxiliary spillway in both sections for the preferred alternative are provided in **Table D.4-1**. The SITES estimated effective vegetal stress was estimated as the difference between these two values. Both spillways were evaluated based on sampling and lab testing as having a fill material of soil types SC and CL with plasticity index (PI) of 20 and a dry density of 110 lb/ft^3 for each. The critical soil type, identified as SC in the soil stress analysis, is presented in the table below.

Table D.4-1. Site No. 5 Auxiliary Spillway Stability Analysis (Soil SC)

SITES Soil Effective Stress (lb/ft^3)	SITES Total Stress (lb/ft^3)	SITES Effective Vegetal Stress (lb/ft^3)	AH 667 Allowable Soil Stress (lb/ft^3)	AH 667 Allowable Vegetal Stress (lb/ft^3)	Passes Stability Criteria? (Allowable Stress > Effective Stress)
Steep Section (3.5% slope)					
1.063	4.41	3.35	0.141	4.20	Fail
Flat Section (0.5% slope)					
0.199	1.13	0.93	0.141	4.20	Fail

Both the flat section and steep section failed the stability criteria. While the Sponsors are not required by TCEQ criteria to address the potential stability issue, they may want to provide erosion protection to the surface of the auxiliary spillway or plan for repairs following storm events that engage the auxiliary spillway.

D.4.3.3 Dam Breach and Population at Risk

Technical Release No. 210- 60 (TR-210-60) *Earth Dams and Reservoirs* (USDA NRCS, 2005) and TR-66 *Simplified Dam-Breach Routing Procedure* (NRCS SCS, 1985) breach criteria and procedures were used to estimate a breach discharge hydrograph as described in Section 3.16 of the *Supplemental Watershed Plan No. I and EA*. Fair weather conditions were assumed for the breach analyses. The initial reservoir pool elevation assumed for the breach scenario was static at top of dam with non-storm conditions downstream.

The population at risk (PAR) was estimated for the existing condition (i.e., with existing dam in place). It should be noted that estimating the PAR is based on professional judgment coupled with empirical data.

PAR estimates were provided for motorists, residents, and other people located downstream that could be affected by flooding from a catastrophic failure of FRS dam.

Guidance for Completion of "Evaluation of Potential Rehabilitation Projects" December 10, 2001, Updated July 5, 2013 was utilized to estimate PAR for residences and motorists downstream of the dam. According to the guidance, three people per residence are estimated to be at risk where floodwaters are greater or equal to 1.0 foot above natural ground elevation. For paved roads with predominantly local traffic, one vehicle per road with two people per vehicle are estimated to be at risk where floodwaters overtop the road deck at a depth of greater or equal to 1.0 foot.

The PAR for FRS No.4 and FRS No. 5 were estimated to be 16 and 37, respectively.

D.4.4 Statistical Storm Event Modeling

The effective FEMA Flood Zone along the portion of Middle Kickapoo Creek passing through Bronte is classified as Zone A and is effective as of March 4, 1986. As no existing models were available, new hydrologic and hydraulic models were developed for this study.

D.4.4.1 Hydrologic Modeling

Hydrologic modeling was performed using HEC-HMS for watersheds upstream of the confluence of West Kickapoo Creek and Middle Kickapoo Creek. Watersheds were delineated using 2019 LiDAR for areas that contribute to flooding along Middle Kickapoo Creek, including Middle Kickapoo Creek and East Kickapoo Creek. The extents are show in **Figure D-1**. The hydrologic modeling tasks performed are summarized as follows:

- Delineation of watersheds, including uncontrolled watersheds as well as watersheds controlled by Kickapoo FRS Nos. 3, 4, 5, and 6 (**Figure D-1**);
- Estimation of rainfall depths for the 24-hour duration events with 100%, 50%, 20%, 10%, 4%, 2%, 1%, and 0.2% AEP storm events using Atlas 14 rainfall data (**Table D.4-3)**;
- Estimation of watershed time of concentration (Tc) by applying the NRCS Velocity Method;
- Estimation of watershed runoff curve numbers(**Table D.4-4)**;
- Estimation of reach routing parameters using the Muskingum-Cunge method for the routing reaches;
- Use of SITES program to develop rating curves for Kickapoo FRS Nos. 3, 4, 5, and 6;
- Use of SITES program to evaluate rehabilitation alternatives for FRS No. 4 and FRS No. 5 and develop rating curves associated with each alternative; and
- Estimation of frequency storm peak flow rates using HEC-HMS 4.11.

During HEC-HMS model development, a potential split flow condition was identified at a location downstream of FRS No. 4 shown in **Figure D-1** that would result in flow bypassing FRS No. 5. Flow bypassing FRS No. 5 rejoins Middle Kickapoo Creek below FRS No. 5 at station 56665, shown in in **Figure D-3**. A 2D model was used to estimate the diversion rating curve at this location, which was modeled as a diversion element in HEC-HMS. The rating curve for this diversion is shown in **Table D.4-2**.

Table D.4-2. Middle Kickapoo Creek Split Flow Rating Curve

Inflow (CFS)	Outflow-to FRS. No. 5 (CFS)	Outflow-Bypassing (CFS)
0	0	0
50	50	0
100	100	0
200	200	0
300	298	2
400	388	12
500	474	25
600	552	37
700	649	50
800	736	64
900	821	79
1,000	905	95
2,000	1,636	364
3,000	2,424	576
4,000	3,219	781
4,500	3,619	881
5,000	4,021	979

Rainfall depths for the 24-hour duration event were obtained from Atlas-14 at the centroid of the study area (see **Table D.4-3**). The frequency storm method was used for rainfall distribution.

Table D.4-3. 24-hr Rainfall Depths

AEP	50%	10%	4%	2%	1%	0.2%
Rainfall Depth (in)	3.21	5.02	6.30	7.37	8.56	9.93

As stated above, time of concentration and lag time for each watershed were estimated by applying the NRCS Velocity Method. Curve numbers were estimated using the 2019 NLCD and SSURGO soils data accessed in 2020. Hydrologic parameters are shown in **Table D.4-4**.

Table D.4-4. Kickapoo River FRS No. 4 and No. 5 Summary of HEC-HMS Hydrologic Parameters

Subbasin Name	Area (sq-mi)	CN	Lag (Min)
Subbasin-01	0.346	60.0	60.87
Subbasin-02	0.753	67.2	26.69
Subbasin-03	0.808	68.8	16.13

Subbasin Name	Area (sq-mi)	CN	Lag (Min)
Subbasin-04	0.681	74.7	23.45
Subbasin-05a	5.274	71.3	130.73
Subbasin-05b	9.185	73.3	400.59
Subbasin-06	2.597	70.0	213.95
Subbasin-07	0.684	69.0	39.24
Subbasin-08	0.703	65.5	50.69
Subbasin-09	1.364	71.9	258.98
Subbasin-10	2.063	71.8	67.13
Subbasin-11	0.696	72.6	70.1
Subbasin-12	2.358	72.9	37.9
Subbasin-13	1.197	67.5	65.76
Subbasin-14a	5.017	70.7	59.95
Subbasin-14b	1.556	67.6	46.45
Subbasin-15	2.102	72.7	51.74
Subbasin-16	3.946	72.2	47.92

D.4.4.2 Hydraulic Modeling

A separate 1D hydraulic (HEC-RAS) model was developed for the section of the river downstream of each dam, with the upper section (Kickapoo 4) starting at the downstream toe of FRS No. 4 and terminating at the normal pool of FRS No. 5, and the lower section (Kickapoo 5) starting at the downstream toe of FRS No. 5 and terminating immediately upstream of the confluence of Middle Kickapoo Creek and West Kickapoo Creek to the south of Bronte, Texas.

The modeling tasks performed as follows:

- Hydraulic model cross-sections were cut from a terrain based on 2019 LiDAR at an average spacing of 425 feet (**Figure D-2** and **Figure D-3**);
- Manning's n values were assigned based on land use, imagery, "Manning's n Values for Various Land Covers To Use for Dam Breach Analyses by NRCS in Kansas" table, and engineering judgment;
- Ineffective flow areas defined within model cross-sections;
- Peak flow values input from HEC-HMS model;
- Cross culverts and bridge geometry input based on field measurements, notes, and photos gathered on 10/16/2020; and
- Estimation of downstream water surface elevations using the computer model HEC-RAS 6.3.

Peak flows values the HEC-HMS Hydrologic Model were applied to cross sections as shown in **Table D.4-5** ,**Table D.4-6**, **Table D.4-7**, and **Table D.4-8** below.

Table D.4-5. Model Peak Flows, Existing Conditions

AEP (%)		100	50	20	10	4	2	1	0.20
Existing Conditions		Flow in Cubic Feet per Second (CFS)							
Kickapoo 4 Station Number	19547.600	39	78	88	92	97	100	103	527
	12792.350	107	214	534	850	1300	1675	2101	3122
	9174.563	345	618	1350	1991	2873	3614	4425	6457
	3301.721	712	1316	2779	4001	5593	6741	7946	11468
Kickapoo 5 Station Number	57242.580	79	100	105	108	113	116	546	3417
	56337.660	85	164	463	670	947	1169	1411	4005
	52507.980	227	426	1014	1605	2398	3013	3670	5399
	51224.300	289	535	1237	1946	2907	3653	4448	6535
	47740.650	305	567	1290	2000	2963	3710	4506	6596
	43211.350	316	594	1375	2006	2789	3467	4230	6309
	41009.300	331	617	1423	2102	2985	3735	4573	6856
	39743.900	351	656	1512	2207	3104	3882	4757	7157
	26904.910	412	759	1728	2580	3756	4736	5463	7770
	15824.020	515	904	1990	2990	4575	5848	7255	15371
	15109.150	525	923	2028	3044	4640	5927	7342	15478
	11250.680	530	932	2036	2997	4510	5807	7126	15432
	4865.795	537	944	2065	3037	4562	5871	7204	15528
	2827.722	538	948	2075	3053	4539	5833	7180	15530

Table D.4-6. Model Peak Flows, Alternative 3

AEP (%)		100	50	20	10	4	2	1	0.20
Alternative 3		Flow in Cubic Feet per Second (CFS)							
Kickapoo 4 Station Number	19547.600	450	797	1729	2580	3744	4663	5635	8151
	12792.350	477	766	1748	2657	3944	4984	6109	9123
	9174.563	709	995	2030	3114	4675	5941	7301	11015
	3301.721	1016	1615	2988	4243	5749	6873	8340	13694
Kickapoo 5 Station Number	57242.580	233	260	284	300	319	519	1882	7156
	56337.660	249	337	623	828	1110	1337	2014	7645
	52507.980	289	493	1169	1769	2564	3182	3842	8115
	51224.300	307	566	1383	2111	3074	3822	4621	8312
	47740.650	330	603	1436	2165	3130	3879	4679	8730
	43211.350	338	631	1498	2110	2933	3631	4405	8190
	41009.300	378	666	1552	2218	3135	3901	4748	8992
	39743.900	386	692	1631	2311	3250	4046	4932	9100
	26904.910	462	828	1850	2703	3908	4901	5503	9503
	15824.020	665	1035	2121	3153	4753	6021	7689	15618

AEP (%)		100	50	20	10	4	2	1	0.20
Alternative 3		**Flow in Cubic Feet per Second (CFS)**							
	15109.150	672	1050	2158	3204	4817	6099	7737	15726
	11250.680	677	1059	2163	3142	4697	5995	7632	15670
	4865.795	682	1071	2191	3180	4749	6058	7677	15767
	2827.722	683	1074	2201	3191	4721	6024	7662	15768

Table D.4-7. Model Peak Flows, Alternative 9

AEP (%)		100	50	20	10	4	2	1	0.20
Alternative 9		**Flow in Cubic Feet per Second (CFS)**							
Kickapoo 4 Station Number	**19547.600**	40	79	88	92	97	100	251	1783
	12792.350	107	214	535	850	1301	1676	2101	3122
	9174.563	345	618	1350	1991	2874	3616	4425	6457
	3301.721	712	1316	2779	4001	5593	6741	7947	11467
Kickapoo 5 Station Number	**57242.580**	89	94	101	105	110	113	668	3670
	56337.660	122	213	465	666	941	1163	1406	4199
	52507.980	230	434	1054	1619	2395	3007	3665	5395
	51224.300	291	541	1281	1965	2905	3647	4443	6531
	47740.650	308	574	1333	2019	2961	3704	4501	6592
	43211.350	319	603	1410	2020	2796	3470	4228	6305
	41009.300	334	628	1458	2115	2991	3737	4570	6853
	39743.900	353	665	1546	2221	3110	3884	4755	7153
	26904.910	417	778	1753	2592	3761	4737	5463	7771
	15824.020	543	934	2008	2999	4577	5846	7253	15371
	15109.150	550	952	2046	3053	4642	5925	7341	15477
	11250.680	556	961	2051	3003	4512	5807	7125	15432
	4865.795	562	973	2080	3043	4565	5872	7203	15529
	2827.722	563	977	2090	3059	4541	5834	7179	15531

Table D.4-8. Model Peak Flows, Alternative 10

AEP (%)		100	50	20	10	4	2	1	0.20
Alternative 10		**Flow in Cubic Feet per Second (CFS)**							
Kickapoo 4 Station Number	**19547.600**	450	797	1729	2580	3744	4663	5635	8151
	12792.350	477	766	1748	2657	3944	4984	6109	9123
	9174.563	709	995	2030	3114	4675	5941	7301	11015
	3301.721	1016	1615	2988	4243	5749	6873	8340	13694

AEP (%)		100	50	20	10	4	2	1	0.20
Alternative 10		Flow in Cubic Feet per Second (CFS)							
Kickapoo 5 Station Number	57242.580	99	101	107	112	180	1073	2841	7731
	56337.660	112	177	465	671	947	1169	2996	8284
	52507.980	227	426	1015	1607	2400	3014	3671	8830
	51224.300	289	535	1238	1948	2909	3654	4449	9045
	47740.650	305	567	1291	2002	2965	3711	4507	9448
	43211.350	316	594	1375	2007	2792	3471	4232	8971
	41009.300	331	618	1424	2103	2987	3738	4575	9806
	39743.900	351	656	1513	2208	3106	3885	4759	9918
	26904.910	413	760	1729	2581	3758	4739	5464	10314
	15824.020	535	906	1991	2991	4577	5850	8727	16416
	15109.150	541	924	2029	3045	4642	5928	8777	16488
	11250.680	546	935	2037	2998	4512	5809	8656	16471
	4865.795	550	948	2065	3037	4564	5874	8701	16544
	2827.722	551	952	2076	3054	4540	5836	8667	16549

Water surface elevations for each of the frequency storm events are provided at each HEC-RAS 1D cross section in **Table D.4-9** through **Table D.4-16** for existing conditions, Alternative 3, Alternative 9, and Alternative 10 (the preferred alternative). See **Figures D-2 and D-3** for the approximate locations of the cross-sections.

Table D.4-9. 100% AEP Storm Event HEC-RAS 1D Water Surface Elevation Comparison

Model Location	Cross Section	100% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 4	19547.600	1967.53	1970.17	1967.54	1970.17
Kickapoo 4	19259.250	1967.22	1969.04	1967.22	1969.04
Kickapoo 4	18754.170	1960.00	1962.88	1960.04	1962.88
Kickapoo 4	18476.980	1959.98	1962.84	1960.03	1962.84
Kickapoo 4	18446.200	Existing Culvert-McDonald Road			
Kickapoo 4	18417.840	1957.64	1959.44	1957.65	1959.44
Kickapoo 4	18146.350	1953.38	1955.82	1953.39	1955.82
Kickapoo 4	17959.880	1952.90	1954.75	1952.91	1954.75
Kickapoo 4	17506.210	1949.36	1951.17	1949.37	1951.17
Kickapoo 4	17041.840	1948.77	1950.98	1948.78	1950.98
Kickapoo 4	16621.050	1948.73	1950.53	1948.74	1950.53
Kickapoo 4	16572.550	1948.60	1949.78	1948.61	1949.78
Kickapoo 4	16201.950	1944.95	1946.66	1944.96	1946.66
Kickapoo 4	15958.090	1943.31	1945.53	1943.32	1945.53
Kickapoo 4	15561.380	1941.87	1944.54	1941.88	1944.54

Model Location	Cross Section	100% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 4	15309.160	1939.95	1942.48	1939.95	1942.48
Kickapoo 4	15286.760	1939.37	1942.32	1939.39	1942.32
Kickapoo 4	14992.140	1937.74	1939.99	1937.75	1939.99
Kickapoo 4	14515.910	1935.27	1938.22	1935.28	1938.22
Kickapoo 4	14070.890	1934.36	1937.67	1934.38	1937.67
Kickapoo 4	13742.310	1933.23	1935.90	1933.25	1935.90
Kickapoo 4	13537.160	1932.94	1935.86	1932.95	1935.86
Kickapoo 4	13265.340	1932.71	1935.08	1932.71	1935.08
Kickapoo 4	13244.630	1932.69	1935.13	1932.69	1935.13
Kickapoo 4	12792.350	1931.58	1932.85	1931.58	1932.85
Kickapoo 4	12596.590	1930.31	1932.76	1930.31	1932.76
Kickapoo 4	12572.050	1930.32	1932.59	1930.32	1932.59
Kickapoo 4	12181.860	1928.77	1930.92	1928.77	1930.92
Kickapoo 4	11733.890	1927.60	1929.80	1927.60	1929.80
Kickapoo 4	11294.220	1926.30	1928.45	1926.30	1928.45
Kickapoo 4	10865.430	1922.17	1924.75	1922.17	1924.75
Kickapoo 4	10352.410	1919.75	1924.26	1919.75	1924.26
Kickapoo 4	9542.112	1918.88	1923.76	1918.88	1923.76
Kickapoo 4	9529.200	Existing Culvert-Nipple Peak Road			
Kickapoo 4	9516.422	1918.19	1920.08	1918.19	1920.08
Kickapoo 4	9174.563	1917.05	1918.77	1917.05	1918.77
Kickapoo 4	8677.874	1914.89	1916.40	1914.89	1916.40
Kickapoo 4	8370.359	1914.08	1915.94	1914.08	1915.94
Kickapoo 4	8085.566	1913.06	1914.93	1913.06	1914.93
Kickapoo 4	7673.817	1911.42	1913.18	1911.42	1913.18
Kickapoo 4	7127.514	1909.46	1911.33	1909.46	1911.33
Kickapoo 4	6360.571	1907.46	1909.51	1907.46	1909.51
Kickapoo 4	6039.239	1906.87	1908.76	1906.87	1908.76
Kickapoo 4	5707.882	1906.20	1907.78	1906.20	1907.78
Kickapoo 4	5544.297	1905.52	1907.06	1905.52	1907.06
Kickapoo 4	5523.448	1905.54	1907.10	1905.54	1907.10
Kickapoo 4	5076.510	1904.72	1906.31	1904.72	1906.31
Kickapoo 4	4753.666	1904.23	1905.79	1904.23	1905.79
Kickapoo 4	4483.647	1903.72	1905.08	1903.72	1905.08
Kickapoo 4	4240.891	1903.19	1904.17	1903.19	1904.17
Kickapoo 4	3775.772	1902.96	1903.73	1902.96	1903.73
Kickapoo 4	3536.016	1902.84	1903.44	1902.84	1903.44
Kickapoo 4	3301.721	1902.34	1902.94	1902.34	1902.94

Model Location	Cross Section	100% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 4	2743.317	1900.34	1901.22	1900.34	1901.22
Kickapoo 4	2097.358	1899.71	1900.59	1899.71	1900.59
Kickapoo 4	2037.804	1899.54	1900.43	1899.54	1900.43
Kickapoo 4	1488.130	1897.05	1897.42	1897.05	1897.42
Kickapoo 4	1137.432	1895.86	1896.21	1895.86	1896.21
Kickapoo 5	57242.5800	1874.30	1875.62	1874.41	1874.52
Kickapoo 5	56665.6800	1872.58	1873.41	1872.70	1872.73
Kickapoo 5	56337.6600	1869.58	1870.55	1869.85	1869.79
Kickapoo 5	56318.2000	Existing Bridge-Railroad Road			
Kickapoo 5	56308.0600	1869.25	1870.30	1869.53	1869.46
Kickapoo 5	55754.1200	1865.98	1867.01	1866.26	1866.20
Kickapoo 5	55114.7900	1864.10	1865.76	1864.55	1864.45
Kickapoo 5	54604.8200	1863.06	1864.79	1863.56	1863.44
Kickapoo 5	54041.7000	1862.11	1863.45	1862.48	1862.39
Kickapoo 5	53743.6900	1860.83	1862.33	1861.32	1861.22
Kickapoo 5	53244.6600	1860.15	1860.89	1860.26	1860.22
Kickapoo 5	52745.1500	1860.08	1860.55	1860.12	1860.09
Kickapoo 5	52507.9800	1859.82	1860.22	1859.84	1859.82
Kickapoo 5	52244.4200	1859.40	1859.78	1859.42	1859.40
Kickapoo 5	52024.5700	1859.31	1859.69	1859.32	1859.31
Kickapoo 5	51983.3000	Existing Bridge-Railroad Road			
Kickapoo 5	51952.4500	1859.23	1859.59	1859.24	1859.23
Kickapoo 5	51752.1000	1858.40	1858.66	1858.42	1858.40
Kickapoo 5	51694.0600	1857.94	1858.18	1857.95	1857.94
Kickapoo 5	51539.2700	1857.48	1857.61	1857.49	1857.48
Kickapoo 5	51224.3000	1856.03	1856.10	1856.04	1856.03
Kickapoo 5	50921.0700	1855.40	1855.49	1855.41	1855.40
Kickapoo 5	49976.6400	1853.91	1854.02	1853.92	1853.91
Kickapoo 5	49454.1900	1852.86	1852.97	1852.88	1852.86
Kickapoo 5	48796.6500	1851.84	1851.95	1851.85	1851.84
Kickapoo 5	48070.1900	1850.46	1850.61	1850.48	1850.46
Kickapoo 5	47740.6500	1849.84	1849.98	1849.86	1849.84
Kickapoo 5	47387.6300	1849.38	1849.51	1849.39	1849.38
Kickapoo 5	46701.9000	1848.67	1848.80	1848.68	1848.67
Kickapoo 5	45992.4100	1847.47	1847.59	1847.48	1847.47
Kickapoo 5	45958.8000	1846.46	1846.52	1846.47	1846.46
Kickapoo 5	45290.0000	1843.98	1844.13	1843.99	1843.98
Kickapoo 5	44497.8200	1842.55	1842.67	1842.56	1842.55

Model Location	Cross Section	100% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 5	44195.5400	1841.85	1841.97	1841.86	1841.85
Kickapoo 5	43929.1500	1841.35	1841.47	1841.36	1841.35
Kickapoo 5	43211.3500	1839.63	1839.74	1839.65	1839.63
Kickapoo 5	42642.4300	1837.42	1837.57	1837.44	1837.42
Kickapoo 5	42254.6800	1836.86	1837.04	1836.88	1836.86
Kickapoo 5	41790.5700	1836.36	1836.55	1836.38	1836.36
Kickapoo 5	41009.3000	1834.48	1834.65	1834.49	1834.48
Kickapoo 5	40984.0000	Existing Bridge-Railroad Road			
Kickapoo 5	40854.2100	1833.32	1833.55	1833.34	1833.32
Kickapoo 5	40742.4400	1832.90	1833.12	1832.91	1832.90
Kickapoo 5	39981.9800	1831.22	1831.39	1831.23	1831.22
Kickapoo 5	39743.9000	1830.75	1830.93	1830.77	1830.75
Kickapoo 5	39527.2600	1830.50	1830.66	1830.51	1830.50
Kickapoo 5	39272.5000	1830.21	1830.35	1830.23	1830.21
Kickapoo 5	38825.8200	1830.27	1830.42	1830.28	1830.27
Kickapoo 5	38755.5500	1830.15	1830.29	1830.16	1830.15
Kickapoo 5	38202.5800	1828.46	1828.62	1828.47	1828.46
Kickapoo 5	38157.2000	1828.24	1828.38	1828.25	1828.24
Kickapoo 5	37239.8500	1825.63	1825.80	1825.64	1825.63
Kickapoo 5	37120.3500	1825.68	1825.85	1825.69	1825.68
Kickapoo 5	36929.8100	1825.47	1825.63	1825.48	1825.47
Kickapoo 5	36651.9700	1824.52	1824.70	1824.53	1824.52
Kickapoo 5	36346.2300	1823.60	1823.81	1823.62	1823.60
Kickapoo 5	35838.5000	1822.68	1822.89	1822.70	1822.68
Kickapoo 5	35444.1900	1821.78	1821.98	1821.80	1821.78
Kickapoo 5	35239.5700	1821.42	1821.61	1821.43	1821.42
Kickapoo 5	34781.5500	1820.52	1820.71	1820.53	1820.52
Kickapoo 5	34443.2400	1819.85	1820.05	1819.87	1819.85
Kickapoo 5	33446.0900	1817.99	1818.17	1818.00	1817.99
Kickapoo 5	32833.7200	1817.32	1817.50	1817.33	1817.32
Kickapoo 5	32756.4800	1817.04	1817.23	1817.05	1817.04
Kickapoo 5	32313.4100	1816.12	1816.35	1816.14	1816.12
Kickapoo 5	30512.4200	1813.39	1813.59	1813.41	1813.39
Kickapoo 5	29815.1300	1811.73	1811.89	1811.74	1811.73
Kickapoo 5	29076.5400	1810.21	1810.29	1810.21	1810.21
Kickapoo 5	28458.6400	1808.14	1808.31	1808.16	1808.14
Kickapoo 5	28380.5000	1807.94	1808.12	1807.96	1807.94
Kickapoo 5	27848.7300	1807.19	1807.40	1807.21	1807.20

Model Location	Cross Section	100% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 5	27489.2100	1806.60	1806.79	1806.62	1806.60
Kickapoo 5	26904.9100	1804.67	1804.85	1804.69	1804.67
Kickapoo 5	25805.1300	1801.31	1801.58	1801.34	1801.31
Kickapoo 5	25790.5600	1801.34	1801.61	1801.37	1801.34
Kickapoo 5	25374.0100	1800.38	1800.62	1800.40	1800.38
Kickapoo 5	25039.8500	1799.55	1799.78	1799.58	1799.55
Kickapoo 5	24776.5900	1798.99	1799.22	1799.02	1798.99
Kickapoo 5	24326.6600	1798.09	1798.28	1798.10	1798.09
Kickapoo 5	23696.8800	1796.27	1796.51	1796.30	1796.27
Kickapoo 5	23243.9700	1795.23	1795.48	1795.25	1795.23
Kickapoo 5	22629.9100	1793.98	1794.17	1794.00	1793.98
Kickapoo 5	22030.0900	1792.10	1792.26	1792.11	1792.10
Kickapoo 5	21091.7500	1790.09	1790.24	1790.11	1790.09
Kickapoo 5	20534.8800	1787.64	1787.74	1787.64	1787.64
Kickapoo 5	19937.8400	1784.85	1784.94	1784.86	1784.85
Kickapoo 5	19873.6000	Existing Bridge-US 277			
Kickapoo 5	19835.1100	1784.49	1784.59	1784.50	1784.50
Kickapoo 5	19631.1200	1784.11	1784.26	1784.12	1784.11
Kickapoo 5	19102.9600	1782.97	1783.17	1782.99	1782.97
Kickapoo 5	18790.5500	1782.34	1782.51	1782.36	1782.34
Kickapoo 5	18548.0200	1781.83	1781.90	1781.83	1781.83
Kickapoo 5	18194.4600	1781.68	1781.73	1781.68	1781.68
Kickapoo 5	18167.8000	Existing Bridge-E Main Street			
Kickapoo 5	18140.6600	1781.65	1781.69	1781.65	1781.65
Kickapoo 5	17150.5800	1781.51	1781.51	1781.50	1781.51
Kickapoo 5	16802.4300	1775.19	1775.56	1775.25	1775.22
Kickapoo 5	16527.5400	1774.71	1775.14	1774.79	1774.76
Kickapoo 5	15824.0200	1773.65	1774.05	1773.73	1773.70
Kickapoo 5	15796.9000	Existing Bridge-E Oliver Avenue			
Kickapoo 5	15775.4100	1773.48	1773.86	1773.56	1773.53
Kickapoo 5	15513.0900	1771.59	1771.83	1771.62	1771.62
Kickapoo 5	15484.3000	1769.80	1770.27	1769.88	1769.85
Kickapoo 5	15109.1500	1768.96	1769.34	1769.03	1769.00
Kickapoo 5	14720.6700	1767.39	1767.79	1767.46	1767.43
Kickapoo 5	14307.9500	1765.77	1766.12	1765.83	1765.81
Kickapoo 5	13908.3900	1764.73	1765.03	1764.78	1764.76
Kickapoo 5	13069.3300	1763.70	1763.90	1763.73	1763.72
Kickapoo 5	13026.5000	Existing Bridge-SH 158			

Model Location	Cross Section	100% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 5	12998.6000	1762.89	1763.06	1762.92	1762.91
Kickapoo 5	12367.0600	1760.02	1760.51	1760.11	1760.08
Kickapoo 5	11629.0400	1758.70	1759.01	1758.76	1758.74
Kickapoo 5	11583.8300	1758.66	1758.96	1758.72	1758.70
Kickapoo 5	11250.6800	1757.77	1758.20	1757.85	1757.82
Kickapoo 5	9396.1250	1754.90	1755.25	1754.96	1754.94
Kickapoo 5	7881.1570	1753.88	1754.12	1753.93	1753.91
Kickapoo 5	4865.7950	1749.84	1750.07	1749.88	1749.87
Kickapoo 5	2827.7220	1744.00	1744.26	1744.05	1744.03
Kickapoo 5	1312.8390	1739.71	1739.98	1739.76	1739.73
Kickapoo 5	552.9967	1737.37	1737.82	1737.43	1737.40
Kickapoo 5	504.9114	1737.03	1737.47	1737.08	1737.06

Table D.4-10. 50% AEP Storm Event HEC-RAS 1D Water Surface Elevation Comparison

Model Location	Cross Section	50% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 4	19547.600	1968.00	1971.39	1968.00	1971.39
Kickapoo 4	19259.250	1967.54	1969.86	1967.54	1969.86
Kickapoo 4	18754.170	1961.67	1963.37	1961.67	1963.37
Kickapoo 4	18476.980	1961.67	1963.29	1961.67	1963.29
Kickapoo 4	18446.200	Existing Culvert-McDonald Road			
Kickapoo 4	18417.840	1957.96	1960.28	1957.96	1960.28
Kickapoo 4	18146.350	1953.84	1956.92	1953.85	1956.92
Kickapoo 4	17959.880	1953.29	1955.36	1953.30	1955.36
Kickapoo 4	17506.210	1949.61	1952.42	1949.61	1952.42
Kickapoo 4	17041.840	1949.13	1952.09	1949.14	1952.09
Kickapoo 4	16621.050	1949.04	1951.40	1949.04	1951.40
Kickapoo 4	16572.550	1948.83	1950.43	1948.84	1950.43
Kickapoo 4	16201.950	1945.21	1947.62	1945.21	1947.62
Kickapoo 4	15958.090	1943.71	1946.56	1943.71	1946.56
Kickapoo 4	15561.380	1942.34	1945.06	1942.34	1945.06
Kickapoo 4	15309.160	1940.37	1943.77	1940.38	1943.77
Kickapoo 4	15286.760	1940.04	1942.71	1940.05	1942.71
Kickapoo 4	14992.140	1938.15	1940.59	1938.15	1940.59
Kickapoo 4	14515.910	1935.85	1938.52	1935.86	1938.52
Kickapoo 4	14070.890	1934.92	1937.92	1934.92	1937.92

Model Location	Cross Section	50% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 4	13742.310	1934.06	1936.42	1934.06	1936.42
Kickapoo 4	13537.160	1933.85	1935.98	1933.85	1935.98
Kickapoo 4	13265.340	1933.69	1935.44	1933.69	1935.44
Kickapoo 4	13244.630	1933.67	1935.27	1933.67	1935.27
Kickapoo 4	12792.350	1931.92	1933.70	1931.92	1933.70
Kickapoo 4	12596.590	1931.36	1933.19	1931.36	1933.19
Kickapoo 4	12572.050	1931.29	1933.10	1931.29	1933.10
Kickapoo 4	12181.860	1930.17	1931.65	1930.17	1931.65
Kickapoo 4	11733.890	1929.04	1929.94	1929.04	1929.94
Kickapoo 4	11294.220	1927.56	1928.90	1927.56	1928.90
Kickapoo 4	10865.430	1923.11	1925.74	1923.11	1925.74
Kickapoo 4	10352.410	1921.38	1924.77	1921.38	1924.77
Kickapoo 4	9542.112	1920.85	1923.58	1920.85	1923.58
Kickapoo 4	9529.200	Existing Culvert-Nipple Peak Road			
Kickapoo 4	9516.422	1919.64	1921.48	1919.64	1921.48
Kickapoo 4	9174.563	1918.40	1920.05	1918.40	1920.05
Kickapoo 4	8677.874	1916.05	1917.39	1916.05	1917.39
Kickapoo 4	8370.359	1915.53	1917.07	1915.53	1917.07
Kickapoo 4	8085.566	1914.51	1916.11	1914.51	1916.11
Kickapoo 4	7673.817	1912.79	1914.24	1912.79	1914.24
Kickapoo 4	7127.514	1910.89	1911.64	1910.89	1911.64
Kickapoo 4	6360.571	1909.02	1910.53	1909.02	1910.53
Kickapoo 4	6039.239	1908.34	1909.78	1908.34	1909.78
Kickapoo 4	5707.882	1907.46	1908.62	1907.46	1908.62
Kickapoo 4	5544.297	1906.77	1907.81	1906.77	1907.81
Kickapoo 4	5523.448	1906.80	1907.86	1906.80	1907.86
Kickapoo 4	5076.510	1906.04	1907.03	1906.04	1907.03
Kickapoo 4	4753.666	1905.56	1906.45	1905.56	1906.45
Kickapoo 4	4483.647	1904.92	1905.68	1904.92	1905.68
Kickapoo 4	4240.891	1904.28	1904.92	1904.28	1904.92
Kickapoo 4	3775.772	1904.06	1904.59	1904.06	1904.59
Kickapoo 4	3536.016	1903.91	1904.35	1903.91	1904.35
Kickapoo 4	3301.721	1903.49	1903.96	1903.49	1903.96
Kickapoo 4	2743.317	1901.79	1902.23	1901.79	1902.23
Kickapoo 4	2097.358	1901.00	1901.25	1901.00	1901.25
Kickapoo 4	2037.804	1900.91	1901.18	1900.91	1901.18
Kickapoo 4	1488.130	1897.91	1898.66	1897.91	1898.66
Kickapoo 4	1137.432	1896.50	1896.76	1896.50	1896.76

Model Location	Cross Section	50% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 5	57242.5800	1874.51	1875.76	1874.42	1874.52
Kickapoo 5	56665.6800	1872.83	1873.61	1872.90	1872.86
Kickapoo 5	56337.6600	1870.11	1870.92	1870.38	1870.18
Kickapoo 5	56318.2000	Existing Bridge-Railroad Road			
Kickapoo 5	56308.0600	1869.82	1870.71	1870.11	1869.90
Kickapoo 5	55754.1200	1866.54	1867.46	1866.82	1866.62
Kickapoo 5	55114.7900	1865.01	1866.42	1865.46	1865.13
Kickapoo 5	54604.8200	1864.03	1865.43	1864.49	1864.16
Kickapoo 5	54041.7000	1862.84	1863.95	1863.21	1862.95
Kickapoo 5	53743.6900	1861.82	1862.84	1862.13	1861.90
Kickapoo 5	53244.6600	1861.39	1861.88	1861.48	1861.40
Kickapoo 5	52745.1500	1861.32	1861.69	1861.37	1861.32
Kickapoo 5	52507.9800	1860.99	1861.31	1861.03	1860.99
Kickapoo 5	52244.4200	1860.49	1860.79	1860.53	1860.49
Kickapoo 5	52024.5700	1860.42	1860.73	1860.45	1860.42
Kickapoo 5	51983.3000	Existing Bridge-Railroad Road			
Kickapoo 5	51952.4500	1860.29	1860.59	1860.33	1860.29
Kickapoo 5	51752.1000	1859.14	1859.35	1859.17	1859.14
Kickapoo 5	51694.0600	1858.65	1858.83	1858.67	1858.65
Kickapoo 5	51539.2700	1858.16	1858.27	1858.18	1858.16
Kickapoo 5	51224.3000	1856.94	1857.05	1856.96	1856.94
Kickapoo 5	50921.0700	1856.55	1856.69	1856.58	1856.55
Kickapoo 5	49976.6400	1855.28	1855.43	1855.31	1855.28
Kickapoo 5	49454.1900	1854.17	1854.31	1854.20	1854.17
Kickapoo 5	48796.6500	1853.11	1853.25	1853.14	1853.11
Kickapoo 5	48070.1900	1851.79	1851.95	1851.83	1851.79
Kickapoo 5	47740.6500	1851.07	1851.20	1851.09	1851.07
Kickapoo 5	47387.6300	1850.58	1850.71	1850.60	1850.58
Kickapoo 5	46701.9000	1849.72	1849.84	1849.75	1849.72
Kickapoo 5	45992.4100	1848.42	1848.54	1848.45	1848.42
Kickapoo 5	45958.8000	1847.21	1847.29	1847.23	1847.21
Kickapoo 5	45290.0000	1845.28	1845.43	1845.31	1845.28
Kickapoo 5	44497.8200	1843.69	1843.82	1843.71	1843.69
Kickapoo 5	44195.5400	1843.05	1843.19	1843.09	1843.05
Kickapoo 5	43929.1500	1842.61	1842.76	1842.65	1842.61
Kickapoo 5	43211.3500	1840.95	1841.08	1840.98	1840.95
Kickapoo 5	42642.4300	1838.86	1839.03	1838.90	1838.86
Kickapoo 5	42254.6800	1838.27	1838.44	1838.31	1838.27

Model Location	Cross Section	50% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 5	41790.5700	1837.60	1837.76	1837.64	1837.60
Kickapoo 5	41009.3000	1835.27	1835.38	1835.30	1835.27
Kickapoo 5	40984.0000	Existing Bridge-Railroad Road			
Kickapoo 5	40854.2100	1834.55	1834.72	1834.59	1834.55
Kickapoo 5	40742.4400	1834.06	1834.23	1834.10	1834.06
Kickapoo 5	39981.9800	1832.50	1832.63	1832.53	1832.50
Kickapoo 5	39743.9000	1832.07	1832.21	1832.11	1832.07
Kickapoo 5	39527.2600	1831.73	1831.85	1831.76	1831.73
Kickapoo 5	39272.5000	1831.28	1831.39	1831.31	1831.28
Kickapoo 5	38825.8200	1831.39	1831.51	1831.42	1831.39
Kickapoo 5	38755.5500	1831.26	1831.37	1831.29	1831.26
Kickapoo 5	38202.5800	1829.67	1829.79	1829.70	1829.67
Kickapoo 5	38157.2000	1829.31	1829.42	1829.34	1829.31
Kickapoo 5	37239.8500	1826.95	1827.08	1826.98	1826.95
Kickapoo 5	37120.3500	1827.00	1827.14	1827.03	1827.00
Kickapoo 5	36929.8100	1826.69	1826.82	1826.73	1826.69
Kickapoo 5	36651.9700	1825.91	1826.06	1825.95	1825.91
Kickapoo 5	36346.2300	1825.18	1825.34	1825.22	1825.18
Kickapoo 5	35838.5000	1824.21	1824.36	1824.24	1824.21
Kickapoo 5	35444.1900	1823.32	1823.47	1823.35	1823.32
Kickapoo 5	35239.5700	1822.86	1823.01	1822.90	1822.86
Kickapoo 5	34781.5500	1821.99	1822.14	1822.03	1821.99
Kickapoo 5	34443.2400	1821.37	1821.52	1821.41	1821.37
Kickapoo 5	33446.0900	1819.39	1819.54	1819.43	1819.39
Kickapoo 5	32833.7200	1818.76	1818.91	1818.80	1818.76
Kickapoo 5	32756.4800	1818.56	1818.71	1818.59	1818.56
Kickapoo 5	32313.4100	1817.83	1818.00	1817.87	1817.83
Kickapoo 5	30512.4200	1814.87	1815.02	1814.91	1814.87
Kickapoo 5	29815.1300	1812.88	1812.98	1812.90	1812.88
Kickapoo 5	29076.5400	1810.87	1810.95	1810.89	1810.87
Kickapoo 5	28458.6400	1809.42	1809.54	1809.45	1809.42
Kickapoo 5	28380.5000	1809.25	1809.37	1809.28	1809.25
Kickapoo 5	27848.7300	1808.61	1808.72	1808.63	1808.61
Kickapoo 5	27489.2100	1807.98	1808.11	1808.01	1807.98
Kickapoo 5	26904.9100	1805.92	1806.13	1805.97	1805.92
Kickapoo 5	25805.1300	1802.39	1802.58	1802.45	1802.39
Kickapoo 5	25790.5600	1802.44	1802.63	1802.49	1802.44
Kickapoo 5	25374.0100	1801.91	1802.14	1801.97	1801.91

Model Location	Cross Section	50% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 5	25039.8500	1800.96	1801.20	1801.03	1800.96
Kickapoo 5	24776.5900	1800.41	1800.65	1800.48	1800.41
Kickapoo 5	24326.6600	1799.27	1799.47	1799.32	1799.27
Kickapoo 5	23696.8800	1797.70	1797.94	1797.76	1797.70
Kickapoo 5	23243.9700	1796.73	1796.98	1796.80	1796.73
Kickapoo 5	22629.9100	1795.17	1795.36	1795.22	1795.17
Kickapoo 5	22030.0900	1793.09	1793.25	1793.13	1793.09
Kickapoo 5	21091.7500	1791.00	1791.15	1791.05	1791.00
Kickapoo 5	20534.8800	1788.27	1788.38	1788.30	1788.27
Kickapoo 5	19937.8400	1785.52	1785.68	1785.56	1785.52
Kickapoo 5	19873.6000	Existing Bridge-US 277			
Kickapoo 5	19835.1100	1785.31	1785.50	1785.36	1785.31
Kickapoo 5	19631.1200	1785.17	1785.37	1785.22	1785.17
Kickapoo 5	19102.9600	1784.23	1784.44	1784.29	1784.23
Kickapoo 5	18790.5500	1783.47	1783.69	1783.53	1783.48
Kickapoo 5	18548.0200	1782.29	1782.37	1782.31	1782.29
Kickapoo 5	18194.4600	1782.08	1782.17	1782.10	1782.08
Kickapoo 5	18167.8000	Existing Bridge-E Main Street			
Kickapoo 5	18140.6600	1781.96	1782.03	1781.97	1781.96
Kickapoo 5	17150.5800	1781.51	1781.50	1781.50	1781.51
Kickapoo 5	16802.4300	1776.53	1776.80	1776.60	1776.53
Kickapoo 5	16527.5400	1775.91	1776.21	1775.99	1775.92
Kickapoo 5	15824.0200	1774.55	1774.80	1774.61	1774.55
Kickapoo 5	15796.9000	Existing Bridge-E Oliver Avenue			
Kickapoo 5	15775.4100	1774.35	1774.59	1774.41	1774.35
Kickapoo 5	15513.0900	1772.22	1772.41	1772.26	1772.22
Kickapoo 5	15484.3000	1770.95	1771.26	1771.02	1770.95
Kickapoo 5	15109.1500	1769.88	1770.13	1769.94	1769.89
Kickapoo 5	14720.6700	1768.38	1768.66	1768.44	1768.38
Kickapoo 5	14307.9500	1766.64	1766.87	1766.69	1766.64
Kickapoo 5	13908.3900	1765.48	1765.67	1765.53	1765.48
Kickapoo 5	13069.3300	1764.22	1764.37	1764.25	1764.22
Kickapoo 5	13026.5000	Existing Bridge-SH 158			
Kickapoo 5	12998.6000	1763.34	1763.49	1763.37	1763.34
Kickapoo 5	12367.0600	1761.25	1761.55	1761.31	1761.25
Kickapoo 5	11629.0400	1759.50	1759.73	1759.55	1759.51
Kickapoo 5	11583.8300	1759.46	1759.69	1759.52	1759.47
Kickapoo 5	11250.6800	1758.81	1759.07	1758.87	1758.82

Model Location	Cross Section	50% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 5	9396.1250	1755.77	1756.00	1755.83	1755.78
Kickapoo 5	7881.1570	1754.48	1754.65	1754.52	1754.49
Kickapoo 5	4865.7950	1750.40	1750.57	1750.44	1750.41
Kickapoo 5	2827.7220	1744.73	1744.92	1744.77	1744.73
Kickapoo 5	1312.8390	1740.31	1740.47	1740.35	1740.32
Kickapoo 5	552.9967	1738.30	1738.51	1738.35	1738.31
Kickapoo 5	504.9114	1737.93	1738.12	1737.97	1737.93

Table D.4-11. 20% AEP Storm Event HEC-RAS 1D Water Surface Elevation Comparison

Model Location	Cross Section	20% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 4	19547.600	1968.10	1973.35	1968.10	1973.35
Kickapoo 4	19259.250	1967.61	1971.70	1967.61	1971.70
Kickapoo 4	18754.170	1961.79	1964.37	1961.79	1964.37
Kickapoo 4	18476.980	1961.79	1964.19	1961.79	1964.19
Kickapoo 4	18446.200	Existing Culvert-McDonald Road			
Kickapoo 4	18417.840	1958.03	1961.41	1958.03	1961.41
Kickapoo 4	18146.350	1953.94	1958.95	1953.94	1958.95
Kickapoo 4	17959.880	1953.38	1956.81	1953.38	1956.81
Kickapoo 4	17506.210	1949.66	1954.61	1949.66	1954.61
Kickapoo 4	17041.840	1949.21	1954.21	1949.21	1954.21
Kickapoo 4	16621.050	1949.10	1953.08	1949.10	1953.08
Kickapoo 4	16572.550	1948.88	1951.82	1948.88	1951.82
Kickapoo 4	16201.950	1945.27	1949.34	1945.27	1949.34
Kickapoo 4	15958.090	1943.79	1947.58	1943.79	1947.58
Kickapoo 4	15561.380	1942.44	1945.87	1942.44	1945.87
Kickapoo 4	15309.160	1940.47	1944.38	1940.47	1944.38
Kickapoo 4	15286.760	1940.19	1943.66	1940.19	1943.66
Kickapoo 4	14992.140	1938.24	1941.26	1938.24	1941.26
Kickapoo 4	14515.910	1936.02	1939.45	1936.02	1939.45
Kickapoo 4	14070.890	1935.37	1938.80	1935.37	1938.80
Kickapoo 4	13742.310	1935.11	1937.17	1935.11	1937.17
Kickapoo 4	13537.160	1935.05	1936.71	1935.05	1936.71
Kickapoo 4	13265.340	1934.94	1935.79	1934.94	1935.79
Kickapoo 4	13244.630	1934.94	1935.70	1934.94	1935.70
Kickapoo 4	12792.350	1933.15	1934.69	1933.14	1934.69

Model Location	Cross Section	20% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 4	12596.590	1932.97	1934.37	1932.97	1934.37
Kickapoo 4	12572.050	1932.71	1934.26	1932.71	1934.26
Kickapoo 4	12181.860	1931.24	1932.72	1931.24	1932.72
Kickapoo 4	11733.890	1929.67	1931.00	1929.67	1931.00
Kickapoo 4	11294.220	1928.66	1929.37	1928.67	1929.37
Kickapoo 4	10865.430	1924.99	1927.77	1924.98	1927.77
Kickapoo 4	10352.410	1924.35	1925.66	1924.35	1925.66
Kickapoo 4	9542.112	1923.74	1925.26	1923.73	1925.26
Kickapoo 4	9529.200	Existing Culvert-Nipple Peak Road			
Kickapoo 4	9516.422	1922.59	1924.10	1922.59	1924.10
Kickapoo 4	9174.563	1921.23	1922.27	1921.23	1922.27
Kickapoo 4	8677.874	1918.21	1919.12	1918.21	1919.12
Kickapoo 4	8370.359	1917.89	1918.59	1917.89	1918.59
Kickapoo 4	8085.566	1916.87	1918.05	1916.87	1918.05
Kickapoo 4	7673.817	1915.18	1916.41	1915.18	1916.41
Kickapoo 4	7127.514	1912.43	1913.75	1912.43	1913.75
Kickapoo 4	6360.571	1911.41	1912.46	1911.41	1912.46
Kickapoo 4	6039.239	1910.62	1911.32	1910.62	1911.32
Kickapoo 4	5707.882	1909.14	1910.03	1909.14	1910.03
Kickapoo 4	5544.297	1908.80	1909.51	1908.80	1909.51
Kickapoo 4	5523.448	1908.54	1909.46	1908.54	1909.46
Kickapoo 4	5076.510	1907.64	1908.51	1907.64	1908.51
Kickapoo 4	4753.666	1906.99	1907.76	1906.99	1907.76
Kickapoo 4	4483.647	1906.26	1906.99	1906.26	1906.99
Kickapoo 4	4240.891	1905.53	1906.04	1905.53	1906.04
Kickapoo 4	3775.772	1905.22	1905.52	1905.22	1905.52
Kickapoo 4	3536.016	1905.04	1905.17	1905.04	1905.17
Kickapoo 4	3301.721	1904.60	1904.70	1904.60	1904.70
Kickapoo 4	2743.317	1903.09	1903.22	1903.09	1903.22
Kickapoo 4	2097.358	1902.09	1902.24	1902.09	1902.24
Kickapoo 4	2037.804	1901.98	1902.15	1901.98	1902.15
Kickapoo 4	1488.130	1899.63	1899.64	1899.63	1899.64
Kickapoo 4	1137.432	1896.47	1896.56	1896.47	1896.56
Kickapoo 5	57242.5800	1874.45	1875.78	1874.41	1874.47
Kickapoo 5	56665.6800	1873.54	1874.20	1873.53	1873.54
Kickapoo 5	56337.6600	1871.37	1871.84	1871.37	1871.37
Kickapoo 5	56318.2000	Existing Bridge-Railroad Road			
Kickapoo 5	56308.0600	1871.22	1871.82	1871.23	1871.23

Model Location	Cross Section	20% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 5	55754.1200	1868.07	1868.78	1868.07	1868.07
Kickapoo 5	55114.7900	1867.24	1868.11	1867.26	1867.25
Kickapoo 5	54604.8200	1866.25	1867.05	1866.26	1866.25
Kickapoo 5	54041.7000	1864.81	1865.44	1864.87	1864.81
Kickapoo 5	53743.6900	1864.21	1864.81	1864.31	1864.22
Kickapoo 5	53244.6600	1863.86	1864.38	1863.99	1863.86
Kickapoo 5	52745.1500	1863.79	1864.28	1863.92	1863.79
Kickapoo 5	52507.9800	1863.34	1863.82	1863.46	1863.34
Kickapoo 5	52244.4200	1862.64	1863.09	1862.76	1862.64
Kickapoo 5	52024.5700	1862.65	1863.11	1862.77	1862.65
Kickapoo 5	51983.3000	Existing Bridge-Railroad Road			
Kickapoo 5	51952.4500	1862.42	1862.87	1862.54	1862.43
Kickapoo 5	51752.1000	1860.64	1860.96	1860.73	1860.65
Kickapoo 5	51694.0600	1860.10	1860.39	1860.18	1860.10
Kickapoo 5	51539.2700	1859.88	1860.23	1859.99	1859.88
Kickapoo 5	51224.3000	1859.31	1859.74	1859.44	1859.31
Kickapoo 5	50921.0700	1859.11	1859.56	1859.25	1859.11
Kickapoo 5	49976.6400	1857.96	1858.40	1858.09	1857.96
Kickapoo 5	49454.1900	1856.64	1857.04	1856.76	1856.64
Kickapoo 5	48796.6500	1855.49	1855.88	1855.61	1855.49
Kickapoo 5	48070.1900	1854.20	1854.57	1854.31	1854.20
Kickapoo 5	47740.6500	1853.17	1853.50	1853.27	1853.17
Kickapoo 5	47387.6300	1852.71	1853.05	1852.82	1852.72
Kickapoo 5	46701.9000	1851.55	1851.84	1851.64	1851.55
Kickapoo 5	45992.4100	1850.02	1850.26	1850.08	1850.02
Kickapoo 5	45958.8000	1849.00	1849.42	1849.13	1849.00
Kickapoo 5	45290.0000	1847.72	1848.10	1847.83	1847.72
Kickapoo 5	44497.8200	1846.02	1846.34	1846.11	1846.02
Kickapoo 5	44195.5400	1845.40	1845.73	1845.50	1845.40
Kickapoo 5	43929.1500	1844.98	1845.30	1845.07	1844.98
Kickapoo 5	43211.3500	1842.75	1842.98	1842.82	1842.75
Kickapoo 5	42642.4300	1841.55	1841.83	1841.63	1841.55
Kickapoo 5	42254.6800	1840.92	1841.17	1840.99	1840.92
Kickapoo 5	41790.5700	1839.94	1840.15	1840.00	1839.94
Kickapoo 5	41009.3000	1836.99	1837.30	1837.08	1836.99
Kickapoo 5	40984.0000	Existing Bridge-Railroad Road			
Kickapoo 5	40854.2100	1837.02	1837.34	1837.11	1837.03
Kickapoo 5	40742.4400	1836.46	1836.77	1836.55	1836.46

Model Location	Cross Section	20% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 5	39981.9800	1835.10	1835.41	1835.19	1835.10
Kickapoo 5	39743.9000	1834.76	1835.08	1834.85	1834.76
Kickapoo 5	39527.2600	1834.26	1834.57	1834.35	1834.26
Kickapoo 5	39272.5000	1833.57	1833.87	1833.66	1833.57
Kickapoo 5	38825.8200	1833.79	1834.09	1833.87	1833.79
Kickapoo 5	38755.5500	1833.65	1833.95	1833.74	1833.65
Kickapoo 5	38202.5800	1832.09	1832.38	1832.17	1832.09
Kickapoo 5	38157.2000	1831.38	1831.63	1831.46	1831.39
Kickapoo 5	37239.8500	1829.67	1830.01	1829.77	1829.67
Kickapoo 5	37120.3500	1829.74	1830.08	1829.84	1829.74
Kickapoo 5	36929.8100	1829.28	1829.62	1829.37	1829.28
Kickapoo 5	36651.9700	1828.76	1829.11	1828.85	1828.76
Kickapoo 5	36346.2300	1828.24	1828.60	1828.34	1828.24
Kickapoo 5	35838.5000	1827.19	1827.54	1827.29	1827.19
Kickapoo 5	35444.1900	1826.37	1826.72	1826.47	1826.37
Kickapoo 5	35239.5700	1825.69	1826.01	1825.79	1825.70
Kickapoo 5	34781.5500	1824.90	1825.22	1824.99	1824.90
Kickapoo 5	34443.2400	1824.34	1824.66	1824.43	1824.34
Kickapoo 5	33446.0900	1822.43	1822.71	1822.51	1822.43
Kickapoo 5	32833.7200	1822.01	1822.29	1822.09	1822.02
Kickapoo 5	32756.4800	1821.88	1822.16	1821.96	1821.88
Kickapoo 5	32313.4100	1821.32	1821.57	1821.39	1821.32
Kickapoo 5	30512.4200	1818.05	1818.29	1818.13	1818.06
Kickapoo 5	29815.1300	1814.78	1814.98	1814.84	1814.78
Kickapoo 5	29076.5400	1812.46	1812.66	1812.52	1812.46
Kickapoo 5	28458.6400	1811.64	1811.88	1811.70	1811.64
Kickapoo 5	28380.5000	1811.41	1811.64	1811.47	1811.41
Kickapoo 5	27848.7300	1810.57	1810.80	1810.63	1810.57
Kickapoo 5	27489.2100	1809.92	1810.15	1809.97	1809.92
Kickapoo 5	26904.9100	1808.34	1808.59	1808.39	1808.34
Kickapoo 5	25805.1300	1804.70	1804.96	1804.75	1804.70
Kickapoo 5	25790.5600	1804.75	1805.00	1804.80	1804.75
Kickapoo 5	25374.0100	1804.70	1804.99	1804.76	1804.70
Kickapoo 5	25039.8500	1803.65	1803.92	1803.70	1803.65
Kickapoo 5	24776.5900	1803.14	1803.42	1803.20	1803.14
Kickapoo 5	24326.6600	1801.60	1801.83	1801.64	1801.60
Kickapoo 5	23696.8800	1800.32	1800.58	1800.37	1800.32
Kickapoo 5	23243.9700	1799.39	1799.65	1799.44	1799.39

Model Location	Cross Section	20% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 5	22629.9100	1797.37	1797.59	1797.41	1797.37
Kickapoo 5	22030.0900	1794.98	1795.17	1795.02	1794.98
Kickapoo 5	21091.7500	1792.69	1792.86	1792.73	1792.69
Kickapoo 5	20534.8800	1789.53	1789.65	1789.55	1789.53
Kickapoo 5	19937.8400	1787.68	1787.90	1787.72	1787.68
Kickapoo 5	19873.6000	Existing Bridge-US 277			
Kickapoo 5	19835.1100	1787.60	1787.83	1787.64	1787.60
Kickapoo 5	19631.1200	1787.55	1787.78	1787.59	1787.55
Kickapoo 5	19102.9600	1786.41	1786.59	1786.45	1786.41
Kickapoo 5	18790.5500	1785.35	1785.44	1785.36	1785.35
Kickapoo 5	18548.0200	1784.43	1784.53	1784.45	1784.43
Kickapoo 5	18194.4600	1783.84	1784.08	1783.89	1783.84
Kickapoo 5	18167.8000	Existing Bridge-E Main Street			
Kickapoo 5	18140.6600	1783.20	1783.37	1783.24	1783.21
Kickapoo 5	17150.5800	1781.51	1781.51	1781.51	1781.51
Kickapoo 5	16802.4300	1779.13	1779.32	1779.16	1779.13
Kickapoo 5	16527.5400	1778.38	1778.58	1778.41	1778.38
Kickapoo 5	15824.0200	1776.40	1776.62	1776.43	1776.40
Kickapoo 5	15796.9000	Existing Bridge-E Oliver Avenue			
Kickapoo 5	15775.4100	1776.00	1776.15	1776.02	1776.00
Kickapoo 5	15513.0900	1773.53	1773.68	1773.55	1773.52
Kickapoo 5	15484.3000	1773.20	1773.42	1773.23	1773.20
Kickapoo 5	15109.1500	1771.77	1771.95	1771.80	1771.77
Kickapoo 5	14720.6700	1770.45	1770.65	1770.48	1770.45
Kickapoo 5	14307.9500	1768.24	1768.39	1768.26	1768.24
Kickapoo 5	13908.3900	1766.83	1766.96	1766.85	1766.83
Kickapoo 5	13069.3300	1765.30	1765.42	1765.32	1765.30
Kickapoo 5	13026.5000	Existing Bridge-SH 158			
Kickapoo 5	12998.6000	1764.59	1764.72	1764.61	1764.59
Kickapoo 5	12367.0600	1762.97	1763.11	1762.99	1762.97
Kickapoo 5	11629.0400	1760.91	1761.01	1760.92	1760.91
Kickapoo 5	11583.8300	1760.88	1761.00	1760.90	1760.88
Kickapoo 5	11250.6800	1760.45	1760.59	1760.47	1760.45
Kickapoo 5	9396.1250	1757.27	1757.39	1757.28	1757.27
Kickapoo 5	7881.1570	1755.50	1755.58	1755.51	1755.50
Kickapoo 5	4865.7950	1751.49	1751.59	1751.50	1751.49
Kickapoo 5	2827.7220	1746.15	1746.27	1746.16	1746.15
Kickapoo 5	1312.8390	1741.52	1741.63	1741.54	1741.52

Model Location	Cross Section	20% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 5	552.9967	1739.80	1739.93	1739.81	1739.80
Kickapoo 5	504.9114	1739.30	1739.41	1739.31	1739.30

Table D.4-12. 10% AEP Storm Event HEC-RAS 1D Water Surface Elevation Comparison

Model Location	Cross Section	10% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 4	19547.600	1968.13	1972.38	1968.13	1972.38
Kickapoo 4	19259.250	1967.64	1972.03	1967.64	1972.03
Kickapoo 4	18754.170	1961.81	1965.02	1961.81	1965.02
Kickapoo 4	18476.980	1961.81	1964.78	1961.81	1964.78
Kickapoo 4	18446.200	Existing Culvert-McDonald Road			
Kickapoo 4	18417.840	1958.05	1962.99	1958.06	1962.99
Kickapoo 4	18146.350	1953.97	1960.20	1953.97	1960.20
Kickapoo 4	17959.880	1953.40	1958.03	1953.41	1958.03
Kickapoo 4	17506.210	1949.69	1956.06	1949.67	1956.06
Kickapoo 4	17041.840	1949.24	1955.68	1949.24	1955.68
Kickapoo 4	16621.050	1949.13	1954.25	1949.13	1954.25
Kickapoo 4	16572.550	1948.90	1952.84	1948.90	1952.84
Kickapoo 4	16201.950	1945.29	1949.97	1945.29	1949.97
Kickapoo 4	15958.090	1943.82	1948.01	1943.82	1948.01
Kickapoo 4	15561.380	1942.47	1946.49	1942.47	1946.49
Kickapoo 4	15309.160	1940.50	1944.73	1940.49	1944.73
Kickapoo 4	15286.760	1940.24	1944.57	1940.23	1944.57
Kickapoo 4	14992.140	1938.26	1941.45	1938.26	1941.45
Kickapoo 4	14515.910	1936.04	1940.06	1936.04	1940.06
Kickapoo 4	14070.890	1935.32	1939.34	1935.32	1939.34
Kickapoo 4	13742.310	1935.00	1937.69	1935.00	1937.69
Kickapoo 4	13537.160	1934.92	1937.23	1934.92	1937.23
Kickapoo 4	13265.340	1934.82	1936.29	1934.82	1936.29
Kickapoo 4	13244.630	1934.80	1936.21	1934.80	1936.21
Kickapoo 4	12792.350	1933.70	1935.34	1933.70	1935.34
Kickapoo 4	12596.590	1933.34	1935.00	1933.34	1935.00
Kickapoo 4	12572.050	1933.26	1934.89	1933.26	1934.89
Kickapoo 4	12181.860	1931.75	1933.51	1931.75	1933.51
Kickapoo 4	11733.890	1930.06	1931.38	1930.06	1931.38
Kickapoo 4	11294.220	1929.07	1929.96	1929.07	1929.96

Model Location	Cross Section	10% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 4	10865.430	1925.98	1927.85	1925.97	1927.85
Kickapoo 4	10352.410	1924.93	1926.73	1924.93	1926.73
Kickapoo 4	9542.112	1923.50	1924.29	1923.50	1924.29
Kickapoo 4	9529.200	Existing Culvert-Nipple Peak Road			
Kickapoo 4	9516.422	1922.97	1924.30	1922.97	1924.30
Kickapoo 4	9174.563	1922.21	1923.59	1922.21	1923.59
Kickapoo 4	8677.874	1919.07	1920.06	1919.07	1920.06
Kickapoo 4	8370.359	1918.55	1919.31	1918.55	1919.31
Kickapoo 4	8085.566	1918.00	1919.06	1918.00	1919.06
Kickapoo 4	7673.817	1916.37	1916.96	1916.37	1916.96
Kickapoo 4	7127.514	1913.54	1914.83	1913.54	1914.83
Kickapoo 4	6360.571	1912.41	1912.94	1912.41	1912.94
Kickapoo 4	6039.239	1911.29	1912.06	1911.29	1912.06
Kickapoo 4	5707.882	1910.00	1910.92	1910.00	1910.92
Kickapoo 4	5544.297	1909.46	1910.55	1909.46	1910.55
Kickapoo 4	5523.448	1909.42	1910.50	1909.42	1910.50
Kickapoo 4	5076.510	1908.47	1909.52	1908.47	1909.52
Kickapoo 4	4753.666	1907.73	1908.74	1907.73	1908.74
Kickapoo 4	4483.647	1906.97	1907.90	1906.97	1907.90
Kickapoo 4	4240.891	1906.19	1906.78	1906.19	1906.78
Kickapoo 4	3775.772	1905.87	1906.22	1905.87	1906.22
Kickapoo 4	3536.016	1905.68	1905.82	1905.68	1905.82
Kickapoo 4	3301.721	1905.20	1905.34	1905.20	1905.34
Kickapoo 4	2743.317	1904.29	1904.47	1904.29	1904.47
Kickapoo 4	2097.358	1901.70	1901.70	1901.70	1901.70
Kickapoo 4	2037.804	1901.54	1901.73	1901.54	1901.73
Kickapoo 4	1488.130	1899.74	1899.65	1899.74	1899.65
Kickapoo 4	1137.432	1897.02	1897.45	1897.02	1897.45
Kickapoo 5	57242.5800	1874.56	1875.84	1874.53	1874.59
Kickapoo 5	56665.6800	1874.04	1874.60	1874.02	1874.05
Kickapoo 5	56337.6600	1871.98	1872.45	1871.96	1871.98
Kickapoo 5	56318.2000	Existing Bridge-Railroad Road			
Kickapoo 5	56308.0600	1871.98	1872.51	1871.96	1871.98
Kickapoo 5	55754.1200	1869.02	1869.67	1869.01	1869.03
Kickapoo 5	55114.7900	1868.46	1869.19	1868.45	1868.46
Kickapoo 5	54604.8200	1867.48	1868.15	1867.48	1867.49
Kickapoo 5	54041.7000	1866.25	1866.78	1866.27	1866.26
Kickapoo 5	53743.6900	1865.94	1866.44	1865.98	1865.95

Model Location	Cross Section	10% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 5	53244.6600	1865.72	1866.18	1865.76	1865.73
Kickapoo 5	52745.1500	1865.67	1866.12	1865.71	1865.68
Kickapoo 5	52507.9800	1865.18	1865.63	1865.22	1865.19
Kickapoo 5	52244.4200	1864.18	1864.56	1864.22	1864.19
Kickapoo 5	52024.5700	1864.25	1864.64	1864.29	1864.26
Kickapoo 5	51983.3000	Existing Bridge-Railroad Road			
Kickapoo 5	51952.4500	1863.95	1864.32	1863.99	1863.96
Kickapoo 5	51752.1000	1861.98	1862.34	1862.01	1861.98
Kickapoo 5	51694.0600	1861.61	1861.98	1861.65	1861.62
Kickapoo 5	51539.2700	1861.68	1862.09	1861.73	1861.69
Kickapoo 5	51224.3000	1861.39	1861.82	1861.43	1861.39
Kickapoo 5	50921.0700	1861.25	1861.68	1861.29	1861.25
Kickapoo 5	49976.6400	1860.15	1860.58	1860.20	1860.15
Kickapoo 5	49454.1900	1858.78	1859.16	1858.82	1858.78
Kickapoo 5	48796.6500	1857.48	1857.90	1857.53	1857.49
Kickapoo 5	48070.1900	1855.96	1856.43	1856.01	1855.97
Kickapoo 5	47740.6500	1854.70	1855.20	1854.74	1854.71
Kickapoo 5	47387.6300	1854.27	1854.72	1854.31	1854.27
Kickapoo 5	46701.9000	1852.85	1853.16	1852.88	1852.86
Kickapoo 5	45992.4100	1851.32	1851.69	1851.35	1851.33
Kickapoo 5	45958.8000	1850.78	1851.19	1850.81	1850.79
Kickapoo 5	45290.0000	1849.47	1849.78	1849.51	1849.48
Kickapoo 5	44497.8200	1847.49	1847.75	1847.52	1847.50
Kickapoo 5	44195.5400	1846.92	1847.17	1846.95	1846.92
Kickapoo 5	43929.1500	1846.46	1846.69	1846.49	1846.46
Kickapoo 5	43211.3500	1843.88	1844.06	1843.90	1843.88
Kickapoo 5	42642.4300	1842.90	1843.11	1842.93	1842.90
Kickapoo 5	42254.6800	1842.15	1842.33	1842.17	1842.15
Kickapoo 5	41790.5700	1840.97	1841.12	1840.99	1840.97
Kickapoo 5	41009.3000	1838.62	1838.85	1838.65	1838.62
Kickapoo 5	40984.0000	Existing Bridge-Railroad Road			
Kickapoo 5	40854.2100	1838.70	1838.94	1838.73	1838.70
Kickapoo 5	40742.4400	1838.02	1838.24	1838.05	1838.02
Kickapoo 5	39981.9800	1836.75	1836.96	1836.78	1836.75
Kickapoo 5	39743.9000	1836.44	1836.66	1836.47	1836.44
Kickapoo 5	39527.2600	1835.91	1836.13	1835.94	1835.92
Kickapoo 5	39272.5000	1835.11	1835.31	1835.14	1835.11
Kickapoo 5	38825.8200	1835.41	1835.63	1835.44	1835.41

Model Location	Cross Section	10% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 5	38755.5500	1835.31	1835.54	1835.34	1835.31
Kickapoo 5	38202.5800	1833.70	1833.94	1833.73	1833.70
Kickapoo 5	38157.2000	1832.78	1832.99	1832.81	1832.78
Kickapoo 5	37239.8500	1831.31	1831.51	1831.34	1831.32
Kickapoo 5	37120.3500	1831.39	1831.58	1831.41	1831.39
Kickapoo 5	36929.8100	1830.86	1831.05	1830.89	1830.87
Kickapoo 5	36651.9700	1830.42	1830.60	1830.44	1830.42
Kickapoo 5	36346.2300	1829.94	1830.13	1829.97	1829.95
Kickapoo 5	35838.5000	1829.00	1829.20	1829.03	1829.01
Kickapoo 5	35444.1900	1828.20	1828.42	1828.23	1828.20
Kickapoo 5	35239.5700	1827.44	1827.66	1827.47	1827.44
Kickapoo 5	34781.5500	1826.62	1826.85	1826.66	1826.63
Kickapoo 5	34443.2400	1826.06	1826.28	1826.09	1826.06
Kickapoo 5	33446.0900	1823.90	1824.06	1823.92	1823.90
Kickapoo 5	32833.7200	1823.43	1823.57	1823.45	1823.43
Kickapoo 5	32756.4800	1823.27	1823.41	1823.29	1823.27
Kickapoo 5	32313.4100	1822.47	1822.58	1822.48	1822.47
Kickapoo 5	30512.4200	1819.32	1819.48	1819.34	1819.32
Kickapoo 5	29815.1300	1815.82	1815.96	1815.84	1815.82
Kickapoo 5	29076.5400	1813.61	1813.77	1813.63	1813.61
Kickapoo 5	28458.6400	1813.06	1813.24	1813.08	1813.06
Kickapoo 5	28380.5000	1812.80	1812.98	1812.82	1812.80
Kickapoo 5	27848.7300	1812.02	1812.21	1812.04	1812.02
Kickapoo 5	27489.2100	1811.48	1811.69	1811.50	1811.48
Kickapoo 5	26904.9100	1810.02	1810.25	1810.04	1810.02
Kickapoo 5	25805.1300	1806.39	1806.62	1806.42	1806.40
Kickapoo 5	25790.5600	1806.42	1806.65	1806.44	1806.42
Kickapoo 5	25374.0100	1806.62	1806.87	1806.64	1806.62
Kickapoo 5	25039.8500	1805.45	1805.70	1805.48	1805.46
Kickapoo 5	24776.5900	1804.96	1805.20	1804.98	1804.96
Kickapoo 5	24326.6600	1803.12	1803.32	1803.13	1803.12
Kickapoo 5	23696.8800	1801.91	1802.12	1801.93	1801.91
Kickapoo 5	23243.9700	1800.98	1801.19	1801.00	1800.98
Kickapoo 5	22629.9100	1798.81	1799.02	1798.83	1798.81
Kickapoo 5	22030.0900	1796.22	1796.38	1796.24	1796.22
Kickapoo 5	21091.7500	1793.76	1793.89	1793.77	1793.76
Kickapoo 5	20534.8800	1790.34	1790.45	1790.35	1790.35
Kickapoo 5	19937.8400	1788.62	1788.73	1788.63	1788.62

Model Location	Cross Section	10% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 5	19873.6000	Existing Bridge-US 277			
Kickapoo 5	19835.1100	1788.53	1788.63	1788.54	1788.53
Kickapoo 5	19631.1200	1788.47	1788.57	1788.48	1788.47
Kickapoo 5	19102.9600	1787.88	1787.99	1787.89	1787.88
Kickapoo 5	18790.5500	1786.19	1786.19	1786.19	1786.19
Kickapoo 5	18548.0200	1785.32	1785.53	1785.34	1785.33
Kickapoo 5	18194.4600	1785.28	1785.47	1785.30	1785.29
Kickapoo 5	18167.8000	Existing Bridge-E Main Street			
Kickapoo 5	18140.6600	1784.35	1784.51	1784.37	1784.35
Kickapoo 5	17150.5800	1781.50	1781.51	1781.51	1781.50
Kickapoo 5	16802.4300	1780.12	1780.17	1780.12	1780.12
Kickapoo 5	16527.5400	1779.93	1780.01	1779.94	1779.93
Kickapoo 5	15824.0200	1778.29	1778.62	1778.30	1778.29
Kickapoo 5	15796.9000	Existing Bridge-E Oliver Avenue			
Kickapoo 5	15775.4100	1777.10	1777.26	1777.11	1777.10
Kickapoo 5	15513.0900	1774.46	1774.59	1774.47	1774.46
Kickapoo 5	15484.3000	1774.79	1775.01	1774.80	1774.79
Kickapoo 5	15109.1500	1773.15	1773.34	1773.16	1773.15
Kickapoo 5	14720.6700	1771.97	1772.19	1771.98	1771.97
Kickapoo 5	14307.9500	1769.31	1769.46	1769.32	1769.31
Kickapoo 5	13908.3900	1767.73	1767.85	1767.74	1767.73
Kickapoo 5	13069.3300	1766.16	1766.28	1766.16	1766.16
Kickapoo 5	13026.5000	Existing Bridge-SH 158			
Kickapoo 5	12998.6000	1765.52	1765.65	1765.53	1765.52
Kickapoo 5	12367.0600	1763.96	1764.09	1763.96	1763.96
Kickapoo 5	11629.0400	1761.57	1761.65	1761.57	1761.57
Kickapoo 5	11583.8300	1761.61	1761.70	1761.62	1761.61
Kickapoo 5	11250.6800	1761.27	1761.38	1761.28	1761.27
Kickapoo 5	9396.1250	1758.21	1758.31	1758.22	1758.21
Kickapoo 5	7881.1570	1756.07	1756.18	1756.07	1756.07
Kickapoo 5	4865.7950	1752.17	1752.17	1752.18	1752.17
Kickapoo 5	2827.7220	1747.03	1747.15	1747.03	1747.03
Kickapoo 5	1312.8390	1742.31	1742.41	1742.31	1742.31
Kickapoo 5	552.9967	1740.68	1740.79	1740.68	1740.68
Kickapoo 5	504.9114	1740.08	1740.17	1740.08	1740.08

Table D.4-13. 4% AEP Storm Event HEC-RAS 1D Water Surface Elevation Comparison

Model Location	Cross Section	4% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 4	19547.600	1968.18	1972.79	1968.17	1972.79
Kickapoo 4	19259.250	1967.67	1972.03	1967.67	1972.03
Kickapoo 4	18754.170	1961.84	1965.73	1961.85	1965.73
Kickapoo 4	18476.980	1961.84	1965.42	1961.84	1965.42
Kickapoo 4	18446.200	Existing Culvert-McDonald Road			
Kickapoo 4	18417.840	1958.09	1964.80	1958.08	1964.80
Kickapoo 4	18146.350	1954.01	1961.37	1954.01	1961.37
Kickapoo 4	17959.880	1953.44	1959.41	1953.44	1959.41
Kickapoo 4	17506.210	1949.71	1957.65	1949.71	1957.65
Kickapoo 4	17041.840	1949.28	1957.30	1949.28	1957.30
Kickapoo 4	16621.050	1949.16	1955.47	1949.16	1955.47
Kickapoo 4	16572.550	1948.92	1954.22	1948.92	1954.22
Kickapoo 4	16201.950	1945.32	1950.62	1945.32	1950.62
Kickapoo 4	15958.090	1943.85	1948.92	1943.85	1948.92
Kickapoo 4	15561.380	1942.51	1947.03	1942.51	1947.03
Kickapoo 4	15309.160	1940.54	1945.14	1940.54	1945.14
Kickapoo 4	15286.760	1940.38	1944.66	1940.37	1944.66
Kickapoo 4	14992.140	1938.30	1942.25	1938.31	1942.25
Kickapoo 4	14515.910	1936.17	1940.65	1936.17	1940.65
Kickapoo 4	14070.890	1935.62	1939.78	1935.62	1939.78
Kickapoo 4	13742.310	1935.42	1938.23	1935.42	1938.23
Kickapoo 4	13537.160	1935.37	1937.56	1935.37	1937.56
Kickapoo 4	13265.340	1935.36	1936.91	1935.36	1936.91
Kickapoo 4	13244.630	1935.36	1936.81	1935.36	1936.81
Kickapoo 4	12792.350	1934.24	1936.05	1934.24	1936.05
Kickapoo 4	12596.590	1933.97	1935.70	1933.97	1935.70
Kickapoo 4	12572.050	1933.88	1935.60	1933.88	1935.60
Kickapoo 4	12181.860	1932.26	1934.31	1932.26	1934.31
Kickapoo 4	11733.890	1930.56	1932.01	1930.56	1932.01
Kickapoo 4	11294.220	1929.32	1930.45	1929.32	1930.45
Kickapoo 4	10865.430	1927.11	1928.63	1927.11	1928.63
Kickapoo 4	10352.410	1925.53	1926.97	1925.53	1926.97
Kickapoo 4	9542.112	1924.65	1925.24	1924.65	1925.24
Kickapoo 4	9529.200	Existing Culvert-Nipple Peak Road			
Kickapoo 4	9516.422	1923.46	1925.17	1923.46	1925.17
Kickapoo 4	9174.563	1923.33	1924.35	1923.33	1924.35
Kickapoo 4	8677.874	1919.91	1921.13	1919.91	1921.13
Kickapoo 4	8370.359	1919.27	1920.19	1919.27	1920.19

Model Location	Cross Section	4% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 4	8085.566	1919.07	1920.11	1919.08	1920.11
Kickapoo 4	7673.817	1916.57	1917.85	1916.56	1917.85
Kickapoo 4	7127.514	1914.60	1915.44	1914.60	1915.44
Kickapoo 4	6360.571	1912.81	1913.72	1912.81	1913.72
Kickapoo 4	6039.239	1911.91	1912.95	1911.91	1912.95
Kickapoo 4	5707.882	1910.73	1911.94	1910.73	1911.94
Kickapoo 4	5544.297	1910.34	1911.60	1910.34	1911.60
Kickapoo 4	5523.448	1910.29	1911.53	1910.29	1911.53
Kickapoo 4	5076.510	1909.26	1910.41	1909.26	1910.41
Kickapoo 4	4753.666	1908.53	1909.58	1908.53	1909.58
Kickapoo 4	4483.647	1907.73	1908.71	1907.73	1908.71
Kickapoo 4	4240.891	1906.85	1907.61	1906.85	1907.61
Kickapoo 4	3775.772	1906.53	1906.91	1906.53	1906.91
Kickapoo 4	3536.016	1906.32	1906.40	1906.32	1906.40
Kickapoo 4	3301.721	1905.79	1905.84	1905.79	1905.84
Kickapoo 4	2743.317	1904.44	1904.50	1904.44	1904.50
Kickapoo 4	2097.358	1902.83	1902.87	1902.83	1902.87
Kickapoo 4	2037.804	1902.16	1902.23	1902.16	1902.23
Kickapoo 4	1488.130	1899.65	1899.65	1899.65	1899.65
Kickapoo 4	1137.432	1897.82	1897.86	1897.82	1897.86
Kickapoo 5	57242.5800	1874.89	1875.99	1874.87	1875.24
Kickapoo 5	56665.6800	1874.64	1875.13	1874.62	1874.71
Kickapoo 5	56337.6600	1872.83	1873.33	1872.82	1872.83
Kickapoo 5	56318.2000	Existing Bridge-Railroad Road			
Kickapoo 5	56308.0600	1872.91	1873.42	1872.89	1872.91
Kickapoo 5	55754.1200	1870.30	1870.86	1870.39	1870.30
Kickapoo 5	55114.7900	1869.95	1870.53	1870.09	1869.95
Kickapoo 5	54604.8200	1869.04	1869.54	1869.26	1869.04
Kickapoo 5	54041.7000	1868.03	1868.40	1868.43	1868.03
Kickapoo 5	53743.6900	1867.85	1868.19	1868.29	1867.85
Kickapoo 5	53244.6600	1867.68	1867.97	1868.15	1867.68
Kickapoo 5	52745.1500	1867.64	1867.93	1868.11	1867.64
Kickapoo 5	52507.9800	1867.19	1867.48	1867.76	1867.20
Kickapoo 5	52244.4200	1865.97	1866.20	1866.88	1865.97
Kickapoo 5	52024.5700	1866.04	1866.29	1866.84	1866.05
Kickapoo 5	51983.3000	Existing Bridge-Railroad Road			
Kickapoo 5	51952.4500	1865.70	1865.94	1866.43	1865.70
Kickapoo 5	51752.1000	1863.95	1864.12	1864.04	1863.95

Model Location	Cross Section	4% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 5	51694.0600	1863.85	1864.16	1863.95	1863.86
Kickapoo 5	51539.2700	1863.53	1863.80	1863.42	1863.53
Kickapoo 5	51224.3000	1863.26	1863.47	1863.26	1863.26
Kickapoo 5	50921.0700	1863.10	1863.31	1863.10	1863.10
Kickapoo 5	49976.6400	1862.29	1862.54	1862.29	1862.30
Kickapoo 5	49454.1900	1860.59	1860.79	1860.59	1860.60
Kickapoo 5	48796.6500	1859.31	1859.50	1859.31	1859.32
Kickapoo 5	48070.1900	1857.76	1857.91	1857.76	1857.76
Kickapoo 5	47740.6500	1856.61	1856.84	1856.61	1856.61
Kickapoo 5	47387.6300	1856.06	1856.25	1856.05	1856.06
Kickapoo 5	46701.9000	1854.51	1854.71	1854.50	1854.51
Kickapoo 5	45992.4100	1852.92	1853.16	1852.92	1852.92
Kickapoo 5	45958.8000	1852.49	1852.74	1852.49	1852.49
Kickapoo 5	45290.0000	1851.13	1851.44	1851.13	1851.14
Kickapoo 5	44497.8200	1849.03	1849.32	1849.03	1849.03
Kickapoo 5	44195.5400	1848.44	1848.69	1848.45	1848.45
Kickapoo 5	43929.1500	1847.90	1848.13	1847.91	1847.90
Kickapoo 5	43211.3500	1845.19	1845.40	1845.20	1845.20
Kickapoo 5	42642.4300	1844.40	1844.65	1844.42	1844.41
Kickapoo 5	42254.6800	1843.51	1843.73	1843.52	1843.51
Kickapoo 5	41790.5700	1842.15	1842.34	1842.16	1842.15
Kickapoo 5	41009.3000	1840.36	1840.62	1840.37	1840.36
Kickapoo 5	40984.0000	Existing Bridge-Railroad Road			
Kickapoo 5	40854.2100	1840.46	1840.70	1840.47	1840.46
Kickapoo 5	40742.4400	1839.68	1839.91	1839.69	1839.69
Kickapoo 5	39981.9800	1838.35	1838.56	1838.36	1838.36
Kickapoo 5	39743.9000	1838.02	1838.23	1838.03	1838.03
Kickapoo 5	39527.2600	1837.41	1837.61	1837.42	1837.42
Kickapoo 5	39272.5000	1836.92	1837.12	1836.93	1836.92
Kickapoo 5	38825.8200	1837.09	1837.29	1837.10	1837.09
Kickapoo 5	38755.5500	1837.04	1837.25	1837.05	1837.05
Kickapoo 5	38202.5800	1835.97	1836.23	1835.98	1835.98
Kickapoo 5	38157.2000	1834.46	1834.62	1834.47	1834.47
Kickapoo 5	37239.8500	1832.87	1833.10	1832.88	1832.88
Kickapoo 5	37120.3500	1832.92	1833.15	1832.93	1832.93
Kickapoo 5	36929.8100	1832.28	1832.49	1832.29	1832.29
Kickapoo 5	36651.9700	1831.88	1832.09	1831.88	1831.88
Kickapoo 5	36346.2300	1831.42	1831.64	1831.43	1831.43

Model Location	Cross Section	4% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 5	35838.5000	1830.54	1830.75	1830.55	1830.54
Kickapoo 5	35444.1900	1829.77	1829.96	1829.77	1829.77
Kickapoo 5	35239.5700	1829.08	1829.28	1829.09	1829.09
Kickapoo 5	34781.5500	1828.22	1828.42	1828.23	1828.22
Kickapoo 5	34443.2400	1827.63	1827.82	1827.64	1827.64
Kickapoo 5	33446.0900	1825.15	1825.28	1825.16	1825.15
Kickapoo 5	32833.7200	1824.69	1824.81	1824.70	1824.70
Kickapoo 5	32756.4800	1824.49	1824.60	1824.50	1824.50
Kickapoo 5	32313.4100	1823.45	1823.56	1823.46	1823.45
Kickapoo 5	30512.4200	1819.97	1820.06	1819.98	1819.97
Kickapoo 5	29815.1300	1817.17	1817.33	1817.17	1817.17
Kickapoo 5	29076.5400	1815.19	1815.35	1815.20	1815.19
Kickapoo 5	28458.6400	1814.70	1814.84	1814.70	1814.70
Kickapoo 5	28380.5000	1814.46	1814.60	1814.47	1814.46
Kickapoo 5	27848.7300	1813.12	1813.24	1813.12	1813.12
Kickapoo 5	27489.2100	1812.58	1812.69	1812.59	1812.59
Kickapoo 5	26904.9100	1811.65	1811.81	1811.66	1811.65
Kickapoo 5	25805.1300	1807.56	1807.66	1807.56	1807.56
Kickapoo 5	25790.5600	1807.57	1807.66	1807.57	1807.57
Kickapoo 5	25374.0100	1808.04	1808.18	1808.05	1808.05
Kickapoo 5	25039.8500	1807.57	1807.72	1807.58	1807.58
Kickapoo 5	24776.5900	1806.58	1806.72	1806.59	1806.59
Kickapoo 5	24326.6600	1804.85	1804.97	1804.86	1804.86
Kickapoo 5	23696.8800	1803.10	1802.99	1803.11	1803.11
Kickapoo 5	23243.9700	1801.68	1801.78	1801.68	1801.68
Kickapoo 5	22629.9100	1800.10	1800.20	1800.10	1800.10
Kickapoo 5	22030.0900	1797.38	1797.46	1797.39	1797.39
Kickapoo 5	21091.7500	1794.87	1794.98	1794.87	1794.87
Kickapoo 5	20534.8800	1791.24	1791.35	1791.25	1791.24
Kickapoo 5	19937.8400	1789.50	1789.59	1789.50	1789.50
Kickapoo 5	19873.6000	Existing Bridge-US 277			
Kickapoo 5	19835.1100	1789.37	1789.46	1789.37	1789.37
Kickapoo 5	19631.1200	1789.30	1789.39	1789.30	1789.30
Kickapoo 5	19102.9600	1788.72	1788.81	1788.72	1788.73
Kickapoo 5	18790.5500	1786.68	1786.77	1786.70	1786.68
Kickapoo 5	18548.0200	1785.94	1785.90	1785.95	1785.94
Kickapoo 5	18194.4600	1785.78	1785.72	1785.79	1785.79
Kickapoo 5	18167.8000	Existing Bridge-E Main Street			

Model Location	Cross Section	4% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 5	18140.6600	1783.53	1783.54	1783.53	1783.53
Kickapoo 5	17150.5800	1782.70	1782.87	1782.71	1782.70
Kickapoo 5	16802.4300	1779.82	1779.73	1779.82	1779.82
Kickapoo 5	16527.5400	1780.39	1780.45	1780.41	1780.39
Kickapoo 5	15824.0200	1779.26	1779.35	1779.97	1779.26
Kickapoo 5	15796.9000	Existing Bridge-E Oliver Avenue			
Kickapoo 5	15775.4100	1778.42	1778.56	1777.70	1778.42
Kickapoo 5	15513.0900	1776.21	1776.40	1776.68	1776.21
Kickapoo 5	15484.3000	1776.69	1776.86	1776.69	1776.69
Kickapoo 5	15109.1500	1774.60	1774.72	1774.61	1774.61
Kickapoo 5	14720.6700	1773.81	1773.96	1773.81	1773.81
Kickapoo 5	14307.9500	1770.84	1771.00	1770.84	1770.84
Kickapoo 5	13908.3900	1769.03	1769.19	1769.03	1769.03
Kickapoo 5	13069.3300	1767.33	1767.45	1767.33	1767.33
Kickapoo 5	13026.5000	Existing Bridge-SH 158			
Kickapoo 5	12998.6000	1766.69	1766.81	1766.69	1766.69
Kickapoo 5	12367.0600	1765.09	1765.19	1765.09	1765.09
Kickapoo 5	11629.0400	1762.21	1762.29	1762.21	1762.21
Kickapoo 5	11583.8300	1762.33	1762.41	1762.33	1762.33
Kickapoo 5	11250.6800	1762.03	1762.12	1762.03	1762.03
Kickapoo 5	9396.1250	1759.15	1759.24	1759.15	1759.15
Kickapoo 5	7881.1570	1756.87	1756.94	1756.87	1756.87
Kickapoo 5	4865.7950	1752.79	1752.87	1752.79	1752.79
Kickapoo 5	2827.7220	1748.07	1748.18	1748.07	1748.07
Kickapoo 5	1312.8390	1743.34	1743.45	1743.34	1743.34
Kickapoo 5	552.9967	1741.64	1741.74	1741.64	1741.64
Kickapoo 5	504.9114	1741.02	1741.12	1741.02	1741.02

Table D.4-14. 2% AEP Storm Event HEC-RAS 1D Water Surface Elevation Comparison

Model Location	Cross Section	2% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 4	19547.600	1968.21	1973.11	1968.20	1973.11
Kickapoo 4	19259.250	1967.69	1972.09	1967.69	1972.09
Kickapoo 4	18754.170	1961.87	1966.48	1961.86	1966.48
Kickapoo 4	18476.980	1961.87	1966.19	1961.85	1966.19
Kickapoo 4	18446.200	Existing Culvert-McDonald Road			

Model Location	Cross Section	2% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 4	18417.840	1958.10	1966.04	1958.09	1966.04
Kickapoo 4	18146.350	1954.04	1962.06	1954.04	1962.06
Kickapoo 4	17959.880	1953.47	1960.30	1953.47	1960.30
Kickapoo 4	17506.210	1949.71	1958.41	1949.71	1958.41
Kickapoo 4	17041.840	1949.30	1958.01	1949.30	1958.01
Kickapoo 4	16621.050	1949.18	1956.96	1949.18	1956.96
Kickapoo 4	16572.550	1948.94	1955.04	1948.94	1955.04
Kickapoo 4	16201.950	1945.33	1950.49	1945.33	1950.49
Kickapoo 4	15958.090	1943.88	1949.38	1943.88	1949.38
Kickapoo 4	15561.380	1942.54	1947.14	1942.54	1947.14
Kickapoo 4	15309.160	1940.57	1945.41	1940.57	1945.41
Kickapoo 4	15286.760	1940.42	1944.96	1940.42	1944.96
Kickapoo 4	14992.140	1938.32	1942.62	1938.33	1942.62
Kickapoo 4	14515.910	1936.19	1941.07	1936.19	1941.07
Kickapoo 4	14070.890	1935.61	1940.11	1935.61	1940.11
Kickapoo 4	13742.310	1935.38	1938.62	1935.38	1938.62
Kickapoo 4	13537.160	1935.32	1937.96	1935.33	1937.96
Kickapoo 4	13265.340	1935.23	1937.33	1935.23	1937.33
Kickapoo 4	13244.630	1935.23	1937.22	1935.23	1937.22
Kickapoo 4	12792.350	1934.64	1936.55	1934.64	1936.55
Kickapoo 4	12596.590	1934.32	1936.22	1934.32	1936.22
Kickapoo 4	12572.050	1934.22	1936.12	1934.22	1936.12
Kickapoo 4	12181.860	1932.64	1934.79	1932.64	1934.79
Kickapoo 4	11733.890	1930.88	1932.38	1930.88	1932.38
Kickapoo 4	11294.220	1929.55	1930.81	1929.55	1930.81
Kickapoo 4	10865.430	1927.24	1929.08	1927.24	1929.08
Kickapoo 4	10352.410	1925.79	1927.43	1925.79	1927.43
Kickapoo 4	9542.112	1924.30	1925.78	1924.30	1925.78
Kickapoo 4	9529.200	Existing Culvert-Nipple Peak Road			
Kickapoo 4	9516.422	1924.43	1925.67	1924.43	1925.67
Kickapoo 4	9174.563	1923.75	1924.67	1923.76	1924.67
Kickapoo 4	8677.874	1920.73	1922.03	1920.73	1922.03
Kickapoo 4	8370.359	1919.57	1920.40	1919.57	1920.40
Kickapoo 4	8085.566	1919.42	1919.79	1919.43	1919.79
Kickapoo 4	7673.817	1917.26	1917.99	1917.26	1917.99
Kickapoo 4	7127.514	1914.84	1916.08	1914.84	1916.08
Kickapoo 4	6360.571	1913.21	1914.27	1913.21	1914.27
Kickapoo 4	6039.239	1912.36	1913.56	1912.36	1913.56

Model Location	Cross Section	2% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 4	5707.882	1911.29	1912.57	1911.29	1912.57
Kickapoo 4	5544.297	1910.94	1912.22	1910.94	1912.22
Kickapoo 4	5523.448	1910.87	1912.19	1910.87	1912.19
Kickapoo 4	5076.510	1909.84	1910.94	1909.84	1910.94
Kickapoo 4	4753.666	1909.07	1910.08	1909.07	1910.08
Kickapoo 4	4483.647	1908.15	1909.10	1908.15	1909.10
Kickapoo 4	4240.891	1907.32	1908.18	1907.32	1908.18
Kickapoo 4	3775.772	1906.97	1907.38	1906.97	1907.38
Kickapoo 4	3536.016	1906.74	1906.82	1906.74	1906.82
Kickapoo 4	3301.721	1906.19	1906.24	1906.19	1906.24
Kickapoo 4	2743.317	1904.86	1904.93	1904.86	1904.93
Kickapoo 4	2097.358	1903.15	1903.16	1903.15	1903.16
Kickapoo 4	2037.804	1902.63	1902.68	1902.63	1902.68
Kickapoo 4	1488.130	1899.65	1899.65	1899.65	1899.65
Kickapoo 4	1137.432	1898.10	1898.13	1898.10	1898.13
Kickapoo 5	57242.5800	1875.26	1876.81	1875.24	1878.58
Kickapoo 5	56665.6800	1875.11	1875.66	1875.09	1875.56
Kickapoo 5	56337.6600	1873.52	1874.01	1873.50	1873.52
Kickapoo 5	56318.2000	Existing Bridge-Railroad Road			
Kickapoo 5	56308.0600	1873.61	1874.11	1873.60	1873.62
Kickapoo 5	55754.1200	1871.18	1871.67	1871.16	1871.18
Kickapoo 5	55114.7900	1870.90	1871.40	1870.88	1870.90
Kickapoo 5	54604.8200	1869.96	1870.36	1869.94	1869.96
Kickapoo 5	54041.7000	1868.99	1869.31	1868.97	1868.99
Kickapoo 5	53743.6900	1868.81	1869.13	1868.80	1868.82
Kickapoo 5	53244.6600	1868.63	1868.91	1868.62	1868.63
Kickapoo 5	52745.1500	1868.59	1868.86	1868.58	1868.59
Kickapoo 5	52507.9800	1868.11	1868.37	1868.10	1868.11
Kickapoo 5	52244.4200	1866.57	1866.77	1866.56	1866.57
Kickapoo 5	52024.5700	1866.69	1866.89	1866.69	1866.69
Kickapoo 5	51983.3000	Existing Bridge-Railroad Road			
Kickapoo 5	51952.4500	1866.24	1866.39	1866.24	1866.24
Kickapoo 5	51752.1000	1864.94	1865.11	1864.94	1864.94
Kickapoo 5	51694.0600	1864.79	1864.98	1864.79	1864.80
Kickapoo 5	51539.2700	1864.47	1864.65	1864.47	1864.47
Kickapoo 5	51224.3000	1864.19	1864.38	1864.19	1864.19
Kickapoo 5	50921.0700	1863.98	1864.17	1863.98	1863.98
Kickapoo 5	49976.6400	1863.28	1863.48	1863.27	1863.28

Model Location	Cross Section	2% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 5	49454.1900	1861.40	1861.57	1861.39	1861.40
Kickapoo 5	48796.6500	1860.14	1860.32	1860.13	1860.14
Kickapoo 5	48070.1900	1858.48	1858.63	1858.47	1858.48
Kickapoo 5	47740.6500	1857.57	1857.76	1857.56	1857.57
Kickapoo 5	47387.6300	1856.93	1857.13	1856.92	1856.93
Kickapoo 5	46701.9000	1855.42	1855.62	1855.41	1855.42
Kickapoo 5	45992.4100	1853.92	1854.14	1853.91	1853.92
Kickapoo 5	45958.8000	1853.52	1853.74	1853.51	1853.52
Kickapoo 5	45290.0000	1852.21	1852.39	1852.20	1852.21
Kickapoo 5	44497.8200	1850.20	1850.39	1850.20	1850.20
Kickapoo 5	44195.5400	1849.53	1849.74	1849.53	1849.54
Kickapoo 5	43929.1500	1848.89	1849.08	1848.89	1848.89
Kickapoo 5	43211.3500	1846.11	1846.26	1846.11	1846.11
Kickapoo 5	42642.4300	1845.55	1845.74	1845.55	1845.55
Kickapoo 5	42254.6800	1844.51	1844.70	1844.52	1844.52
Kickapoo 5	41790.5700	1843.02	1843.20	1843.02	1843.03
Kickapoo 5	41009.3000	1841.52	1841.73	1841.53	1841.53
Kickapoo 5	40984.0000	Existing Bridge-Railroad Road			
Kickapoo 5	40854.2100	1841.54	1841.73	1841.55	1841.55
Kickapoo 5	40742.4400	1840.71	1840.88	1840.71	1840.71
Kickapoo 5	39981.9800	1839.19	1839.32	1839.19	1839.19
Kickapoo 5	39743.9000	1838.81	1838.92	1838.81	1838.81
Kickapoo 5	39527.2600	1838.08	1838.17	1838.09	1838.09
Kickapoo 5	39272.5000	1837.51	1837.56	1837.52	1837.52
Kickapoo 5	38825.8200	1837.72	1837.78	1837.72	1837.72
Kickapoo 5	38755.5500	1837.68	1837.74	1837.68	1837.68
Kickapoo 5	38202.5800	1837.44	1833.97	1837.44	1837.45
Kickapoo 5	38157.2000	1835.31	1835.51	1835.31	1835.31
Kickapoo 5	37239.8500	1833.95	1834.14	1833.95	1833.95
Kickapoo 5	37120.3500	1833.99	1834.18	1833.99	1833.99
Kickapoo 5	36929.8100	1833.30	1833.49	1833.30	1833.30
Kickapoo 5	36651.9700	1832.89	1833.07	1832.89	1832.89
Kickapoo 5	36346.2300	1832.43	1832.61	1832.43	1832.43
Kickapoo 5	35838.5000	1831.50	1831.68	1831.50	1831.50
Kickapoo 5	35444.1900	1830.76	1830.94	1830.76	1830.76
Kickapoo 5	35239.5700	1830.05	1830.23	1830.05	1830.05
Kickapoo 5	34781.5500	1829.20	1829.38	1829.20	1829.20
Kickapoo 5	34443.2400	1828.55	1828.72	1828.56	1828.56

Model Location	Cross Section	2% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 5	33446.0900	1825.57	1825.84	1825.57	1825.57
Kickapoo 5	32833.7200	1824.91	1825.35	1824.92	1824.92
Kickapoo 5	32756.4800	1824.60	1825.06	1824.60	1824.60
Kickapoo 5	32313.4100	1824.18	1820.71	1824.19	1824.19
Kickapoo 5	30512.4200	1820.52	1820.63	1820.52	1820.52
Kickapoo 5	29815.1300	1817.71	1817.79	1817.71	1817.71
Kickapoo 5	29076.5400	1816.01	1816.25	1816.01	1816.01
Kickapoo 5	28458.6400	1815.50	1815.76	1815.50	1815.50
Kickapoo 5	28380.5000	1815.24	1815.51	1815.25	1815.25
Kickapoo 5	27848.7300	1813.84	1813.97	1813.84	1813.85
Kickapoo 5	27489.2100	1813.33	1813.46	1813.33	1813.33
Kickapoo 5	26904.9100	1812.64	1812.80	1812.65	1812.65
Kickapoo 5	25805.1300	1808.01	1808.03	1808.01	1808.01
Kickapoo 5	25790.5600	1808.00	1808.02	1808.00	1808.00
Kickapoo 5	25374.0100	1808.79	1808.88	1808.79	1808.79
Kickapoo 5	25039.8500	1808.33	1808.42	1808.34	1808.34
Kickapoo 5	24776.5900	1807.12	1807.11	1807.12	1807.12
Kickapoo 5	24326.6600	1806.06	1805.67	1806.06	1806.06
Kickapoo 5	23696.8800	1803.54	1803.80	1803.54	1803.54
Kickapoo 5	23243.9700	1802.30	1802.39	1802.30	1802.30
Kickapoo 5	22629.9100	1800.74	1800.84	1800.74	1800.74
Kickapoo 5	22030.0900	1797.81	1797.87	1797.81	1797.81
Kickapoo 5	21091.7500	1795.51	1795.61	1795.52	1795.51
Kickapoo 5	20534.8800	1791.90	1792.00	1791.90	1791.91
Kickapoo 5	19937.8400	1790.10	1790.20	1790.10	1790.11
Kickapoo 5	19873.6000	Existing Bridge-US 277			
Kickapoo 5	19835.1100	1789.94	1790.03	1789.94	1789.94
Kickapoo 5	19631.1200	1789.87	1789.96	1789.87	1789.87
Kickapoo 5	19102.9600	1789.28	1789.38	1789.29	1789.29
Kickapoo 5	18790.5500	1787.17	1787.23	1787.17	1787.16
Kickapoo 5	18548.0200	1786.28	1786.36	1786.28	1786.28
Kickapoo 5	18194.4600	1786.02	1786.07	1786.02	1786.02
Kickapoo 5	18167.8000	Existing Bridge-E Main Street			
Kickapoo 5	18140.6600	1783.95	1784.08	1783.95	1783.95
Kickapoo 5	17150.5800	1783.94	1784.16	1783.95	1783.95
Kickapoo 5	16802.4300	1780.09	1780.27	1780.09	1780.09
Kickapoo 5	16527.5400	1780.78	1780.83	1780.78	1780.78
Kickapoo 5	15824.0200	1779.71	1779.80	1779.71	1779.71

Model Location	Cross Section	2% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 5	15796.9000	Existing Bridge-E Oliver Avenue			
Kickapoo 5	15775.4100	1778.21	1778.28	1778.22	1778.22
Kickapoo 5	15513.0900	1777.91	1778.06	1777.91	1777.91
Kickapoo 5	15484.3000	1777.93	1778.07	1777.92	1777.93
Kickapoo 5	15109.1500	1774.97	1775.03	1774.97	1774.97
Kickapoo 5	14720.6700	1774.60	1774.71	1774.60	1774.60
Kickapoo 5	14307.9500	1772.13	1772.23	1772.13	1772.13
Kickapoo 5	13908.3900	1769.96	1770.03	1769.96	1769.96
Kickapoo 5	13069.3300	1767.88	1767.98	1767.88	1767.88
Kickapoo 5	13026.5000	Existing Bridge-SH 158			
Kickapoo 5	12998.6000	1766.63	1766.69	1766.63	1766.63
Kickapoo 5	12367.0600	1765.36	1765.42	1765.36	1765.36
Kickapoo 5	11629.0400	1762.73	1762.79	1762.73	1762.73
Kickapoo 5	11583.8300	1762.88	1762.96	1762.88	1762.88
Kickapoo 5	11250.6800	1762.61	1762.68	1762.61	1762.61
Kickapoo 5	9396.1250	1759.33	1759.39	1759.33	1759.33
Kickapoo 5	7881.1570	1757.08	1757.14	1757.08	1757.08
Kickapoo 5	4865.7950	1753.32	1753.40	1753.32	1753.33
Kickapoo 5	2827.7220	1748.80	1748.89	1748.80	1748.80
Kickapoo 5	1312.8390	1744.09	1744.18	1744.09	1744.09
Kickapoo 5	552.9967	1742.31	1742.40	1742.31	1742.31
Kickapoo 5	504.9114	1741.69	1741.78	1741.69	1741.69

Table D.4-15. 1% AEP Storm Event HEC-RAS 1D Water Surface Elevation Comparison

Model Location	Cross Section	1% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 4	19547.600	1968.23	1973.23	1969.24	1973.23
Kickapoo 4	19259.250	1967.71	1972.23	1968.41	1972.23
Kickapoo 4	18754.170	1961.89	1967.24	1962.43	1967.24
Kickapoo 4	18476.980	1961.89	1967.19	1962.42	1967.19
Kickapoo 4	18446.200	Existing Culvert-McDonald Road			
Kickapoo 4	18417.840	1958.12	1967.19	1958.82	1967.19
Kickapoo 4	18146.350	1954.07	1962.78	1955.00	1962.78
Kickapoo 4	17959.880	1953.49	1961.18	1954.27	1961.18
Kickapoo 4	17506.210	1949.74	1958.92	1950.30	1958.92
Kickapoo 4	17041.840	1949.32	1958.42	1950.16	1958.42

Model Location	Cross Section	1% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 4	16621.050	1949.20	1958.59	1949.87	1958.59
Kickapoo 4	16572.550	1948.95	1955.81	1949.43	1955.81
Kickapoo 4	16201.950	1945.35	1951.00	1946.02	1951.00
Kickapoo 4	15958.090	1943.90	1949.38	1944.71	1949.38
Kickapoo 4	15561.380	1942.57	1947.37	1943.57	1947.37
Kickapoo 4	15309.160	1940.60	1945.58	1941.54	1945.58
Kickapoo 4	15286.760	1940.45	1945.33	1941.55	1945.33
Kickapoo 4	14992.140	1938.36	1942.91	1939.30	1942.91
Kickapoo 4	14515.910	1936.26	1941.43	1937.23	1941.43
Kickapoo 4	14070.890	1935.77	1940.42	1936.60	1940.42
Kickapoo 4	13742.310	1935.57	1938.88	1935.83	1938.88
Kickapoo 4	13537.160	1935.53	1938.35	1935.61	1938.35
Kickapoo 4	13265.340	1935.52	1937.78	1935.57	1937.78
Kickapoo 4	13244.630	1935.52	1937.68	1935.56	1937.68
Kickapoo 4	12792.350	1934.97	1937.05	1934.97	1937.05
Kickapoo 4	12596.590	1934.65	1936.71	1934.65	1936.71
Kickapoo 4	12572.050	1934.54	1936.61	1934.54	1936.61
Kickapoo 4	12181.860	1932.99	1935.18	1932.99	1935.18
Kickapoo 4	11733.890	1931.23	1932.70	1931.23	1932.70
Kickapoo 4	11294.220	1929.61	1931.15	1929.61	1931.15
Kickapoo 4	10865.430	1927.58	1929.49	1927.59	1929.49
Kickapoo 4	10352.410	1925.87	1927.93	1925.86	1927.93
Kickapoo 4	9542.112	1924.99	1926.35	1924.97	1926.35
Kickapoo 4	9529.200	Existing Culvert-Nipple Peak Road			
Kickapoo 4	9516.422	1924.95	1926.21	1924.94	1926.21
Kickapoo 4	9174.563	1924.24	1925.21	1924.24	1925.21
Kickapoo 4	8677.874	1921.01	1922.45	1921.01	1922.45
Kickapoo 4	8370.359	1920.05	1920.83	1920.05	1920.83
Kickapoo 4	8085.566	1919.96	1920.23	1919.95	1920.23
Kickapoo 4	7673.817	1917.69	1918.30	1917.72	1918.30
Kickapoo 4	7127.514	1915.31	1916.56	1915.31	1916.56
Kickapoo 4	6360.571	1913.61	1914.88	1913.61	1914.88
Kickapoo 4	6039.239	1912.82	1914.10	1912.82	1914.10
Kickapoo 4	5707.882	1911.79	1913.06	1911.79	1913.06
Kickapoo 4	5544.297	1911.46	1912.63	1911.46	1912.63
Kickapoo 4	5523.448	1911.38	1912.67	1911.38	1912.67
Kickapoo 4	5076.510	1910.30	1911.42	1910.30	1911.42
Kickapoo 4	4753.666	1909.49	1910.51	1909.49	1910.51

Model Location	Cross Section	1% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 4	4483.647	1908.54	1909.54	1908.54	1909.54
Kickapoo 4	4240.891	1907.79	1908.72	1907.79	1908.72
Kickapoo 4	3775.772	1907.39	1907.87	1907.39	1907.87
Kickapoo 4	3536.016	1907.14	1907.29	1907.14	1907.29
Kickapoo 4	3301.721	1906.58	1906.70	1906.58	1906.70
Kickapoo 4	2743.317	1905.24	1905.34	1905.24	1905.34
Kickapoo 4	2097.358	1903.53	1903.66	1903.53	1903.66
Kickapoo 4	2037.804	1902.91	1902.99	1902.91	1902.99
Kickapoo 4	1488.130	1899.84	1899.92	1899.84	1899.92
Kickapoo 4	1137.432	1898.38	1898.47	1898.38	1898.47
Kickapoo 5	57242.5800	1876.92	1879.98	1877.30	1881.15
Kickapoo 5	56665.6800	1875.82	1877.04	1875.84	1878.58
Kickapoo 5	56337.6600	1874.25	1875.80	1874.24	1877.86
Kickapoo 5	56318.2000	Existing Bridge-Railroad Road			
Kickapoo 5	56308.0600	1874.35	1875.87	1874.33	1877.90
Kickapoo 5	55754.1200	1872.03	1873.39	1872.01	1874.94
Kickapoo 5	55114.7900	1871.79	1873.18	1871.78	1874.85
Kickapoo 5	54604.8200	1870.82	1871.87	1870.81	1873.25
Kickapoo 5	54041.7000	1870.01	1870.58	1870.00	1871.25
Kickapoo 5	53743.6900	1869.88	1870.37	1869.87	1870.86
Kickapoo 5	53244.6600	1869.59	1869.85	1869.58	1869.77
Kickapoo 5	52745.1500	1869.52	1869.71	1869.52	1869.43
Kickapoo 5	52507.9800	1869.01	1869.20	1869.00	1869.01
Kickapoo 5	52244.4200	1867.35	1867.52	1867.34	1867.35
Kickapoo 5	52024.5700	1867.50	1867.69	1867.49	1867.50
Kickapoo 5	51983.3000	Existing Bridge-Railroad Road			
Kickapoo 5	51952.4500	1866.81	1866.94	1866.80	1866.81
Kickapoo 5	51752.1000	1865.67	1865.82	1865.67	1865.67
Kickapoo 5	51694.0600	1865.61	1865.77	1865.61	1865.61
Kickapoo 5	51539.2700	1865.28	1865.43	1865.28	1865.29
Kickapoo 5	51224.3000	1865.04	1865.19	1865.03	1865.04
Kickapoo 5	50921.0700	1864.80	1864.98	1864.80	1864.80
Kickapoo 5	49976.6400	1864.14	1864.30	1864.14	1864.14
Kickapoo 5	49454.1900	1862.11	1862.19	1862.11	1862.11
Kickapoo 5	48796.6500	1860.98	1860.97	1860.98	1860.98
Kickapoo 5	48070.1900	1859.18	1859.42	1859.17	1859.17
Kickapoo 5	47740.6500	1858.44	1858.59	1858.43	1858.43
Kickapoo 5	47387.6300	1857.82	1857.98	1857.82	1857.82

Model Location	Cross Section	1% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 5	46701.9000	1856.32	1856.46	1856.31	1856.30
Kickapoo 5	45992.4100	1854.86	1855.00	1854.86	1854.82
Kickapoo 5	45958.8000	1854.46	1854.58	1854.46	1854.40
Kickapoo 5	45290.0000	1853.00	1852.99	1852.99	1852.87
Kickapoo 5	44497.8200	1850.91	1851.08	1850.90	1850.97
Kickapoo 5	44195.5400	1850.61	1850.34	1850.60	1850.61
Kickapoo 5	43929.1500	1849.76	1849.86	1849.76	1849.76
Kickapoo 5	43211.3500	1846.76	1846.89	1846.76	1846.77
Kickapoo 5	42642.4300	1846.38	1846.52	1846.37	1846.38
Kickapoo 5	42254.6800	1845.29	1845.40	1845.29	1845.29
Kickapoo 5	41790.5700	1843.86	1844.04	1843.86	1843.86
Kickapoo 5	41009.3000	1842.57	1842.78	1842.56	1842.57
Kickapoo 5	40984.0000	Existing Bridge-Railroad Road			
Kickapoo 5	40854.2100	1842.43	1842.60	1842.42	1842.43
Kickapoo 5	40742.4400	1841.57	1841.74	1841.57	1841.57
Kickapoo 5	39981.9800	1840.00	1840.17	1840.00	1840.00
Kickapoo 5	39743.9000	1839.48	1839.62	1839.47	1839.48
Kickapoo 5	39527.2600	1838.65	1838.79	1838.65	1838.65
Kickapoo 5	39272.5000	1837.91	1838.02	1837.91	1837.91
Kickapoo 5	38825.8200	1838.17	1838.29	1838.17	1838.17
Kickapoo 5	38755.5500	1838.13	1838.26	1838.13	1838.14
Kickapoo 5	38202.5800	1835.77	1835.86	1835.79	1835.78
Kickapoo 5	38157.2000	1835.75	1835.92	1835.75	1835.75
Kickapoo 5	37239.8500	1834.88	1835.05	1834.88	1834.88
Kickapoo 5	37120.3500	1834.91	1835.08	1834.91	1834.91
Kickapoo 5	36929.8100	1834.20	1834.36	1834.20	1834.20
Kickapoo 5	36651.9700	1833.77	1833.93	1833.77	1833.77
Kickapoo 5	36346.2300	1833.31	1833.47	1833.31	1833.31
Kickapoo 5	35838.5000	1832.35	1832.51	1832.35	1832.36
Kickapoo 5	35444.1900	1831.61	1831.77	1831.61	1831.62
Kickapoo 5	35239.5700	1830.84	1830.98	1830.83	1830.84
Kickapoo 5	34781.5500	1829.90	1830.03	1829.90	1829.90
Kickapoo 5	34443.2400	1829.37	1829.52	1829.37	1829.37
Kickapoo 5	33446.0900	1826.11	1826.14	1826.11	1826.11
Kickapoo 5	32833.7200	1825.26	1825.38	1825.25	1825.26
Kickapoo 5	32756.4800	1824.79	1824.87	1824.79	1824.79
Kickapoo 5	32313.4100	1824.08	1824.16	1824.08	1824.08
Kickapoo 5	30512.4200	1821.07	1821.17	1821.07	1821.07

Model Location	Cross Section	1% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 5	29815.1300	1818.22	1818.33	1818.22	1818.22
Kickapoo 5	29076.5400	1816.85	1816.98	1816.85	1816.85
Kickapoo 5	28458.6400	1816.37	1816.49	1816.37	1816.37
Kickapoo 5	28380.5000	1816.10	1816.23	1816.10	1816.10
Kickapoo 5	27848.7300	1814.45	1814.51	1814.45	1814.45
Kickapoo 5	27489.2100	1813.91	1813.94	1813.91	1813.91
Kickapoo 5	26904.9100	1813.35	1813.39	1813.35	1813.35
Kickapoo 5	25805.1300	1808.15	1808.16	1808.15	1808.15
Kickapoo 5	25790.5600	1808.16	1808.17	1808.16	1808.16
Kickapoo 5	25374.0100	1809.25	1809.28	1809.25	1809.25
Kickapoo 5	25039.8500	1808.80	1808.83	1808.80	1808.80
Kickapoo 5	24776.5900	1807.42	1807.44	1807.42	1807.42
Kickapoo 5	24326.6600	1806.04	1806.06	1806.04	1806.04
Kickapoo 5	23696.8800	1804.13	1804.16	1804.14	1804.14
Kickapoo 5	23243.9700	1802.70	1802.72	1802.70	1802.70
Kickapoo 5	22629.9100	1801.18	1801.20	1801.18	1801.18
Kickapoo 5	22030.0900	1798.05	1798.07	1798.06	1798.06
Kickapoo 5	21091.7500	1795.95	1795.97	1795.95	1795.95
Kickapoo 5	20534.8800	1792.34	1792.37	1792.35	1792.35
Kickapoo 5	19937.8400	1790.52	1790.54	1790.52	1790.52
Kickapoo 5	19873.6000	Existing Bridge-US 277			
Kickapoo 5	19835.1100	1790.33	1790.35	1790.33	1790.33
Kickapoo 5	19631.1200	1790.26	1790.28	1790.26	1790.26
Kickapoo 5	19102.9600	1789.67	1789.69	1789.67	1789.67
Kickapoo 5	18790.5500	1787.47	1787.50	1787.48	1787.48
Kickapoo 5	18548.0200	1786.59	1786.61	1786.59	1786.59
Kickapoo 5	18194.4600	1786.25	1786.27	1786.25	1786.25
Kickapoo 5	18167.8000	Existing Bridge-E Main Street			
Kickapoo 5	18140.6600	1784.80	1784.82	1784.80	1784.80
Kickapoo 5	17150.5800	1782.32	1782.32	1782.32	1782.32
Kickapoo 5	16802.4300	1781.67	1781.71	1781.67	1781.83
Kickapoo 5	16527.5400	1781.13	1781.21	1781.13	1781.43
Kickapoo 5	15824.0200	1779.70	1779.88	1779.70	1780.43
Kickapoo 5	15796.9000	Existing Bridge-E Oliver Avenue			
Kickapoo 5	15775.4100	1779.32	1779.61	1779.32	1780.29
Kickapoo 5	15513.0900	1779.10	1779.40	1779.10	1780.13
Kickapoo 5	15484.3000	1779.09	1779.39	1779.10	1780.12
Kickapoo 5	15109.1500	1775.37	1775.59	1775.35	1776.34

Model Location	Cross Section	1% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 5	14720.6700	1774.70	1774.79	1774.70	1775.34
Kickapoo 5	14307.9500	1773.12	1773.33	1773.12	1773.22
Kickapoo 5	13908.3900	1770.56	1770.73	1770.56	1771.29
Kickapoo 5	13069.3300	1768.63	1768.80	1768.63	1769.19
Kickapoo 5	13026.5000	Existing Bridge-SH 158			
Kickapoo 5	12998.6000	1767.10	1767.22	1767.10	1767.52
Kickapoo 5	12367.0600	1765.87	1765.97	1765.87	1765.83
Kickapoo 5	11629.0400	1763.17	1763.37	1763.17	1763.73
Kickapoo 5	11583.8300	1763.38	1763.56	1763.38	1763.91
Kickapoo 5	11250.6800	1763.11	1763.28	1763.11	1763.63
Kickapoo 5	9396.1250	1759.69	1759.83	1759.69	1760.08
Kickapoo 5	7881.1570	1757.48	1757.62	1757.48	1757.89
Kickapoo 5	4865.7950	1753.70	1753.85	1753.70	1754.14
Kickapoo 5	2827.7220	1749.27	1749.45	1749.27	1749.79
Kickapoo 5	1312.8390	1744.76	1744.98	1744.76	1745.41
Kickapoo 5	552.9967	1742.95	1743.17	1742.94	1743.63
Kickapoo 5	504.9114	1742.32	1742.54	1742.32	1742.98

Table D.4-16. 0.2% AEP Storm Event HEC-RAS 1D Water Surface Elevation Comparison

Model Location	Cross Section	0.2% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 4	19547.600	1970.48	1974.27	1973.42	1974.27
Kickapoo 4	19259.250	1969.23	1972.54	1971.78	1972.54
Kickapoo 4	18754.170	1962.99	1967.59	1964.42	1967.59
Kickapoo 4	18476.980	1962.94	1967.58	1964.23	1967.58
Kickapoo 4	18446.200	Existing Culvert-McDonald Road			
Kickapoo 4	18417.840	1959.62	1967.58	1961.53	1967.58
Kickapoo 4	18146.350	1956.09	1967.38	1959.06	1967.38
Kickapoo 4	17959.880	1954.89	1963.20	1956.85	1963.20
Kickapoo 4	17506.210	1951.50	1959.63	1954.71	1959.63
Kickapoo 4	17041.840	1951.26	1958.22	1954.31	1958.22
Kickapoo 4	16621.050	1950.75	1958.66	1953.17	1958.66
Kickapoo 4	16572.550	1949.91	1957.25	1951.88	1957.25
Kickapoo 4	16201.950	1946.90	1952.41	1949.12	1952.41
Kickapoo 4	15958.090	1945.84	1949.83	1947.63	1949.83
Kickapoo 4	15561.380	1944.89	1947.99	1945.93	1947.99

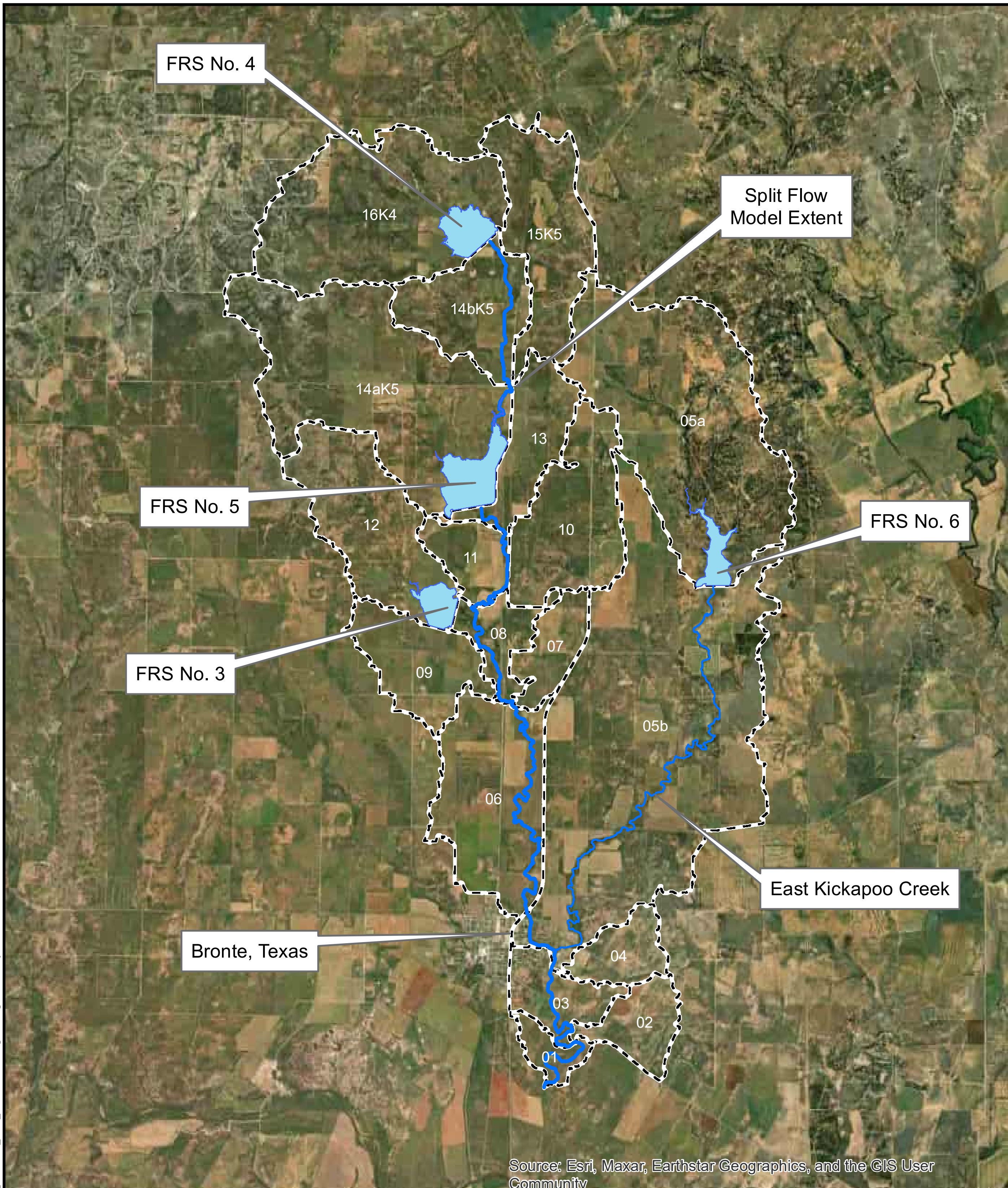
Model Location	Cross Section	0.2% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 4	15309.160	1942.80	1946.01	1944.40	1946.01
Kickapoo 4	15286.760	1942.54	1945.94	1943.72	1945.94
Kickapoo 4	14992.140	1940.19	1944.00	1941.28	1944.00
Kickapoo 4	14515.910	1938.25	1942.16	1939.49	1942.16
Kickapoo 4	14070.890	1937.95	1941.05	1938.84	1941.05
Kickapoo 4	13742.310	1936.02	1939.63	1937.24	1939.63
Kickapoo 4	13537.160	1936.15	1939.11	1936.86	1939.11
Kickapoo 4	13265.340	1936.05	1938.52	1936.27	1938.52
Kickapoo 4	13244.630	1936.05	1938.42	1936.24	1938.42
Kickapoo 4	12792.350	1935.61	1937.69	1935.61	1937.69
Kickapoo 4	12596.590	1935.27	1937.20	1935.27	1937.20
Kickapoo 4	12572.050	1935.16	1937.05	1935.16	1937.05
Kickapoo 4	12181.860	1933.79	1935.97	1933.79	1935.97
Kickapoo 4	11733.890	1931.65	1933.45	1931.65	1933.45
Kickapoo 4	11294.220	1930.14	1931.92	1930.14	1931.92
Kickapoo 4	10865.430	1928.20	1930.45	1928.20	1930.45
Kickapoo 4	10352.410	1926.64	1928.95	1926.64	1928.95
Kickapoo 4	9542.112	1925.79	1927.33	1925.79	1927.33
Kickapoo 4	9529.200	Existing Culvert-Nipple Peak Road			
Kickapoo 4	9516.422	1925.76	1927.24	1925.76	1927.24
Kickapoo 4	9174.563	1924.87	1926.25	1924.87	1926.25
Kickapoo 4	8677.874	1922.21	1923.71	1922.20	1923.71
Kickapoo 4	8370.359	1920.58	1921.77	1920.58	1921.77
Kickapoo 4	8085.566	1919.96	1921.25	1919.97	1921.25
Kickapoo 4	7673.817	1918.11	1918.95	1918.10	1918.95
Kickapoo 4	7127.514	1916.28	1917.66	1916.28	1917.66
Kickapoo 4	6360.571	1914.48	1916.11	1914.48	1916.11
Kickapoo 4	6039.239	1913.78	1915.37	1913.78	1915.37
Kickapoo 4	5707.882	1912.78	1913.94	1912.78	1913.94
Kickapoo 4	5544.297	1912.35	1913.55	1912.35	1913.55
Kickapoo 4	5523.448	1912.36	1913.63	1912.36	1913.63
Kickapoo 4	5076.510	1911.13	1912.50	1911.13	1912.50
Kickapoo 4	4753.666	1910.25	1911.45	1910.25	1911.45
Kickapoo 4	4483.647	1909.39	1910.67	1909.39	1910.67
Kickapoo 4	4240.891	1908.86	1910.01	1908.86	1910.01
Kickapoo 4	3775.772	1908.40	1909.18	1908.40	1909.18
Kickapoo 4	3536.016	1908.14	1908.66	1908.14	1908.66
Kickapoo 4	3301.721	1907.52	1907.99	1907.52	1907.99

Model Location	Cross Section	0.2% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 4	2743.317	1905.98	1906.15	1905.98	1906.15
Kickapoo 4	2097.358	1904.56	1905.12	1904.56	1905.12
Kickapoo 4	2037.804	1903.43	1903.66	1903.43	1903.66
Kickapoo 4	1488.130	1900.52	1900.90	1900.52	1900.90
Kickapoo 4	1137.432	1899.10	1899.51	1899.10	1899.51
Kickapoo 5	57242.5800	1881.88	1884.04	1882.18	1884.27
Kickapoo 5	56665.6800	1880.24	1883.13	1880.53	1883.37
Kickapoo 5	56337.6600	1879.69	1882.94	1880.01	1883.20
Kickapoo 5	56318.2000	Existing Bridge-Railroad Road			
Kickapoo 5	56308.0600	1879.59	1882.87	1879.87	1883.15
Kickapoo 5	55754.1200	1876.04	1878.57	1876.19	1879.42
Kickapoo 5	55114.7900	1876.16	1879.08	1876.37	1879.54
Kickapoo 5	54604.8200	1874.68	1877.70	1874.88	1878.19
Kickapoo 5	54041.7000	1873.41	1874.18	1873.58	1874.58
Kickapoo 5	53743.6900	1873.09	1875.43	1873.25	1872.09
Kickapoo 5	53244.6600	1872.06	1873.65	1872.14	1874.05
Kickapoo 5	52745.1500	1871.19	1872.65	1871.18	1872.96
Kickapoo 5	52507.9800	1870.32	1871.56	1870.31	1871.84
Kickapoo 5	52244.4200	1869.43	1869.67	1869.43	1869.81
Kickapoo 5	52024.5700	1869.23	1870.04	1869.22	1870.23
Kickapoo 5	51983.3000	Existing Bridge-Railroad Road			
Kickapoo 5	51952.4500	1867.89	1869.08	1867.88	1869.11
Kickapoo 5	51752.1000	1867.27	1868.30	1867.27	1869.41
Kickapoo 5	51694.0600	1867.14	1867.98	1867.14	1868.34
Kickapoo 5	51539.2700	1866.71	1866.53	1866.71	1866.44
Kickapoo 5	51224.3000	1866.45	1867.17	1866.45	1867.28
Kickapoo 5	50921.0700	1866.20	1866.61	1866.20	1866.88
Kickapoo 5	49976.6400	1865.39	1865.99	1865.39	1866.30
Kickapoo 5	49454.1900	1863.93	1864.17	1863.93	1864.46
Kickapoo 5	48796.6500	1862.36	1862.91	1862.36	1863.18
Kickapoo 5	48070.1900	1860.92	1861.26	1860.92	1861.43
Kickapoo 5	47740.6500	1860.15	1860.65	1860.14	1860.80
Kickapoo 5	47387.6300	1859.61	1859.59	1859.61	1860.41
Kickapoo 5	46701.9000	1858.32	1859.17	1858.32	1858.89
Kickapoo 5	45992.4100	1856.94	1857.32	1856.94	1857.51
Kickapoo 5	45958.8000	1856.61	1856.78	1856.60	1856.93
Kickapoo 5	45290.0000	1854.30	1854.75	1854.30	1854.98
Kickapoo 5	44497.8200	1852.09	1853.24	1852.09	1853.55

Model Location	Cross Section	0.2% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 5	44195.5400	1851.63	1852.73	1851.63	1853.05
Kickapoo 5	43929.1500	1850.87	1851.73	1850.86	1852.01
Kickapoo 5	43211.3500	1848.37	1849.22	1848.37	1849.56
Kickapoo 5	42642.4300	1847.81	1848.39	1847.81	1848.61
Kickapoo 5	42254.6800	1846.48	1847.21	1846.48	1847.74
Kickapoo 5	41790.5700	1845.27	1846.29	1845.26	1845.59
Kickapoo 5	41009.3000	1843.45	1843.80	1843.45	1845.33
Kickapoo 5	40984.0000	Existing Bridge-Railroad Road			
Kickapoo 5	40854.2100	1842.85	1843.50	1842.85	1843.78
Kickapoo 5	40742.4400	1842.92	1843.47	1842.92	1843.75
Kickapoo 5	39981.9800	1841.80	1841.89	1841.80	1842.20
Kickapoo 5	39743.9000	1840.84	1841.59	1840.84	1842.00
Kickapoo 5	39527.2600	1840.23	1841.55	1840.23	1841.96
Kickapoo 5	39272.5000	1837.48	1838.43	1837.47	1838.85
Kickapoo 5	38825.8200	1838.35	1838.62	1838.35	1838.82
Kickapoo 5	38755.5500	1838.27	1838.51	1838.27	1838.72
Kickapoo 5	38202.5800	1837.53	1838.09	1837.52	1838.33
Kickapoo 5	38157.2000	1837.57	1838.09	1837.57	1838.33
Kickapoo 5	37239.8500	1836.60	1838.01	1836.60	1838.24
Kickapoo 5	37120.3500	1836.64	1837.42	1836.64	1837.56
Kickapoo 5	36929.8100	1835.70	1836.03	1835.70	1834.69
Kickapoo 5	36651.9700	1835.20	1833.21	1835.20	1836.30
Kickapoo 5	36346.2300	1834.58	1835.13	1834.57	1833.04
Kickapoo 5	35838.5000	1832.21	1832.21	1832.21	1834.72
Kickapoo 5	35444.1900	1833.14	1832.89	1833.14	1831.80
Kickapoo 5	35239.5700	1830.32	1832.88	1830.31	1832.06
Kickapoo 5	34781.5500	1831.11	1829.99	1831.11	1830.82
Kickapoo 5	34443.2400	1827.83	1829.70	1827.84	1829.70
Kickapoo 5	33446.0900	1827.33	1827.49	1827.33	1827.49
Kickapoo 5	32833.7200	1826.16	1826.16	1826.16	1826.17
Kickapoo 5	32756.4800	1825.85	1826.19	1825.84	1826.20
Kickapoo 5	32313.4100	1825.14	1825.63	1825.13	1825.95
Kickapoo 5	30512.4200	1822.23	1822.95	1822.23	1823.11
Kickapoo 5	29815.1300	1819.48	1820.32	1819.48	1820.67
Kickapoo 5	29076.5400	1818.51	1819.59	1818.51	1819.98
Kickapoo 5	28458.6400	1818.00	1819.05	1818.00	1819.42
Kickapoo 5	28380.5000	1817.69	1818.73	1817.69	1819.10
Kickapoo 5	27848.7300	1815.45	1816.30	1815.45	1816.65

Model Location	Cross Section	0.2% AEP Storm Event WSE (ft)			
		Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 5	27489.2100	1814.56	1815.14	1814.56	1815.38
Kickapoo 5	26904.9100	1812.01	1812.45	1812.01	1812.66
Kickapoo 5	25805.1300	1810.55	1812.82	1810.53	1813.12
Kickapoo 5	25790.5600	1810.28	1810.88	1810.28	1811.18
Kickapoo 5	25374.0100	1810.52	1810.87	1810.52	1810.98
Kickapoo 5	25039.8500	1810.07	1810.30	1810.07	1810.28
Kickapoo 5	24776.5900	1808.47	1809.09	1808.47	1809.34
Kickapoo 5	24326.6600	1807.29	1807.94	1807.29	1808.24
Kickapoo 5	23696.8800	1805.29	1806.07	1805.29	1806.41
Kickapoo 5	23243.9700	1803.80	1804.55	1803.80	1804.91
Kickapoo 5	22629.9100	1802.12	1802.85	1802.12	1803.16
Kickapoo 5	22030.0900	1799.19	1799.68	1799.19	1799.89
Kickapoo 5	21091.7500	1796.21	1796.74	1796.21	1796.97
Kickapoo 5	20534.8800	1793.45	1793.88	1793.44	1794.08
Kickapoo 5	19937.8400	1791.60	1791.73	1791.60	1792.02
Kickapoo 5	19873.6000	Existing Bridge-US 277			
Kickapoo 5	19835.1100	1791.32	1791.28	1791.32	1791.51
Kickapoo 5	19631.1200	1791.25	1791.17	1791.25	1791.40
Kickapoo 5	19102.9600	1790.72	1789.50	1790.72	1789.64
Kickapoo 5	18790.5500	1788.36	1788.59	1788.35	1788.59
Kickapoo 5	18548.0200	1787.32	1787.78	1787.32	1787.98
Kickapoo 5	18194.4600	1786.88	1787.28	1786.88	1787.45
Kickapoo 5	18167.8000	Existing Bridge-E Main Street			
Kickapoo 5	18140.6600	1785.15	1785.56	1785.15	1785.83
Kickapoo 5	17150.5800	1784.52	1784.65	1784.51	1785.01
Kickapoo 5	16802.4300	1784.53	1784.66	1784.53	1785.03
Kickapoo 5	16527.5400	1784.46	1784.59	1784.46	1784.96
Kickapoo 5	15824.0200	1784.21	1784.34	1784.21	1784.72
Kickapoo 5	15796.9000	Existing Bridge-E Oliver Avenue			
Kickapoo 5	15775.4100	1784.19	1784.32	1784.19	1784.71
Kickapoo 5	15513.0900	1784.12	1784.25	1784.12	1784.64
Kickapoo 5	15484.3000	1784.12	1784.25	1784.12	1784.64
Kickapoo 5	15109.1500	1779.41	1779.52	1779.41	1779.87
Kickapoo 5	14720.6700	1777.20	1777.26	1777.20	1777.43
Kickapoo 5	14307.9500	1774.70	1774.73	1774.70	1774.87
Kickapoo 5	13908.3900	1773.66	1773.74	1773.66	1773.98
Kickapoo 5	13069.3300	1771.37	1771.44	1771.37	1771.66
Kickapoo 5	13026.5000	Existing Bridge-SH 158			

Model Location	Cross Section	0.2% AEP Storm Event WSE (ft) Existing Conditions	Alternative 3	Alternative 9	Alternative 10
Kickapoo 5	12998.6000	1767.66	1767.70	1767.66	1767.89
Kickapoo 5	12367.0600	1766.79	1766.84	1766.79	1766.99
Kickapoo 5	11629.0400	1765.95	1766.00	1765.95	1766.16
Kickapoo 5	11583.8300	1765.74	1765.79	1765.74	1765.96
Kickapoo 5	11250.6800	1765.30	1765.35	1765.30	1765.51
Kickapoo 5	9396.1250	1761.42	1761.46	1761.42	1761.60
Kickapoo 5	7881.1570	1759.43	1759.48	1759.43	1759.63
Kickapoo 5	4865.7950	1755.77	1755.82	1755.77	1755.97
Kickapoo 5	2827.7220	1751.53	1751.59	1751.53	1751.80
Kickapoo 5	1312.8390	1747.54	1747.67	1747.54	1747.87
Kickapoo 5	552.9967	1745.62	1745.90	1745.62	1746.08
Kickapoo 5	504.9114	1743.57	1745.13	1743.56	1745.31



N

0 7,500
Feet

Legend

- Middle Kickapoo Creek
- East Kickapoo Creek
- Local Roads
- Highways
- Watersheds

AECOM

Figure D-1
Middle Kickapoo Creek Location, Layout, and Watersheds

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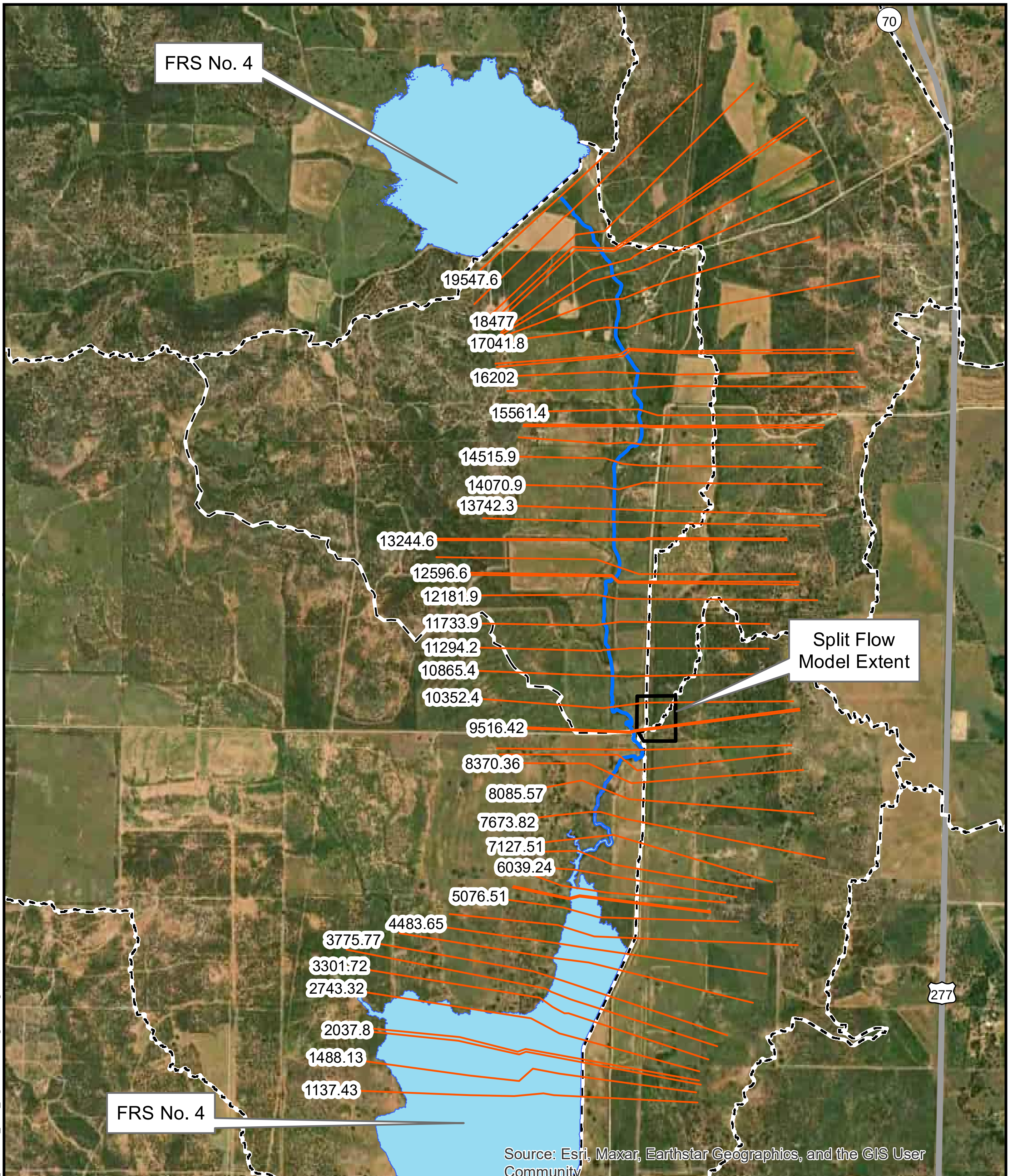

N

0 2,000 Feet

Legend

- Middle Kickapoo Creek
- Watersheds
- Cross-Section

Figure D-2
Kickapoo 4
Cross-Sections

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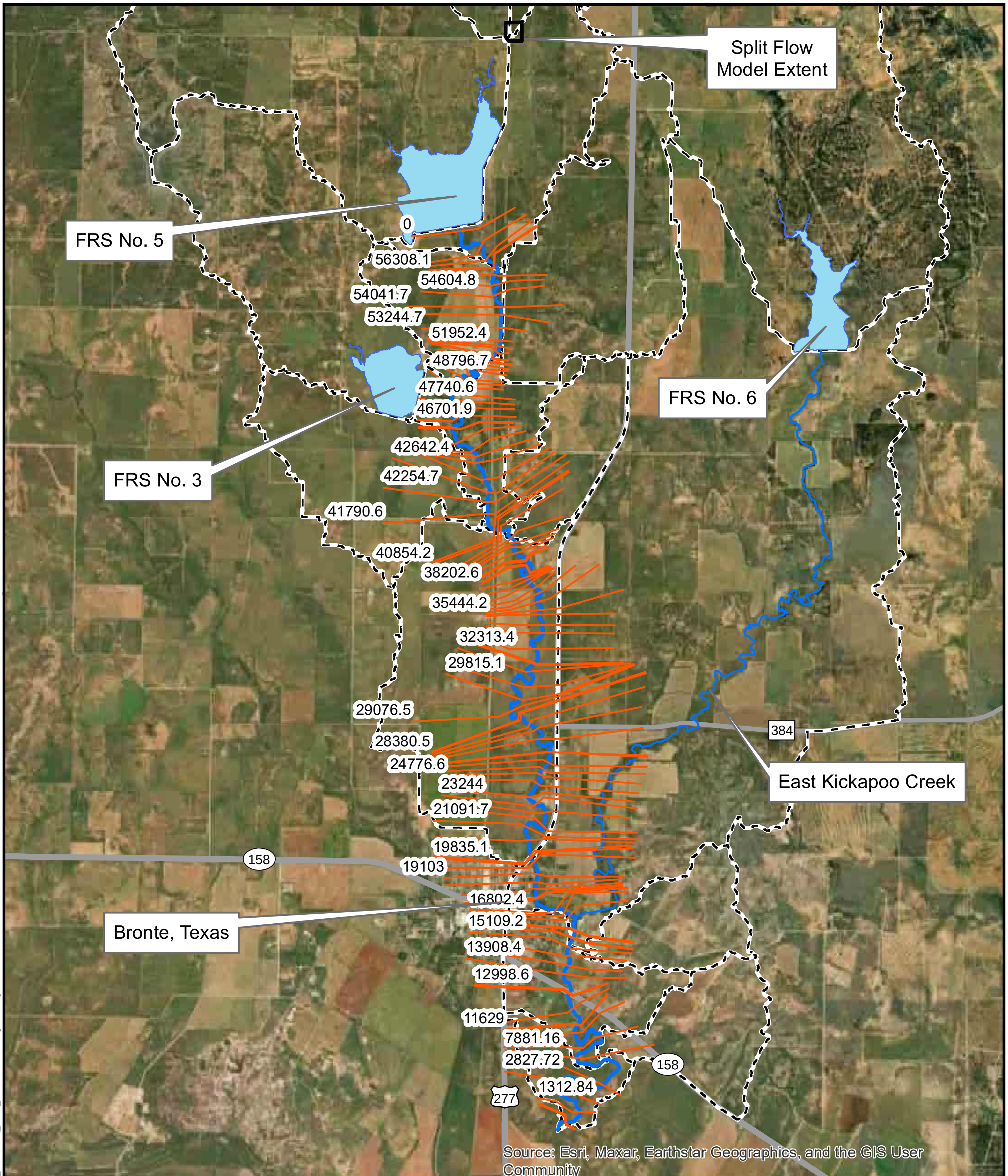

Legend

- Local Roads
- Highways
- Watersheds
- Cross-Section
- Middle Kickapoo Creek
- East Kickapoo Creek

Figure D-3
Kickapoo 5
Cross-Sections

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Appendix E Other Supporting Information

E-1 Evaluation of Potential Rehabilitation Projects – FRS No. 4

EVALUATION OF POTENTIAL REHABILITATION PROJECTS								
STATE	TX	DAM	Kickapoo Creek Dam No. 4	BY	ANB/ANR	DATE	3/23/2022	
		YEAR BUILT	1962	DESIGN HAZARD CLASS	S	DRAINAGE AREA	3.95	mi^2
		WORK PLAN DATE	3/1/1960	CURRENT HAZARD CLASS	H	DAM HEIGHT	28	ft
sht 1 of 5	CONSEQUENCES OF DAM FAILURE (ver. 2013-02)					NID ID	TX03515	

POTENTIAL DAM FAILURE:				
Total Failure Index			190	A
POTENTIAL LOSS OF LIFE:				
Maximum Population-at-Risk [PAR]		(number)	16	B
Total Risk Index			21	C
POTENTIAL LOSS OF PROPERTY:				
Identify major community affected by breach and rate impact as High (H), Medium (M), Low (L) or None(blank)				
Community	Unincorporated	(H,M,L,-)	H	D
Number of homes, businesses, major buildings		(number)	4	E
POTENTIAL LIFELINE DISRUPTION:				
Water supply, identify community disrupted by dam failure, and estimate number/amount				
Municipal sole source	Users	(number)	0	F
Supplemental source	Users	(number)	0	G
Irrigation water	Storage	(Ac-Ft)	0	H
POTENTIAL INFRASTRUCTURE DISRUPTION:				
Transportation system crossings, identify major crossing rendered unusable by dam failure, and estimate number				
Major/Interstate	Roads	(number)	0	I
Secondary/County	McDonald Road, Nipple Peak Road — Roads	(number)	2	J
POTENTIAL ADVERSE IMPACTS ON THE ENVIRONMENT:				
Describe impacts and rate each as High (H), Medium (M), Low (L), or None (blank)				
Threatened & endangered species	Federally and state-listed species with the potential t	(H,M,L,-)	L	K
Sensitive riparian areas	Riparian areas are likely present on site.	(H,M,L,-)	L	L
Contaminated reservoir sediment	Area upstream appears to be undeveloped woodlan	(H,M,L,-)	L	M
Wetland and wildlife habitat	Fringe wetlands and wildlife habitat is likely present	(H,M,L,-)	L	N
Other		(H,M,L,-)	-	O
POTENTIAL ADVERSE SOCIAL IMPACTS:				
Describe impacts and rate each as High (H), Medium (M), Low (L) or None(blank)				
Known cultural resources	3 prehistoric archeological sites present	(H,M,L,-)	H	P
Historic preservation issues	1 historic-age resource present	(H,M,L,-)	L	Q
Socially disadvantaged community	Site is located in a primarily rural area	(H,M,L,-)	L	R
POTENTIAL ADVERSE ECONOMIC IMPACTS:				
Average annual benefits attributed to this dam, updated workplan value		($)	26,841	S
Changes in benefits since workplan; Increase(I), No change(NC), Decrease(D)		(I,NC,D)	I	T
Low income families impacted		(number)	0	U
INPUT BY STATE DAM SAFETY AGENCY:				
State dam safety order issued for repair, modification, removal issued, Yes(Y), No(N)		(Y,N)	N	V
State Dam Safety Agency Priority, High(H), Medium(M), Low(L), None(blank)		(H,M,L,-)	-	W
OTHER CONSIDERATIONS:				
Identify any other considerations and rate as High(H), Medium(M), Low(L) or None(blank)				
		(H,M,L,-)	-	X
		(H,M,L,-)	-	Y

EVALUATION OF POTENTIAL REHABILITATION PROJECTS							
STATE	TX	DAM	Kickapoo Creek Dam No. 4	BY	ANB/ANR	DATE	3/23/2022
sht 2 of 5	FAILURE & RISK INDEXES						ver 2013-02

Adopted from Bureau of Reclamation "Risk Based Profile System"
see: http://www.usbr.gov/dsis/risk/rbpsdocumentation.pdf

LIFE LOSS:

Population-at-Risk [PAR], see NRCS dams inventory definition (number of people)

Estimate PAR for static loading failure; typically assume water at or above invert of the lowest open channel auxiliary spillway	16	A
Estimate PAR for hydrologic loading failure; typically assume water at or above invert of the lowest open channel auxiliary spillway	16	B
Estimate PAR for seismic loading failure; typically assume water at or above invert of the lowest non-gated spillway (sunny day failure)	4	C

Fatality Rates [FR] from dam breach
Adopted from BuRec "A Procedure for Estimating Loss of Life Caused by Dam Failure" DSO-99-06
see: http://www.usbr.gov/research/dam_safety/documents/dso-99-06.pdf
Flood Severity/Lethality [DV] is the average depth [D] times velocity [V] across flood plain (ft2/sec)
DV= (breach discharge - bank full discharge) / breach floodplain width
Warning Time [T] between failure warning and flood wave at population (minutes)
Flood Severity Understanding [U] of the warning issuer of the likely flooding magnitude

Scenario	Breach Discharge	Bankfull Discharge	Breach Floodplain Width	DV	Warning Time, T	Understanding, U
	(cfs)	(cfs)	(ft)	(ft2/sec)	(minutes)	(N/A or Vague)
Static	30,914	78	2,526	12	22	Vague
Hydrologic	20,968	78	1,911	11	25	Vague
Seismic	2,635	78	817	3	45	Vague

For DV≥50	T≤60	U=vague	FR=0.04
	T>60		FR=0.03
For DV<50	T≤60	U=vague	FR=0.007
	T>60		FR=0.0003

Estimate FR for static loading failure scenario	0.007	D
Estimate FR for hydrologic loading failure scenario	0.007	E
Estimate FR for seismic loading failure scenario	0.007	F

Scenario	Load Factor	Response Factor	Failure Index	Fatality Rate	PAR	Risk Index
Static	1	142	142	0.007	16	16
Hydrologic	*	*	48	0.007	16	5
Seismic	0.00	#DIV/0!	0	0.007	4	0
		TOTAL=	190		TOTAL=	21

EVALUATION OF POTENTIAL REHABILITATION PROJECTS							
STATE	TX	DAM	Kickapoo Creek Dam No. 4	BY	ANB/ANR	DATE	3/23/2022
sht 3 of 5	STATIC FAILURE INDEX					ver 2013-02	

PRINCIPAL SPILLWAY SYSTEM (60 points max): (total points)	30		A
Downstream filter or filter zone around conduit (yes=0 or no=10)		10	B
Conduit trench deep (>2d) and narrow (<3d) and steep sideslope (<2:1) (no=0 or yes=10)		0	C
Principal spillway system (inlet, pipe, or outlet) in deteriorated condition (no=0 or yes=10)		0	D
Conduit has seepage cutoff collars or other compaction adverse features (no=0 or yes=10)		10	E
Conduit contains open joints, open cracks, steady seepage (no=0 or yes=10)		0	F
Conduit founded on competent bedrock (yes=0 or no=10)		10	G
Reservoir control gate located at outlet of conduit (no=0 or yes=10)		0	H
RESERVOIR FILLING HISTORY (75 points max): (total points)	75		I
Reservoir has filled to x% of effective height (earth spillway crest minus original streambed)		49	J
(<50%=75 or 51-75%=50 or 76-90%=25 or 91-95%=10 or 96-100%=5 or >100%=0)		75	K
SEEPAGE AND DEFORMATION (85 points max): (total points)	18		L
Seepage carrying fines, or seepage increases with reservoir elevation increases, or sinkholes/jugholes exist in embankment (no=0 or yes=80)		0	M
Large amounts of seepage (no=0 or yes=6)		0	N
Visible and significant slope movement or sloughing (no=0 or yes=6)		0	O
Longitudinal or transverse embankment cracking greater than one foot in depth (no=0 or yes=6)		6	P
Sinkholes/depressions within two times effective height of the dam, either face (no=0 or yes=6)		0	Q
Poor top of dam condition, eroded, trees, rodent holes, settlement (no=0 or yes=6)		6	R
Abnormally wet areas at downstream toe/groin of embankment (no=0 or yes=6)		0	S
Inadequate slope protection against erosion by rainfall or waves (no=0 or yes=6)		6	T
FOUNDATION GEOLOGY (41 points max): (total points)	3		U
Highly fractures rock under core (no=0 or treated=3 or untreated=30)		0	V
Karst terrain and soluble rock (gypsum or limestone) (no=0 or treated=3 or untreated=30)		0	W
Collapsible soils (no=0 or treated=3 or untreated=30)		0	X
Significant stress relief fractures in abutments (no=0 or treated=3 or untreated=30)		0	Y
History of underground mining under embankment area (no=0 or treated=3 or untreated=30)		0	Z
Coarse grained and highly permeable soils (no=0 or yes=3)		0	AA
Presence of weak layers/conditions diminishing embankment stability (no=0 or yes=3)		0	AB
Erodible soils (sandy/silty materials) or weakly cemented rock (no=0 or yes=3)		3	AC
Reservoir area prone to landslides that could cause overtopping (no=0 or yes=3)		0	AD
EMBANKMENT DESIGN AND CONSTRUCTION (24 points max): (total points)	8		AE
Filters for core or foundation or incompatibility between zones (no=4 or yes=0)		4	AF
Embankment or foundation drainage system (yes=0 or no=4)		4	AG
Erodible core material (sands, silts, dispersive clays) (no=0 or yes=4)		0	AH
Incomplete or no foundation cutoff of shallow permeable layers (no=0 or yes=4)		0	AI
Poorly placed earthfill, inadequate density (no=0 or yes=4)		0	AJ
Gate features to drain reservoir (yes=0 or no=4)		0	AK
EMBANKMENT MONITORING (15 points max): (total points)	8		AL
Instruments (except surficial survey points) installed at dam (yes=0 or no=4)		4	AM
Installed instruments routinely read and evaluated (yes=0 or no=4)		0	AN
Visual inspection of dam by engineer less often than yearly (no=0 or yes=4)		4	AO
Good physical/visual access to downstream groin/toe for inspection (yes=0 or no=4)		0	AP
STATIC FAILURE INDEX: A+I+L+U+AE+AL		142	AQ

EVALUATION OF POTENTIAL REHABILITATION PROJECTS							
STATE	TX	**DAM**	Kickapoo Creek Dam No. 4	**BY**	ANB/ANR	**DATE**	3/23/2022
sht 4 of 5	**HYDROLOGIC FAILURE INDEX**						ver 2013-02

HYDROLOGIC LOADING:

Total Spillway Capacity (PS&ES) for 6hr storm [Pfb], Work Plan Tbl 3 (rainfall inches)					18.7	A
Obtained from Work Plan Tbl 3, or dams inventory data, or computer routings						
100 year, 6hr rainfall [P100] (inches)					6.2	B
Probable Maximum Precipitation [PMP] (inches)					25.6	C
if Pfb <=	P100	=	6.18	enter 40		
if Pfb =	P100+0.2(PMP-P100)	=	10.07	enter 25		
if Pfb =	P100+0.4(PMP-P100)		13.96	enter 15		
if Pfb =	P100+0.6(PMP-P100)	=	17.85	enter 7		
if Pfb =	P100+0.8(PMP-P100)	=	21.74	enter 3		
if Pfb =>	PMP	=	25.63	enter 1		
Enter interpolated value					6.1	D

HYDROLOGIC UNCERTAINTY:

Drainage Area [DA] (square miles)	3.95	E
DA<10 enter 1.5 ; 10<DA<20 enter 1.4 ; 20<DA<50 enter 1.3 ; DA=>50 enter 1.2	1.5	F

PIPE SPILLWAY PLUGGING:

Pipe Diameter [D] (inches)	30	G
D<12 enter 1.1; 12<=D<24 enter 1.0; 24<=D enter 0.9	0.9	H
Riser & trash rack type:		
Non-standardized inlet enter 1.1, Open Top riser enter 1.0; Covered or Baffle Top enter 0.9	1.0	I

EARTH SPILLWAY FLOW:

Earth spillway flow depth [Des] from top of dam to spillway crest (feet)(10' max)	5.3	J

DAM EROSION RESISTANCE:

Non-plastic (PI<10) fill enter 2.0 ; Plastic core enter 1.7 ; Overtopping armoring enter 0.8	1.7	K
Vegetal Cover Factor [Cf], see SITES or AH667	0.8	L
http://www.pswcrl.ars.usda.gov/ah667/ah667.htm		
Cf <0.4 enter 1.1; Cf < 0.7 enter 1.0; Cf<1.0 enter 0.9; larger Cf enter 0.8	0.9	M

EARTH SPILLWAY EROSION RESISTANCE:

Low, can be excavated with hand tools, enter 2.0		
PI>10 and SPT blows<8, PI<10 and SPT blows>8, Kh<0.10, seismic velocity<2000fps		
Moderate, can be excavated with construction equipment, easy ripping, enter 1.2		
PI>10 and SPT blows>8, PI<10 and SPT blows>30, Kh<10, seismic velocity<7000fps		
High, very hard ripping, requires drilling and blasting, enter 0.2		
moderately hard rock, Kh>10, seismic velocity>7000fps	1.2	N
Vegetal Cover Factor [Cf], see SITES or AH667	0.8	O
Cf <0.4 enter 1.1; Cf < 0.7 enter 1.0; Cf<1.0 enter 0.9; larger Cf enter 0.8	0.9	P

HYDROLOGIC FAILURE INDEX:

dam overtopping breach: (2)(D)(F)(H)(I)(K)(M)	25	Q
earth spillway breach: (D+5J)(F)(H)(I)(N)(P)	48	R
larger of (2)(D)(F)(H)(I)(K)(M) or (D+5J)(F)(H)(I)(N)(P) but less than 300	48	S

EVALUATION OF POTENTIAL REHABILITATION PROJECTS								
STATE	TX	DAM	Kickapoo Creek Dam No. 4	BY	ANB/ANR	DATE	3/23/2022	
sht 5 of 5	SEISMIC FAILURE INDEX						ver 2013-02	

SEISMIC LOADING:		
Latitude (degrees.decimal)	32.003	A
Longitude (degrees.decimal)	-100.296	B
See "http://earthquake.usgs.gov/hazards/products/conterminous/2008/maps/" (MAP LINK)		
PGA [peak ground acceleration] for 2% chance in 50 years, see NSHM maps (%g)	3.20	C
if PGA is less than 10% g, enter 0		
if PGA is between 10% g and 19% g, enter 0.15		
if PGA is between 20% g and 39% g, enter 0.30		
if PGA is between 40% g and 59% g, enter 0.65		
if PGA is greater than 60% g, enter 1.0	0.00	D
FOUNDATION LIQUEFACTION:		
Select the following foundation conditions which best represents the site		
Loose alluvium, lacustrine, loess materials, enter 10		
Bedrock, glacial till, highly clayey materials, enter 5	5	E
EMBANKMENT FREEBOARD FOR FOUNDATION LIQUEFACTION:		
Dam height (ft)	28	F
Freeboard - Elevation difference from top of dam to assumed pool surface (ft)	5.3	G
Freeboard percent of dam height (%)	19	H
if Freeboard is less than 25% of dam height, enter 10		
if Freeboard is 25% to 50% of dam height, enter 5		
if Freeboard is more than 50% of dam height, enter 1	10	I
EMBANKMENT FREEBOARD FOR EMBANKMENT CRACKING:		
Freeboard is less than or equal to 15 feet (no=0 or yes=1)	1	J
EMBANKMENT CRACKING:		
Embankment contains self-healing filter zones (no=4 or yes=0)	4	K
SEISMIC FAILURE INDEX:		
IF E=10, L=(D)(E)(I) ; IF E=5, L=(D)(E)(J+1)(K+1)); but less than 100	0	L

State Conservation Engineer's Signature
concurring with technical content of sheets 2 thru 5

COMPUTATION OF POPULATION AT RISK (PAR) DURING DAM FAILURE

STATE	TX		BY	TPB	DATE	3/18/22
DAM	Kickapoo Site No. 4: Static		CHECKED BY	ANR	DATE	3/23/22
YEAR BUILT	1962	DESIGN HAZARD CLASS	S	DRAINAGE AREA	3.95	mi^2
WORK PLAN DATE	3/1/1960	CURRENT HAZARD CLASS	H	DAM HEIGHT	28	ft
sht 1 of 3	STATIC FAILURE SCENARIO (ver. 2013-01)				NID ID	TX03515

Structures (Elevated) Impacted by Potential Breach	Number of Structures			PAR per Exposure with Inundation Depths >=2.0 Ft.	PAR
	Inundation Depth Above Natural Ground		Total		
	<2.0 Ft	>=2.0 Ft.			
Mobile Homes				3	
Seasonal Use RV's				2	
Other					

Structures (With Foundations) Impacted by Potential Breach	Number of Structures			PAR per Exposure with Inundation Depths >=1.0 Ft.	PAR
	Inundation Depth Above Natural Ground		Total		
	<1.0 Ft	>=1.0 Ft.			
Homes		4	4	3	12
Seasonal Use Homes and Cabins				1.5	
Duplexes				5	
Apartments					
Commercial Buildings					
Schools (In Use)					
Schools (Not in Use)					
Hospitals					
Other					

Highways and Railroads	Number of Roads, Highways and Railways			PAR per Exposure with Inundation Depths >=1.0 Ft.	PAR
	Road Overflow Depth		Total		
	<1.0 Ft	>=1.0 Ft.			
Main Local Roads and Minor State Highways					
McDonald Road, Nipple Peak Road		2	2	2	4
Name(s) (if applicable)				2	
Major State and Minor Federal Highways					
Highway Name(s) or Number(s)				4	
Highway Name(s) or Number(s)				4	
Major Federal and Interstate Highways					
Highway Name(s) or Number(s)				8	
Highway Name(s) or Number(s)				8	
Railroads					
UPSF Freight Traffic Only				3	
Passenger Traffic				20	
TOTAL NUMBER OF PEOPLE AT RISK (PAR)					**16**

COMPUTATION OF POPULATION AT RISK (PAR) DURING DAM FAILURE

STATE	TX		BY	TPB	DATE	3/18/22
DAM	Kickapoo Site No. 4: Hydrologic		CHECKED BY	ANR	DATE	3/23/22
YEAR BUILT	1962	DESIGN HAZARD CLASS	S	DRAINAGE AREA	3.95	mi^2
WORK PLAN DATE	3/1/1960	CURRENT HAZARD CLASS	H	DAM HEIGHT	28	ft
sht 1 of 3	STATIC FAILURE SCENARIO (ver. 2013-01)				NID ID	TX03515

Structures (Elevated) Impacted by Potential Breach	Number of Structures			PAR per Exposure with Inundation Depths >=2.0 Ft.	PAR
	Inundation Depth Above Natural Ground		Total		
	<2.0 Ft	>=2.0 Ft.			
Mobile Homes				3	
Seasonal Use RV's				2	
Other					
Structures (With Foundations) Impacted by Potential Breach	**Number of Structures**			**PAR per Exposure with Inundation Depths >=1.0 Ft.**	**PAR**
	Inundation Depth Above Natural Ground		**Total**		
	<1.0 Ft	**>=1.0 Ft.**			
Homes		4	4	3	12
Seasonal Use Homes and Cabins				1.5	
Duplexes				5	
Apartments					
Commercial Buildings					
Schools (In Use)					
Schools (Not in Use)					
Hospitals					
Other					
Highways and Railroads	**Number of Roads, Highways and Railways**			**PAR per Exposure with Inundation Depths >=1.0 Ft.**	**PAR**
	Road Overflow Depth		**Total**		
	<1.0 Ft	**>=1.0 Ft.**			
Main Local Roads and Minor State Highways					
McDonald Road, Nipple Peak Road		2	2	2	4
Name(s) (if applicable)				2	
Major State and Minor Federal Highways					
Highway Name(s) or Number(s)				4	
Highway Name(s) or Number(s)				4	
Major Federal and Interstate Highways					
Highway Name(s) or Number(s)				8	
Highway Name(s) or Number(s)				8	
Railroads					
UPSF Freight Traffic Only				3	
Passenger Traffic				20	
TOTAL NUMBER OF PEOPLE AT RISK (PAR)					**16**

COMPUTATION OF POPULATION AT RISK (PAR) DURING DAM FAILURE

STATE	TX		BY	TPB	DATE	3/18/22
DAM	Kickapoo Site No. 4: Seismic		CHECKED BY	ANR	DATE	3/23/22
YEAR BUILT	1962	DESIGN HAZARD CLASS	S	DRAINAGE AREA	3.95	mi^2
WORK PLAN DATE	3/1/1960	CURRENT HAZARD CLASS	H	DAM HEIGHT	28	ft
sht 1 of 3	STATIC FAILURE SCENARIO (ver. 2013-01)				NID ID	TX03515

Structures (Elevated) Impacted by Potential Breach	Number of Structures			PAR per Exposure with Inundation Depths >=2.0 Ft.	PAR
	Inundation Depth Above Natural Ground		Total		
	<2.0 Ft	>=2.0 Ft.			
Mobile Homes				3	
Seasonal Use RV's				2	
Other					

Structures (With Foundations) Impacted by Potential Breach	Number of Structures			PAR per Exposure with Inundation Depths >=1.0 Ft.	PAR
	Inundation Depth Above Natural Ground		Total		
	<1.0 Ft	>=1.0 Ft.			
Homes				3	
Seasonal Use Homes and Cabins				1.5	
Duplexes				5	
Apartments					
Commercial Buildings					
Schools (In Use)					
Schools (Not in Use)					
Hospitals					
Other					

Highways and Railroads	Number of Roads, Highways and Railways			PAR per Exposure with Inundation Depths >=1.0 Ft.	PAR
	Road Overflow Depth		Total		
	<1.0 Ft	>=1.0 Ft.			
Main Local Roads and Minor State Highways					
McDonald Road, Nipple Peak Road		2	2	2	4
Name(s) (if applicable)				2	
Major State and Minor Federal Highways					
Highway Name(s) or Number(s)				4	
Highway Name(s) or Number(s)				4	
Major Federal and Interstate Highways					
Highway Name(s) or Number(s)				8	
Highway Name(s) or Number(s)				8	
Railroads					
UPSF Freight Traffic Only				3	
Passenger Traffic				20	
TOTAL NUMBER OF PEOPLE AT RISK (PAR)					**4**

E-2 Evaluation of Potential Rehabilitation Projects – FRS No. 5

EVALUATION OF POTENTIAL REHABILITATION PROJECTS								
STATE	TX	DAM	Kickapoo Creek Dam No. 5	BY	ANB/ANR	DATE	3/23/2022	
		YEAR BUILT	1963	DESIGN HAZARD CLASS	S	DRAINAGE AREA	12.62	mi^2
		WORK PLAN DATE	3/1/1960	CURRENT HAZARD CLASS	H	DAM HEIGHT	32	ft
sht 1 of 5	CONSEQUENCES OF DAM FAILURE (ver. 2013-02)					NID ID	TX03524	

POTENTIAL DAM FAILURE:				
Total Failure Index			162	A
POTENTIAL LOSS OF LIFE:				
Maximum Population-at-Risk [PAR]		(number)	37	B
Total Risk Index			2	C
POTENTIAL LOSS OF PROPERTY:				
Identify major community affected by breach and rate impact as High (H), Medium (M), Low (L) or None(blank)				
Community	City of Bronte (2 buildings), Unincorporated (7 buildings)	(H,M,L,-)	H	D
Number of homes, businesses, major buildings		(number)	9	E
POTENTIAL LIFELINE DISRUPTION:				
Water supply, identify community disrupted by dam failure, and estimate number/amount				
Municipal sole source	Users	(number)	0	F
Supplemental source	Users	(number)	0	G
Irrigation water	Storage	(Ac-Ft)	0	H
POTENTIAL INFRASTRUCTURE DISRUPTION:				
Transportation system crossings, identify major crossing rendered unusable by dam failure, and estimate number				
Major/Interstate	Roads	(number)	0	I
Secondary/County	Railroad Rd (2), (3), (4), Main St., Oliver Ave. Roads	(number)	5	J
POTENTIAL ADVERSE IMPACTS ON THE ENVIRONMENT:				
Describe impacts and rate each as High (H), Medium (M), Low (L), or None (blank)				
Threatened & endangered species	Federally and state-listed species with the potential	(H,M,L,-)	M	K
Sensitive riparian areas	Riparian areas are likely present on site.	(H,M,L,-)	L	L
Contaminated reservoir sediment	Area upstream appears to be undeveloped shrublan	(H,M,L,-)	L	M
Wetland and wildlife habitat	Fringe wetlands and wildlife habitat is likely present	(H,M,L,-)	L	N
Other		(H,M,L,-)	-	O
POTENTIAL ADVERSE SOCIAL IMPACTS:				
Describe impacts and rate each as High (H), Medium (M), Low (L) or None(blank)				
Known cultural resources	4 prehistoric archeological sites present	(H,M,L,-)	H	P
Historic preservation issues	2 historic-age resources present	(H,M,L,-)	L	Q
Socially disadvantaged community		(H,M,L,-)		R
POTENTIAL ADVERSE ECONOMIC IMPACTS:				
Average annual benefits attributed to this dam, updated workplan value		($)	85,754	S
Changes in benefits since workplan; Increase(I), No change(NC), Decrease(D)		(I,NC,D)	I	T
Low income families impacted		(number)	0	U
INPUT BY STATE DAM SAFETY AGENCY:				
State dam safety order issued for repair, modification, removal issued, Yes(Y), No(N)		(Y,N)	N	V
State Dam Safety Agency Priority, High(H), Medium(M), Low(L), None(blank)		(H,M,L,-)	-	W
OTHER CONSIDERATIONS:				
Identify any other considerations and rate as High(H), Medium(M), Low(L) or None(blank)				
		(H,M,L,-)	-	X
		(H,M,L,-)	-	Y

EVALUATION OF POTENTIAL REHABILITATION PROJECTS							
STATE	TX	**DAM**	Kickapoo Creek Dam No. 5	**BY**	ANB/ANR	**DATE**	3/23/2022
sht 2 of 5	**FAILURE & RISK INDEXES**						ver 2013-02

Adopted from Bureau of Reclamation "Risk Based Profile System"
see: http://www.usbr.gov/dsis/risk/rbpsdocumentation.pdf

LIFE LOSS:

Population-at-Risk [PAR], see NRCS dams inventory definition (number of people)

Estimate PAR for static loading failure; typically assume water at or above invert of the lowest open channel auxiliary spillway	37	A
Estimate PAR for hydrologic loading failure; typically assume water at or above invert of the lowest open channel auxiliary spillway	22	B
Estimate PAR for seismic loading failure; typically assume water at or above invert of the lowest non-gated spillway (sunny day failure)	0	C

Fatality Rates [FR] from dam breach

Adopted from BuRec "A Procedure for Estimating Loss of Life Caused by Dam Failure" DSO-99-06
see: http://www.usbr.gov/research/dam_safety/documents/dso-99-06.pdf

Flood Severity/Lethality [DV] is the average depth [D] times velocity [V] across flood plain (ft2/sec)
DV= (breach discharge - bank full discharge) / breach floodplain width

Warning Time [T] between failure warning and flood wave at population (minutes)

Flood Severity Understanding [U] of the warning issuer of the likely flooding magnitude

Scenario	Breach Discharge	Bankfull Discharge	Breach Floodplain Width	DV	Warning Time, T	Understanding, U
	(cfs)	(cfs)	(ft)	(ft2/sec)	(minutes)	(N/A or Vague)
Static	35,557	66	2,389	15	147	Vague
Hydrologic	21,484	66	1,899	11	167	Vague
Seismic	3,187	66	1	3120	0	N/A

For DV≥50	T≤60	U=vague	FR=0.04
	T>60		FR=0.03
For DV<50	T≤60	U=vague	FR=0.007
	T>60		FR=0.0003

Estimate FR for static loading failure scenario	0.0003	D
Estimate FR for hydrologic loading failure scenario	0.0003	E
Estimate FR for seismic loading failure scenario	0.04	F

Scenario	Load Factor	Response Factor	Failure Index	Fatality Rate	PAR	Risk Index
Static	1	111	111	0.0003	37	1
Hydrologic	*	*	51	0.0003	22	0
Seismic	0.00	#DIV/0!	0	0.04	0	0
		TOTAL=	162		TOTAL=	2

EVALUATION OF POTENTIAL REHABILITATION PROJECTS							
STATE	TX	DAM	Kickapoo Creek Dam No. 5	BY	ANB/ANR	DATE	3/23/2022
sht 3 of 5	STATIC FAILURE INDEX						ver 2013-02

PRINCIPAL SPILLWAY SYSTEM (60 points max): (total points)	30		A
Downstream filter or filter zone around conduit (yes=0 or no=10)		10	B
Conduit trench deep (>2d) and narrow (<3d) and steep sideslope (<2:1) (no=0 or yes=10)		0	C
Principal spillway system (inlet, pipe, or outlet) in deteriorated condition (no=0 or yes=10)		0	D
Conduit has seepage cutoff collars or other compaction adverse features (no=0 or yes=10)		10	E
Conduit contains open joints, open cracks, steady seepage (no=0 or yes=10)		0	F
Conduit founded on competent bedrock (yes=0 or no=10)		10	G
Reservoir control gate located at outlet of conduit (no=0 or yes=10)		0	H
RESERVOIR FILLING HISTORY (75 points max): (total points)	50		I
Reservoir has filled to x% of effective height (earth spillway crest minus original streambed)		50	J
(<50%=75 or 51-75%=50 or 76-90%=25 or 91-95%=10 or 96-100%=5 or >100%=0)		50	K
SEEPAGE AND DEFORMATION (85 points max): (total points)	12		L
Seepage carrying fines, or seepage increases with reservoir elevation increases, or sinkholes/jugholes exist in embankment (no=0 or yes=80)		0	M
Large amounts of seepage (no=0 or yes=6)		0	N
Visible and significant slope movement or sloughing (no=0 or yes=6)		0	O
Longitudinal or transverse embankment cracking greater than one foot in depth (no=0 or yes=6)		0	P
Sinkholes/depressions within two times effective height of the dam, either face (no=0 or yes=6)		0	Q
Poor top of dam condition, eroded, trees, rodent holes, settlement (no=0 or yes=6)		6	R
Abnormally wet areas at downstream toe/groin of embankment (no=0 or yes=6)		0	S
Inadequate slope protection against erosion by rainfall or waves (no=0 or yes=6)		6	T
FOUNDATION GEOLOGY (41 points max): (total points)	3		U
Highly fractures rock under core (no=0 or treated=3 or untreated=30)		0	V
Karst terrain and soluble rock (gypsum or limestone) (no=0 or treated=3 or untreated=30)		0	W
Collapsible soils (no=0 or treated=3 or untreated=30)		0	X
Significant stress relief fractures in abutments (no=0 or treated=3 or untreated=30)		0	Y
History of underground mining under embankment area (no=0 or treated=3 or untreated=30)		0	Z
Coarse grained and highly permeable soils (no=0 or yes=3)		0	AA
Presence of weak layers/conditions diminishing embankment stability (no=0 or yes=3)		0	AB
Erodible soils (sandy/silty materials) or weakly cemented rock (no=0 or yes=3)		3	AC
Reservoir area prone to landslides that could cause overtopping (no=0 or yes=3)		0	AD
EMBANKMENT DESIGN AND CONSTRUCTION (24 points max): (total points)	8		AE
Filters for core or foundation or incompatibility between zones (no=4 or yes=0)		4	AF
Embankment or foundation drainage system (yes=0 or no=4)		4	AG
Erodible core material (sands, silts, dispersive clays) (no=0 or yes=4)		0	AH
Incomplete or no foundation cutoff of shallow permeable layers (no=0 or yes=4)		0	AI
Poorly placed earthfill, inadequate density (no=0 or yes=4)		0	AJ
Gate features to drain reservoir (yes=0 or no=4)		0	AK
EMBANKMENT MONITORING (15 points max): (total points)	8		AL
Instruments (except surficial survey points) installed at dam (yes=0 or no=4)		4	AM
Installed instruments routinely read and evaluated (yes=0 or no=4)		0	AN
Visual inspection of dam by engineer less often than yearly (no=0 or yes=4)		4	AO
Good physical/visual access to downstream groin/toe for inspection (yes=0 or no=4)		0	AP
STATIC FAILURE INDEX: A+I+L+U+AE+AL		111	AQ

EVALUATION OF POTENTIAL REHABILITATION PROJECTS

STATE	TX	DAM	Kickapoo Creek Dam No. 5	BY	ANB/ANR	DATE	3/23/2022
sht 4 of 5	HYDROLOGIC FAILURE INDEX						ver 2013-02

HYDROLOGIC LOADING:		
Total Spillway Capacity (PS&ES) for 6hr storm [Pfb], Work Plan Tbl 3 (rainfall inches)	17.5	A
Obtained from Work Plan Tbl 3, or dams inventory data, or computer routings		
100 year, 6hr rainfall [P100] (inches)	6.2	B
Probable Maximum Precipitation [PMP] (inches)	23.9	C
if Pfb <= P100 = 6.18 enter 40		
if Pfb = P100+0.2(PMP-P100) = 9.72 enter 25		
if Pfb = P100+0.4(PMP-P100) 13.25 enter 15		
if Pfb = P100+0.6(PMP-P100) = 16.79 enter 7		
if Pfb = P100+0.8(PMP-P100) = 20.32 enter 3		
if Pfb => PMP = 23.86 enter 1		
Enter interpolated value	6.2	D
HYDROLOGIC UNCERTAINTY:		
Drainage Area [DA] (square miles)	12.62	E
DA<10 enter 1.5 ; 10<DA<20 enter 1.4 ; 20<DA<50 enter 1.3 ; DA=>50 enter 1.2	1.4	F
PIPE SPILLWAY PLUGGING:		
Pipe Diameter [D] (inches)	30	G
D<12 enter 1.1; 12<=D<24 enter 1.0; 24<=D enter 0.9	0.9	H
Riser & trash rack type:		
Non-standardized inlet enter 1.1, Open Top riser enter 1.0; Covered or Baffle Top enter 0.9	1.0	I
EARTH SPILLWAY FLOW:		
Earth spillway flow depth [Des] from top of dam to spillway crest (feet)(10' max)	6.3	J
DAM EROSION RESISTANCE:		
Non-plastic (PI<10) fill enter 2.0 ; Plastic core enter 1.7 ; Overtopping armoring enter 0.8	1.7	K
Vegetal Cover Factor [Cf], see SITES or AH667	0.8	L
http://www.pswcrl.ars.usda.gov/ah667/ah667.htm		
Cf <0.4 enter 1.1; Cf < 0.7 enter 1.0; Cf<1.0 enter 0.9; larger Cf enter 0.8	0.9	M
EARTH SPILLWAY EROSION RESISTANCE:		
Low, can be excavated with hand tools, enter 2.0		
PI>10 and SPT blows<8, PI<10 and SPT blows>8, Kh<0.10, seismic velocity<2000fps		
Moderate, can be excavated with construction equipment, easy ripping, enter 1.2		
PI>10 and SPT blows>8, PI<10 and SPT blows>30, Kh<10, seismic velocity<7000fps		
High, very hard ripping, requires drilling and blasting, enter 0.2		
moderately hard rock, Kh>10, seismic velocity>7000fps	1.2	N
Vegetal Cover Factor [Cf], see SITES or AH667	0.8	O
Cf <0.4 enter 1.1; Cf < 0.7 enter 1.0; Cf<1.0 enter 0.9; larger Cf enter 0.8	0.9	P
HYDROLOGIC FAILURE INDEX:		
dam overtopping breach: (2)(D)(F)(H)(I)(K)(M)	24	Q
earth spillway breach: (D+5J)(F)(H)(I)(N)(P)	51	R
larger of (2)(D)(F)(H)(I)(K)(M) or (D+5J)(F)(H)(I)(N)(P) but less than 300	51	S

EVALUATION OF POTENTIAL REHABILITATION PROJECTS							
STATE	TX	DAM	Kickapoo Creek Dam No. 5	BY	ANB/ANR	DATE	3/23/2022
sht 5 of 5	SEISMIC FAILURE INDEX						ver 2013-02

SEISMIC LOADING:		
Latitude (degrees.decimal)	31.959	A
Longitude (degrees.decimal)	-100.298	B
See "http://earthquake.usgs.gov/hazards/products/conterminous/2008/maps/" (MAP LINK)		
PGA [peak ground acceleration] for 2% chance in 50 years, see NSHM maps (%g)	3.20	C
if PGA is less than 10% g, enter 0		
if PGA is between 10% g and 19% g, enter 0.15		
if PGA is between 20% g and 39% g, enter 0.30		
if PGA is between 40% g and 59% g, enter 0.65		
if PGA is greater than 60% g, enter 1.0	0.00	D
FOUNDATION LIQUEFACTION:		
Select the following foundation conditions which best represents the site		
Loose alluvium, lacustrine, loess materials, enter 10		
Bedrock, glacial till, highly clayey materials, enter 5	5	E
EMBANKMENT FREEBOARD FOR FOUNDATION LIQUEFACTION:		
Dam height (ft)	32	F
Freeboard - Elevation difference from top of dam to assumed pool surface (ft)	6.3	G
Freeboard percent of dam height (%)	20	H
if Freeboard is less than 25% of dam height, enter 10		
if Freeboard is 25% to 50% of dam height, enter 5		
if Freeboard is more than 50% of dam height, enter 1	10	I
EMBANKMENT FREEBOARD FOR EMBANKMENT CRACKING:		
Freeboard is less than or equal to 15 feet (no=0 or yes=1)	1	J
EMBANKMENT CRACKING:		
Embankment contains self-healing filter zones (no=4 or yes=0)	4	K
SEISMIC FAILURE INDEX:		
IF E=10, L=(D)(E)(I) ; IF E=5, L=(D)(E)(J+1)(K+1)); but less than 100	0	L

State Conservation Engineer's Signature

concurring with technical content of sheets 2 thru 5

COMPUTATION OF POPULATION AT RISK (PAR) DURING DAM FAILURE

STATE	TX		BY	TPB	DATE	3/18/22
DAM	Kickapoo Site No. 5: Static		CHECKED BY	ANR	DATE	3/23/22
YEAR BUILT	1963	DESIGN HAZARD CLASS	S	DRAINAGE AREA	12.62	mi^2
WORK PLAN DATE	3/1/1960	CURRENT HAZARD CLASS	H	DAM HEIGHT	32	ft
sht 1 of 3	STATIC FAILURE SCENARIO (ver. 2013-01)				NID ID	TX03524

Structures (Elevated) Impacted by Potential Breach	Number of Structures			PAR per Exposure with Inundation Depths >=2.0 Ft.	PAR
	Inundation Depth Above Natural Ground		Total		
	<2.0 Ft	>=2.0 Ft.			
Mobile Homes				3	
Seasonal Use RV's				2	
Other					

Structures (With Foundations) Impacted by Potential Breach	Number of Structures			PAR per Exposure with Inundation Depths >=1.0 Ft.	PAR
	Inundation Depth Above Natural Ground		Total		
	<1.0 Ft	>=1.0 Ft.			
Homes	2	7	9	3	21
Seasonal Use Homes and Cabins				1.5	
Duplexes				5	
Apartments					
Commercial Buildings		2	2	3	6
Schools (In Use)					
Schools (Not in Use)					
Hospitals					
Other					

Highways and Railroads	Number of Roads, Highways and Railways			PAR per Exposure with Inundation Depths >=1.0 Ft.	PAR
	Road Overflow Depth		Total		
	<1.0 Ft	>=1.0 Ft.			
Main Local Roads and Minor State Highways					
Railroad Rd (2), Railroad Rd (3), Railroad Rd (4)		3	3	2	6
Main St., Oliver Ave.		2	2	2	4
Major State and Minor Federal Highways					
US 277, SH 158	2		2	4	0
Highway Name(s) or Number(s)				4	
Major Federal and Interstate Highways					
Highway Name(s) or Number(s)				8	
Highway Name(s) or Number(s)				8	
Railroads					
UPSF Freight Traffic Only				3	
Passenger Traffic				20	
TOTAL NUMBER OF PEOPLE AT RISK (PAR)					**37**

COMPUTATION OF POPULATION AT RISK (PAR) DURING DAM FAILURE

STATE	TX		BY	TPB	DATE	3/18/22
DAM	Kickapoo Site No. 5: Hydrologic		CHECKED BY	ANR	DATE	3/23/22
YEAR BUILT	1963	DESIGN HAZARD CLASS	S	DRAINAGE AREA	12.62	mi^2
WORK PLAN DATE	3/1/1960	CURRENT HAZARD CLASS	H	DAM HEIGHT	32	ft
sht 1 of 3	**STATIC FAILURE SCENARIO (ver. 2013-01)**				NID ID	TX03524

Structures (Elevated) Impacted by Potential Breach	Number of Structures: Inundation Depth Above Natural Ground <2.0 Ft	>=2.0 Ft.	Total	PAR per Exposure with Inundation Depths >=2.0 Ft.	PAR
Mobile Homes				3	
Seasonal Use RV's				2	
Other					

Structures (With Foundations) Impacted by Potential Breach	Number of Structures: Inundation Depth Above Natural Ground <1.0 Ft	>=1.0 Ft.	Total	PAR per Exposure with Inundation Depths >=1.0 Ft.	PAR
Homes		2	2	3	6
Seasonal Use Homes and Cabins				1.5	
Duplexes				5	
Apartments					
Commercial Buildings		2	2	3	6
Schools (In Use)					
Schools (Not in Use)					
Hospitals					
Other					

Highways and Railroads	Number of Roads, Highways and Railways: Road Overflow Depth <1.0 Ft	>=1.0 Ft.	Total	PAR per Exposure with Inundation Depths >=1.0 Ft.	PAR
Main Local Roads and Minor State Highways					
ailroad Rd (2), Railroad Rd (3), Railroad Rd (4)		3	3	2	6
Main St., Oliver Ave.		2	2	2	4
Major State and Minor Federal Highways					
US 277, SH 158	2		2	4	0
Highway Name(s) or Number(s)				4	
Major Federal and Interstate Highways					
Highway Name(s) or Number(s)				8	
Highway Name(s) or Number(s)				8	
Railroads					
UPSF Freight Traffic Only				3	
Passenger Traffic				20	
TOTAL NUMBER OF PEOPLE AT RISK (PAR)					**22**

COMPUTATION OF POPULATION AT RISK (PAR) DURING DAM FAILURE

STATE	TX		BY	TPB	DATE	3/18/22
DAM	Kickapoo Site No. 5: Seismic		CHECKED BY	ANR	DATE	3/23/22
YEAR BUILT	1963	DESIGN HAZARD CLASS	S	DRAINAGE AREA	12.62	mi^2
WORK PLAN DATE	3/1/1960	CURRENT HAZARD CLASS	H	DAM HEIGHT	32	ft
sht 1 of 3	STATIC FAILURE SCENARIO (ver. 2013-01)				NID ID	TX03524

Structures (Elevated) Impacted by Potential Breach	Number of Structures			PAR per Exposure with Inundation Depths >=2.0 Ft.	PAR
	Inundation Depth Above Natural Ground		Total		
	<2.0 Ft	>=2.0 Ft.			
Mobile Homes				3	
Seasonal Use RV's				2	
Other					

Structures (With Foundations) Impacted by Potential Breach	Number of Structures			PAR per Exposure with Inundation Depths >=1.0 Ft.	PAR
	Inundation Depth Above Natural Ground		Total		
	<1.0 Ft	>=1.0 Ft.			
Homes				3	
Seasonal Use Homes and Cabins				1.5	
Duplexes				5	
Apartments					
Commercial Buildings					
Schools (In Use)					
Schools (Not in Use)					
Hospitals					
Other					

Highways and Railroads	Number of Roads, Highways and Railways			PAR per Exposure with Inundation Depths >=1.0 Ft.	PAR
	Road Overflow Depth		Total		
	<1.0 Ft	>=1.0 Ft.			
Main Local Roads and Minor State Highways					
ailroad Rd (2), Railroad Rd (3), Railroad Rd (4	3		3	2	0
Main St., Oliver Ave.	2		2	2	0
Major State and Minor Federal Highways					
US 277, SH 158	2		2	4	0
Highway Name(s) or Number(s)				4	
Major Federal and Interstate Highways					
Highway Name(s) or Number(s)				8	
Highway Name(s) or Number(s)				8	
Railroads					
UPSF Freight Traffic Only				3	
Passenger Traffic				20	
TOTAL NUMBER OF PEOPLE AT RISK (PAR)					**0**

E-3 Federal and State Listed Threatened and Endangered Species Assessment – FRS No. 4

AECOM

Federal and State Listed Threatened and Endangered Species Assessment

Kickapoo Creek Floodwater Retarding Structure No.4 Rehabilitation Project

Coke County, Texas

Texas State Soil and Water Conservation Board

Project number: 60630022

August 2023

Delivering a better world

Prepared for:

Texas State Soil and Water Conservation Board

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Figures

Tables

1. Background

1.1 Project description

AECOM Technical Services, Inc. (AECOM) conducted a federal and state listed threatened and endangered species habitat assessment for the proposed Kickapoo Creek Floodwater Retarding Structure (FRS) No. 4 Rehabilitation Project (Project). The proposed Project is located in Coke County, approximately 5.5 miles northwest of Bronte, Texas (**Appendix A, Figure 1**). A literature search and field investigations were conducted for the Project within a potential impact area encompassing approximately 39 acres (Study Area).

1.2 Purpose

The purpose of this assessment is to comply with Section 9 of the Endangered Species Act (ESA), Chapters 67 and 68 of the Texas Parks and Wildlife (TPW) Code, and Sections 65.171 - 65.176 of Title 31 of the Texas Administrative Code (TAC) to avoid 'take' of federal or state listed threatened or endangered species.

A list of the current United States (U.S.) Fish and Wildlife Service (USFWS) and Texas Parks and Wildlife Department (TPWD) threatened and endangered (T&E) species and their associated habitat requirements are described within this document.

2. Methodology

A literature search was conducted to identify federal and state listed T&E species of concern with the potential to occur within the Study Area. Species lists were accessed through the USFWS's Environmental Conservation Online System (ECOS) Information for Planning and Consultation (IPaC) tool and through TPWD's Rare, Threatened, and Endangered Species list for Coke County. The literature search also included a review of studies and reports related to the ecology of the area as well as a review of TPWD's Texas Natural Diversity Database (TXNDD), which was obtained via email request. The TXNDD was reviewed on July 19, 2023, to report if any rare and/or listed threatened or endangered species have been previously observed within or adjacent to the Study Area.

Field investigations were conducted on July 11, 2023, to verify previously reviewed information, document the presence of federal and state listed species and/or suitable habitat, and characterize habitat and vegetation types.

3. Regulations

3.1 U.S. Fish and Wildlife Service

3.1.1 Endangered Species Act

USFWS has legislative authority to list and monitor the status of species whose populations are considered to be imperiled. The federal legislative authority for the federal protection of threatened and endangered species issues from the ESA of 1973 and its subsequent amendments. Regulations supporting this Act are codified and regularly updated in Title 50 Code of Federal Regulations (CFR) Sections 17.11 and 17.12.

The ESA process stratifies potential candidates based upon the species' biological vulnerability. Species listed as endangered or threatened by the federal government are provided full protection under the law. This protection not only prohibits the direct possession (take) of a protected species, but also includes a prohibition of indirect take, such as destruction of habitat. Listed plant species are not protected from take on privately-owned land, although it is illegal to collect or maliciously harm them on federal land. The ESA and accompanying regulations provide the necessary authority and incentive for individual states to establish their own regulatory vehicle for the management and protection of threatened and endangered species.

3.1.2 Migratory Bird Treaty Act

USFWS has legislative authority to prohibit, unless permitted by regulations, the kill, capture, collection, possession, buying, selling, trading, or transport of any migratory bird, nest, young, feather, or egg in part or in whole. The Migratory Bird Treaty Act (MBTA) and its subsequent amendments (16 U.S. Code [USC] 703-712) give the federal legislative authority for protection of migratory bird species. Regulations supporting the MBTA are codified and regularly updated in Title 50 CFR Parts 10 and 21.

3.2 Texas Parks and Wildlife Department

TPWD prohibits the take, possession, transportation, or sale of any of the animal or plant species designated by state law as endangered or threatened without the issuance of a permit (per Chapters 67 [Nongame Species] and 68 [Endangered Species] of the TPW Code and Sections 65.171 - 65.176 [Threatened and Endangered Nongame Species] of Title 31 of the TAC. “Take” is defined in the TPW Code as to “collect, hook, net, shoot, or snare, by any means or device, and includes an attempt to take or to pursue in order to take”.

Unlike federally listed species, there is no protection of habitat afforded to species that are only listed by the state.

4. Environmental Setting

Publicly available data was reviewed to identify aquatic features, soil types, and vegetation types within the Study Area. Data resources reviewed included the U.S. Geological Survey (USGS) National Hydrography Dataset (NHD), the U.S. Department of Agriculture (USDA) NRCS Web Soil Survey, USGS 7.5' quadrangle sheets, and recent aerial photography (Google Earth 2021). This data review was used to describe the site-specific information below.

4.1 Land use

The majority of the Study Area consisted of a dam structure, an auxiliary spillway, and undeveloped land. Based on the NHD, two intermittent streams, Middle Kickapoo Creek and one unnamed stream, were mapped within the Study Area (USGS 2023).

4.2 Topography

The USGS 7.5-minute quadrangle map for Bronte, TX displays the topography of the Study Area (**Appendix A, Figure 2**). Topography within the Study Area is shaped by the current reservoir and dam system Dry Creek and Middle Kickapoo Creek. The surface gradient slopes from northeast to southwest, with the highest elevation located along the northern boundary of the Study Area at approximately 2000 feet above mean sea level (MSL [National Geodetic Vertical Datum of 1929]). The lowest elevation is located along the southern boundary of the Study Area at approximately 1960 feet above MSL (National Geodetic Vertical Datum of 1929) (USGS 2022).

4.3 Soils

According to the USDA NRCS Web Soil Survey Report, the Study Area was mapped as being underlain by six soil map unit types (as shown on **Table 1** below and within **Appendix A, Figure 3**) (USDA 2021).

Table 1. NRCS Soil Mapping Units

Mapping Unit	Soil Type	Listed as Hydric by NRCS
CfB	Cobb fine sandy loam, dry, 1 to 3 percent slopes	No
CnB	Oben and Cobb soils, 1 to 3 percent slopes	No
MmA	Miles fine sandy loam, 0 to 1 percent slopes	No
SPW	Spillway	No
SS	Oplin-Rock outcrop complex, very steep	No
Ya	Westola very fine sandy loam, dry, 0 to 1 percent slopes, occasionally flooded	No

4.4 Vegetation

4.4.1 Historically Mapped and Documented Vegetation Types

According to TPWD's Ecoregion data, the Study Area falls within the Southwestern Table Lands Level 3 Ecoregion and the Caprock Canyons, Badlands, and Breaks Level 4 Ecoregion.

The Study Area lies within one Land Resource Region (LRR H) and one Major Land Resource Area (MLRA 78B). LRR H denotes the Central Great Plains Winter Wheat and Range Region and consists of vegetation mainly of grasslands and agricultural land. MLRA 78B is the Central Rolling Red Plains, Western Part, which can be characterized by red soils weathered from silty sandstone, siltstone, and claystone on rolling plains with ancient stream terraces or terrace remnants associated with stream dissection. Nearly level to gently sloping and consisting of dissected plain areas with steeper slopes occurring along entrenched river and creek valleys. Broad meander belts are associated with the major streams, and wide flood plains are flanked by nearly level stream terraces. More information on LRR H and MLRA 78B can be read within USDA's Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin, Handbook 296.

According to TPWD's Ecological Mapping System of Texas (EMST), the vegetation mapped within the Study Area includes Rolling Plains: Mixedgrass Prairie; Edwards Plateau: Floodplain Ashe Juniper Shrubland; Edwards Plateau: Floodplain Deciduous Shrubland; Edwards Plateau: Floodplain Herbaceous Vegetation; Edwards Plateau: Ashe Juniper-Live Oak Shrubland; Edwards Plateau: Ashe Juniper-Live Oak Slope Shrubland; Edwards Plateau: Riparian Ashe Juniper Forest; Edwards Plateau: Riparian Ashe Juniper Shrubland; Edwards Plateau: Riparian Deciduous Shrubland; Edwards Plateau: Riparian Herbaceous Vegetation; Rolling Plains: Breaks Evergreen Shrubland; Rolling Plains: Breaks Deciduous Shrubland; Barren; Native Invasive: Juniper Shrubland; Native Invasive: Mesquite Shrubland; Native Invasive: Mesquite Woodland; and Row Crops (**Appendix A, Figure 4**) (Elliot et al 2014).

4.4.2 Existing Conditions

Field investigations documented vegetation types throughout the Study Area. The majority of the Study Area consisted of undeveloped grassland / pasture and riparian woodlands. Common species observed within the tree and sapling/shrub stratum include:

- post oak (*Quercus stellata*),
- live oak (*Quercus fuisformis*),
- sugarberry (*Celtis laevigata*),
- American elm (*Ulmus americana*),
- cedar elm (*Ulmus crassifolia*),
- mesquite (*Prosopis glandulosa*), and
- black willow (*Salix nigra*)

Common herbaceous species observed within the Study Area include:

- buffalo grass (*Bouteloua dectyloides*),
- creek oats (*Chasmanthium latifolium*),
- Texas wintergrass (*Nassella leucotricha*),

- western wheatgrass (*Pascopyrum smithii*),
- prairie verbena (*Glandularia bipinnatifida*),
- silverleaf nightshade (*Solanum elaeagnifolium*),
- prickly pear cactus (*Opuntia engelmannii*), and
- bermuda grass (*Cynodon dactylon*).

Vines observed within the Study Area include:

- Virginia creeper (*Parthenocissus quinquefolia*),
- poison ivy (*Toxicodendron radicans*), and
- greenbriar (*Smilax bona-nox*).

See **Appendix B** for representative photographs of the Study Area.

5. Federal and State Listed T&E Species Review

A literature search and database review were conducted to identify federal and state listed T&E species of concern with the potential to occur within the Study Area. Species lists were accessed through the USFWS ECOS IPaC tool and through TPWD's Rare, Threatened, and Endangered Species of Texas (**Appendix C**). Additionally, the literature search included a review of studies and reports related to the ecology of the area.

Two species, the piping plover (*Charadrius melodus*) and red knot (*Calidris canutus rufa*) were listed as federally threatened by the USFWS in Coke County (USFWS 2023a).

One species, the tricolored bat (*Perimyotis subflavus*) was listed by USFWS as proposed endangered in Coke County. One species, the monarch butterfly (*Danaus plexippus*) was listed by the USFWS as federal candidate species in Coke County. However, proposed to be listed and candidate species receive no statutory protection under the ESA (USFWS 2023a).

TPWD listed an additional two federally endangered species for Coke County that were not included in the USFWS IPaC list, including the federally endangered sharpnose shiner (*Notropis oxyrhynchus*) and Texas poppy-mallow (*Callirhoe scabriuscula*). TPWD also listed one federally threatened species, the black rail (*Laterallus jamaicensis*) and two potentially endangered species, Texas fatmucket (*Lampislis bracteata*), and Texas pimpleback (*Cyclonaias petrina*) for Coke County that was not included in the USFWS IPaC list (TPWD 2023a).

Two species were listed as state endangered in Coke County by TPWD. These include the sharpnose shiner and Texas poppy-mallow (TPWD 2023a).

Seven species were listed as state threatened in Coke County by TPWD. These include the black rail, white-faced ibis (*Plegadis chihi*), Brazos water snake (*Nerodia harteri*), Red River pupfish (*Notropis oxyrhynchus*), Texas fatsmucket, Texas pimpleback, and Texas horned lizard (*Phrynosoma cornutum*) (TPWD 2023a).

A summary of federal and state listed species for Coke County, their habitat requirements, and suitable habitat determinations are shown in **Table 2**.

Table 2. Federal and State Listed Threatened and Endangered Species in Coke County, Texas

Common Name	Scientific Name	Listing Status		Habitat Requirements / Species Description	Suitable Habitat within Study Area	Determination
		Federal	State*			
Birds						
Black Rail	*Laterallus jamaicensis*	PT	T	Salt, brackish, and freshwater marshes, pond borders, wet meadows, and grassy swamps; nests in or along edge of marsh; nest usually hidden in marsh grass or at the base of *Salicornia* spp.	No	Species may occur as a migrant/transient; however, marshes are not present within the Study Area. In addition, the Study Area is located outside of this species known breeding range.
Piping Plover	*Charadrius melodus*	T	T	Sand and gravel shores of rivers and lakes. Beaches, sandflats, and dunes along Gulf Coast beaches and adjacent offshore islands.	No	Species may occur as a migrant/transient; however, no sand or gravel shores of rivers or lakes are present within the Study Area.
Red Knot	*Calidris canutus rufa*	T	T	Prefers the shoreline of coast and bays and also uses mudflats during rare inland encounters.	No	Species may occur as a migrant/transient; however, coastal/bay shorelines and mudflats are not present within the Study Area.
White-faced Ibis	*Plegadis chihi*	NL	T	Prefers freshwater marshes, sloughs, and irrigated rice fields, but will attend brackish and saltwater habitats; nests in marshes, in low trees, on the ground in bulrushes or reeds, or on floating mats.	No	Species may occur as a migrant/transient; however, freshwater marshes, sloughs, irrigated rice fields, and brackish habitats are not present within the Study Area.

Common Name	Scientific Name	Listing Status		Habitat Requirements / Species Description	Suitable Habitat within Study Area	Determination
		Federal	State*			
Fishes						
Red River Pupfish	*Cyprinodon rubrofluviatilis*	NL	T	Native to the upper Red River and Brazos River basins where it is typically found in saline waters of main channels and in saline springs. Introduced populations also exist in the Canadian River and Colorado River basins. River edges, channels, backwaters, over sand bottoms. Males establish spawning territories typically in shallowest waters up to 50 cm over sandy shoals and in small coves with little or no current.	No	No suitable habitat, including saline waters and saline springs are present within the Study Area. In addition, the Study Area is located outside of the Red River and Brazos River basins.
Sharpnose Shiner	*Notropis oxyrhynchus*	E	E	This species' range is now restricted to the upper Brazos River, upstream of Possum Kingdom Lake. Habitat typically consists of turbid water over silt and shifting sand substrates.	No	The sharpnose shiner has been extirpated from this region. Possum Kingdom Lake is located approximately 127 miles northeast of the Study Area.
Insects						
Monarch Butterfly	*Danaus plexippus*	C	NL	Monarch butterflies are habitat generalists but require milkweed species (*Asclepias* spp.) as larval hosts and a nectar source for adults (TPWD 2016). Monarch butterflies complete a multi-generational migration from Mexico northward starting in Spring. Monarch butterflies fly to Texas from Mexico beginning in March and lay their eggs on milkweed species present in the state. Those monarch butterflies have completed their journey and reproduction. The eggs and resulting larvae present on milkweeds in Texas then use the milkweed as a food source to prepare for metamorphosis to their butterfly form. Those butterflies then mate and continue to lay eggs on milkweed species as they move north for the summer. In the fall, monarch butterflies start moving into the panhandle of Texas during migration to overwintering grounds in Mexico. In Texas,	Yes	Green milkweed (*Asclepias viridis*), a host plant for this species, was observed in the southern portion of the Study Area. This species is a habitat generalist and suitable habitat may be present throughout the Study Area where nectar plants and/or various species of host plants in the milkweed (*Asclepiadaceae*) family occur.

Common Name	Scientific Name	Listing Status		Habitat Requirements / Species Description	Suitable Habitat within Study Area	Determination
		Federal	State*			
				monarch butterflies and their eggs and larvae are present from March-June and September- October (TPWD 2016).		
Mammals						
Tricolored Bat	*Perimyotis subflavus*	PE	NL	This species is federally proposed for listing as endangered. Tricolored bats roost in caves, mines and abandoned, cave-like structures during the winter. In the spring, summer, and fall, this species can be found in a variety of wooded and forested habitats throughout Texas. This species will roost under foliage of live and recently dead deciduous trees, as well as Spanish moss (*Tillandsia usneoides*) and in pine trees (*Pinus* spp.).	Yes	This species could roost within woodlands and forests in the Study Area in the Spring, Summer, and Fall months. No known caves or hibernacula are present within the Study Area.
Mollusks						
Texas Fatmucket	*Lampsilis bracteata*	PE	T	Reported to occur in slow to moderate current in sand, mud, and gravel substrates among large cobble, boulders, bedrock ledges, horizontal cracks in bedrock slabs, and macrophyte beds. Has also been observed inhabiting the roots of cypress trees and vegetation along steep banks. Past authorities have reported this species intolerant of reservoir conditions but recent surveys suggest it may persist in some impoundment conditions	No	No suitable habitat, including large cobble, boulders, bedrock ledges, horizontal cracks in bedrock slabs, and macrophyte beds are present within the Study Area. Additionally, due the area being comprised of a reservoir and its associated streams the species is not likely to occur within the Study Area.
Texas Pimpleback	*Cyclonaias petrina*	PE	T	Occurs in medium-size streams to large rivers primarily in riffles and runs. Often found in substrates composed of sand, gravel, and cobble, including mud-silt or gravel-filled cracks in bedrock slabs. Considered intolerant of reservoirs.	No	No suitable habitat, including medium-sized streams to large rivers that are not impounded, is present within the Study Area. Species is considered intolerant of reservoirs.
Plants						

Common Name	Scientific Name	Listing Status		Habitat Requirements / Species Description	Suitable Habitat within Study Area	Determination
		Federal	State*			
Texas Poppy-Mallow	*Callirhoe scabriscula*	E	E	Grasslands and open oak shrublands or mesquite woodlands on deep, loose sands (Tivoli Series) of ancient and contemporary Colorado River terraces; flowering (April-) May-June; in late July the plants die back to the taproots, in late August-September basal rosettes form, in April the flowering stems bolt.	No	No suitable habitat, Tivoli Series soils are not present within the Study Area.
Reptiles						
Brazos Water Snake	*Nerodia harteri*	NL	T	Aquatic: Shallow, fast-flowing water with a rocky or gravelly substrate preferred. Adults can be found in deep water with mud bottoms, such as large section of rivers and reservoirs. Riffle habitat is particularly important for this species.	No	No suitable habitat, fast flowing water with rocky or gravelly substrate or riffle habitat is not present within the Study Area.
Texas Horned Lizard	*Phrynosoma cornutum*	NL	T	Arid and semi-arid regions with sparse vegetation, including grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive.	Yes	Suitable habitat, including sparse vegetation, scattered brush, cactus, or scrubby trees in sandy or rocky areas, is present within the Study Area.

NL - Not Listed, T - Threatened, E - Endangered, PE - Proposed Endangered, PT - Proposed Threatened, C - Candidate

Source: USFWS, 2023a; TPWD, 2023a

**Status as returned in a county specific query, not a statewide listing*

Three listed species have the potential to regularly occur within the Study Area: the tricolored bat, monarch butterfly, and Texas horned lizard. These species are described in further detail below.

Tricolored Bat

The tricolored bat is currently proposed for listing as an endangered species by USFWS and does not yet have federal protection. However, habitat was assessed as a matter of due diligence. Based on a 12-month finding on a petition to list the tricolored bat, USFWS found that listing the species is warranted and on September 14, 2022, USFWS proposed a rule to list the tricolored bat as endangered. USFWS will make a final determination no more than 18 months from the proposed rule. This wide-ranging bat was once common across the eastern and central U.S. However, the species currently faces extinction due to white-nose syndrome, a deadly fungal disease affecting cave-dwelling bats across North America. Caves and abandoned mines are considered very important to this species for roosting in the winter months. Tricolored bats can also roost in man-made structures such as culverts and buildings. Tricolored bats use woodlands and forested areas for roosting during the spring, summer, and fall. They typically roost in the leaves of live or recently dead deciduous hardwood trees, as well as Spanish moss and pine trees (USFWS 2023b). Woodlands and forested areas, especially along riparian corridors, could provide suitable roosting and foraging habitat for this species within the Study Area in the Spring, Summer, and Fall. No known caves or hibernacula are present within the Study Area.

Monarch Butterfly

The monarch butterfly is currently considered a candidate species for listing by USFWS and does not yet have federal protection; however, habitat was assessed as a matter of due diligence. Monarch butterflies are habitat generalists but require milkweed species as larval hosts and a nectar source for adults. The presence of milkweed indicates suitable monarch butterfly habitat. In Texas, monarch butterflies and their eggs and larvae are present from March-June and September-October (TPWD 2016). Milkweeds and nectar plants are known to occur along roadsides and in other disturbed and open areas. One species, green milkweed, was observed in the southern portion of the Study Area (See **Appendix B**). Therefore, suitable habitat for the monarch butterfly may be present throughout the Study Area where milkweed and nectar plants are present.

Texas Horned Lizard

Suitable habitat for the state threatened Texas horned lizard were identified within the Study Area, surrounding the Kickapoo Creek FRS No. 4 structure, reservoir, and habitat surrounding up ad downstream areas. This species prefers open habitats with sparse vegetation including; grass, prairie, cactus, scattered brush or scrubby trees, soil varying from sandy to rocky, and harvester ants as a food source. Harvester ant mounds and suitable vegetation and soil types were observed within the Study Area. (See **Appendix B**). Therefore, the Study Area could provide suitable habitat for the Texas horned lizard.

5.1 TXNDD Element Occurrence Review and Critical Habitat

A review of USFWS Critical Habitat was performed for the vicinity of the Study Area. No critical habitat for federally listed species was mapped within or immediately adjacent to the Study Area (USFWS 2022).

Additionally, TPWD’s TXNDD was reviewed on July 19, 2023 to assess if any rare and/or listed endangered and threatened species have been previously observed within or adjacent to the

Study Area. No elements of occurrence (EOs) were reported within the limits of the Study Area (**Appendix A, Figure 5**). Additionally, no EO's were reported within five miles of the Study Area (TPWD 2023b).

No recorded EOs for species does not mean that there is an absence of endangered, threatened, or rare species and should not be solely used for presence/absence determinations.

6. Conclusions

This assessment found that suitable habitat for one federally proposed endangered species, the tricolored bat; one federal candidate species, the monarch butterfly; and one state threatened species, the Texas horned lizard, is present within the Study Area and these species may be affected by Project activities. No additional federal or stated listed T&E species were determined to have suitable habitat within the Study Area and are not likely to be impacted by the proposed Project. Coordination with USFWS and TPWD may be required to avoid potential impacts to protected species and comply with general requirements under federal and state protected species regulations.

No USFWS Critical Habitat was mapped within the Study Area. Additionally, no TXNDD EO's for federal or state listed T&E species were recorded within the Study Area or within five miles of the Study Area.

Depending on the timing of construction and amount of tree/shrub clearing required for construction activities, migratory birds could potentially be impacted by the Project. If clearing of trees and shrubs is necessary, then AECOM recommends conducting nest surveys prior to clearing activities. In accordance with the MBTA, construction activities and any vegetation clearing should be conducted outside peak-nesting seasons (March-August) to avoid any adverse effects to migratory birds and their habitats. Should construction and vegetation clearing occur from March through August, active bird nest surveys should be conducted by a biologist no more than 5 days prior to construction.

7. References

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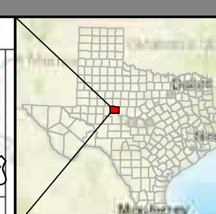
Appendix A Figures



Study Area

Project Location Map

Kickapoo Creek FRS No. 4
Coke County, Texas

N
W E
S
0 150 300
Feet

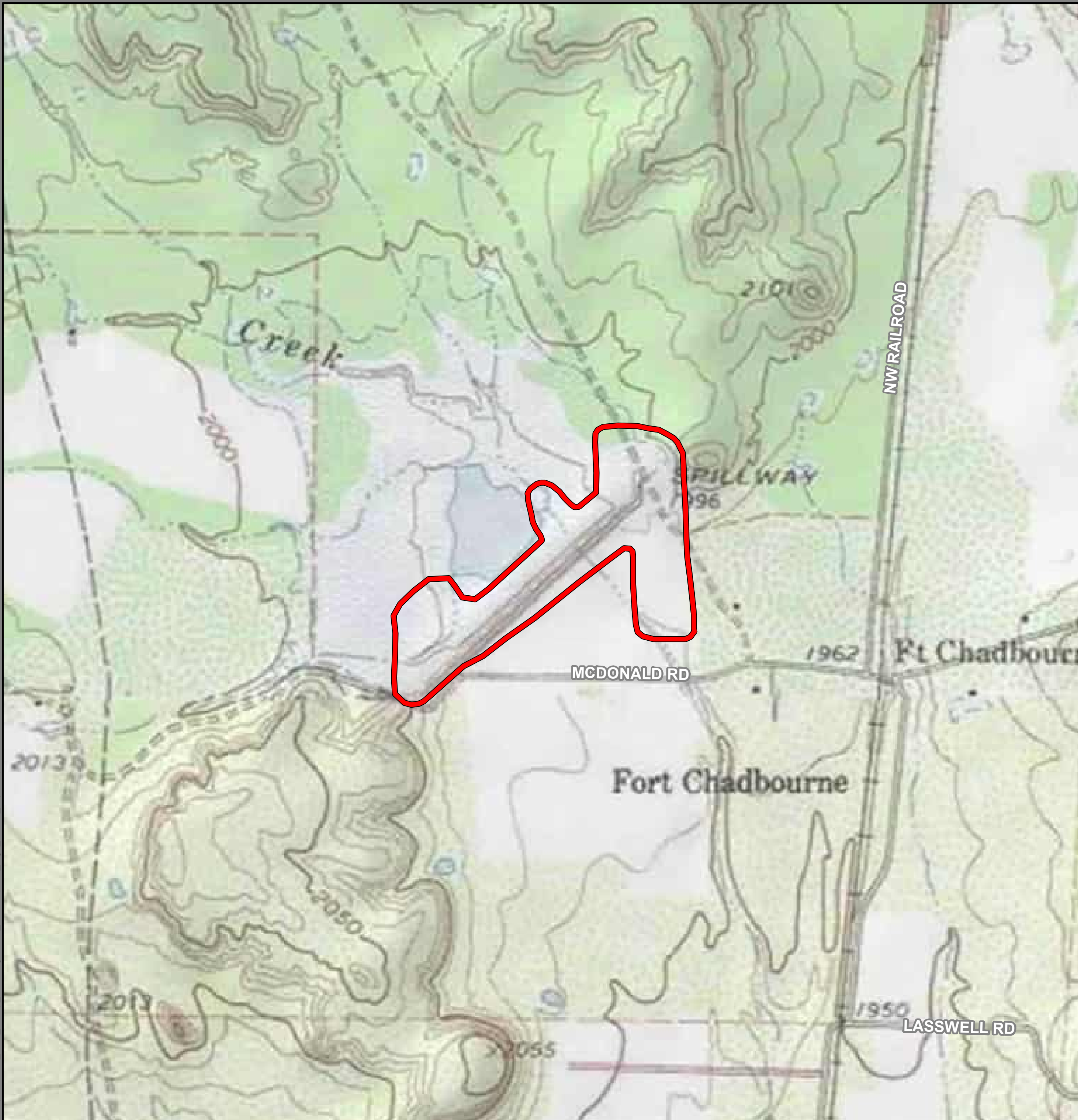
Data Sources: Roads - TxDOT 2023; County Boundaries - TIGER 2021
Basemap: Maxar 6/12/2021

AECOM

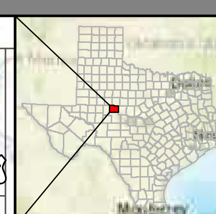
July 2023

Figure 1

Author: helen.potter; Document Path: M:\Dallas_GIS\Projects\TSSWCB\KickapooCreek_FRS_4\Map_Docs\Figures\T_E\Kickapoo4_Fig1_ProjectLocationMap.mxd



Study Area



USGS Topographic Map

Kickapoo Creek FRS No. 4
Coke County, Texas

N W E S

0 500 1000
Feet

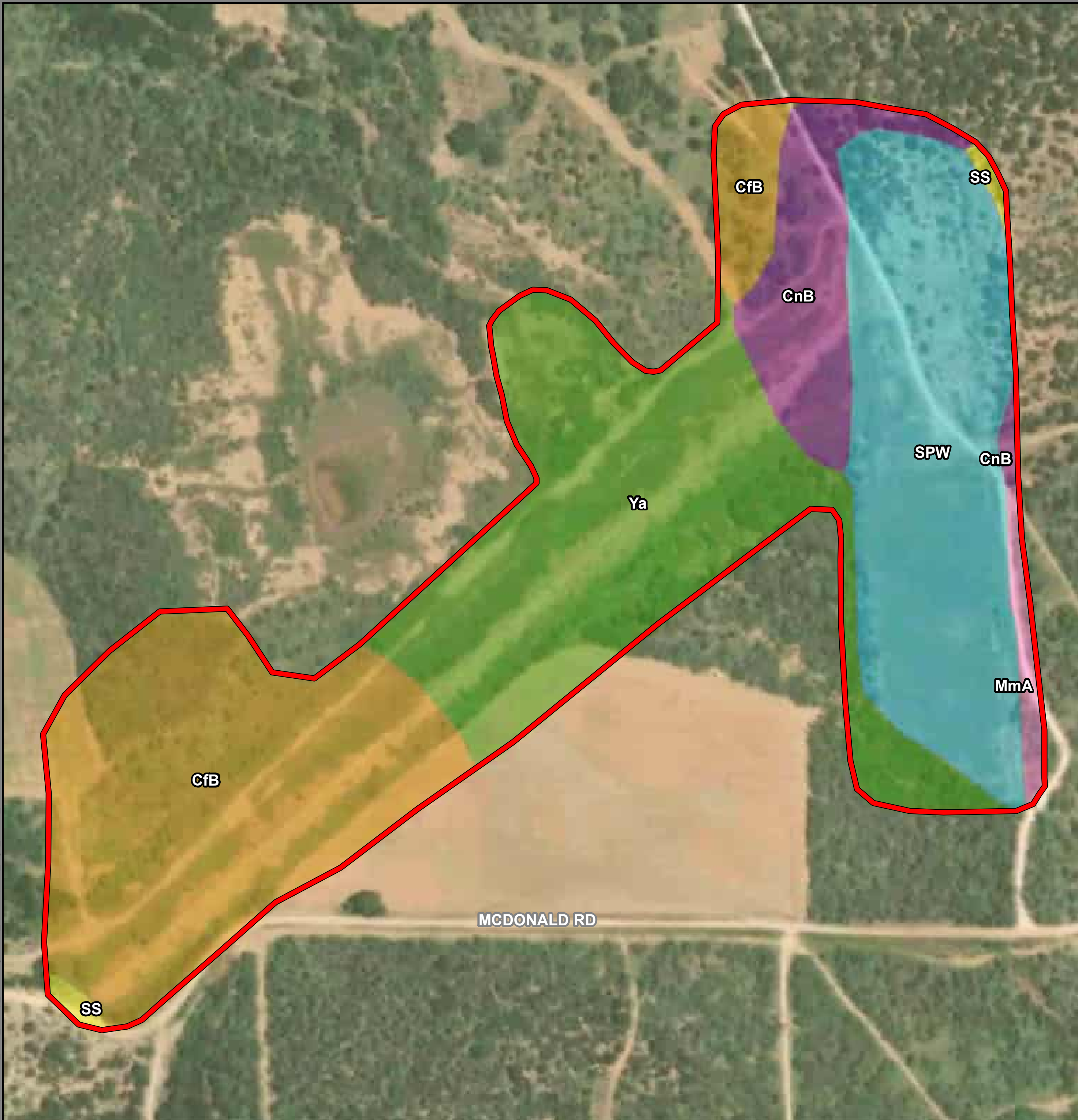
Data Sources: Roads - TxDOT 2023; County Boundaries - TIGER 2021
Basemap: USGS 7.5-minute Topographic Maps: Blackwell and Bronte Quadrangles

AECOM

July 2023

Figure 2

Author: helen.potter; Document Path: M:\Dallas_GIS\Projects\TSSWCB\KickapooCreek_FRS_4\Map_Docs\Figures\T_E\Kickapoo4_Fig2_USGS_TopoMap.mxd



Study Area

NRCS Soil Types

CfB: Cobb fine sandy loam, dry, 1 to 3 percent slopes

CnB: Oben and Cobb soils, 1 to 3 percent slopes

MmA: Miles fine sandy loam, 0 to 1 percent slopes

SPW: Spillway

SS: Oplin-Rock outcrop complex, very steep

Ya: Westola very fine sandy loam, dry, 0 to 1 percent slopes, occasionally flooded

NRCS Soils Map

Kickapoo Creek FRS No. 4
Coke County, Texas

N W E S

0 150 300
Feet

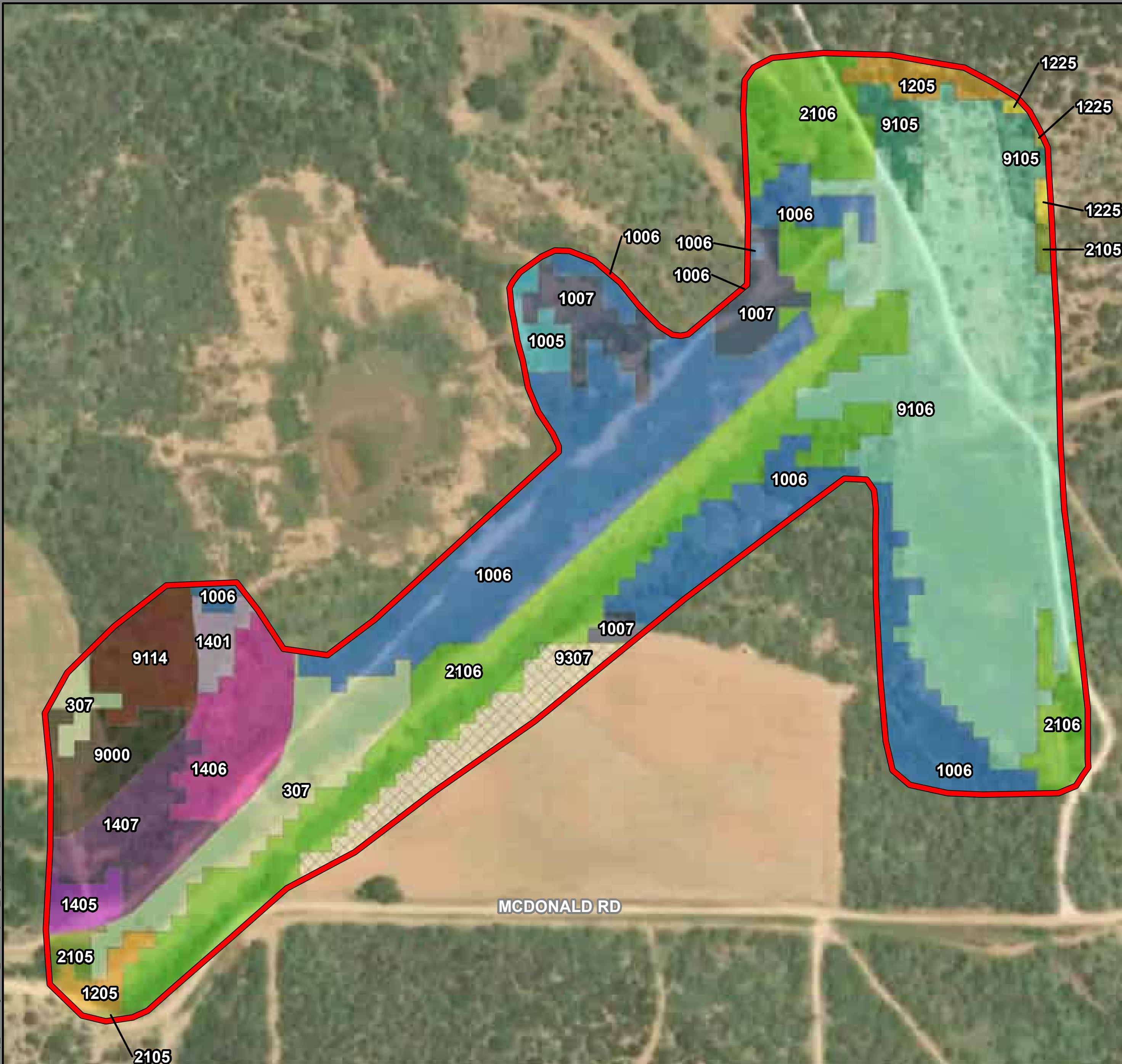
Data Sources: Soils - USDA NRCS 2018; Roads - TxDOT 2023; County Boundaries - TIGER 2021
Basemap: Maxar 6/12/2021

AECOM

July 2023

Figure 3

Author: helen.potter; Document Path: M:\Dallas_GIS\Projects\TSSWCB\KickapooCreek_FRS_4\Map_Docs\Figures\T_E\Kickapoo4_Fig3_NRCS_SoilsMap.mxd



- Study Area

EMST Vegetation Types

- 307 - Rolling Plains: Mixedgrass Prairie
- 1005 - Edwards Plateau: Floodplain Ashe Juniper Shrubland
- 1006 - Edwards Plateau: Floodplain Deciduous Shrubland
- 1007 - Edwards Plateau: Floodplain Herbaceous Vegetation
- 1205 - Edwards Plateau: Ashe Juniper-Live Oak Shrubland
- 1225 - Edwards Plateau: Ashe Juniper-Live Oak Slope Shrubland
- 1401 - Edwards Plateau: Riparian Ashe Juniper Forest
- 1405 - Edwards Plateau: Riparian Ashe Juniper Shrubland
- 1406 - Edwards Plateau: Riparian Deciduous Shrubland
- 1407 - Edwards Plateau: Riparian Herbaceous Vegetation
- 2105 - Rolling Plains: Breaks Evergreen Shrubland
- 2106 - Rolling Plains: Breaks Deciduous Shrubland
- 9000 - Barren
- 9105 - Native Invasive: Juniper Shrubland
- 9106 - Native Invasive: Mesquite Shrubland
- 9114 - Native Invasive: Mesquite Woodland
- 9307 - Row Crops

Ecological Mapping Systems of Texas (EMST) Map

Kickapoo Creek FRS No. 4
Coke County, Texas

N
W E
S
0 150 300
Feet

Data Sources: EMST - TPWD 2023; Roads - TxDOT 2023; County Boundaries - TIGER 2021
Basemap: Maxar 6/12/2021

AECOM

July 2023

Figure 4

Author: helen.potter; Document Path: M:\Dallas_GIS\Projects\TSSWCB\KickapooCreek_FRS_4\Map_Docs\Figures\T_E\Kickapoo4_Fig4_EMST_Map.mxd

Appendix B Photographic Log

AECOM

PHOTOGRAPHIC LOG

Site Name: Kickapoo Creek FRS No. 4	Site Location: Coke County, TX	Project No. 60630022

Photo No. 1	Date: 07/11/23

Direction Photo Taken:

Northwest

Description:

View of Kickapoo Creek Flood Retarding Structure (FRS) No. 4 and habitat in the central portion of the Study Area.

Photo No. 2	Date: 07/11/23

Direction Photo Taken:

Southwest

Description:

View of Kickapoo Creek FRS No. 4 structure and habitat in the central portion of the Study Area.

Site Name:	Site Location:	Project No.
Kickapoo Creek FRS No. 4	Coke County, TX	60630022

Photo No.	Date:
3	07/11/23

Direction Photo Taken:

Northwest

Description:

View of harvester ant mound located within the Study Area.

Photo No.	Date:
4	07/11/23

Direction Photo Taken:

Northwest

Description:

View of habitat and vegetation north of the dam structure within the Study Area.

AECOM	PHOTOGRAPHIC LOG

Site Name: Kickapoo Creek FRS No. 4	Site Location: Coke County, TX	Project No. 60630022

Photo No. 5	Date: 07/11/23

Direction Photo Taken:

South

Description:

View of habitat and vegetation south of the dam structure within the Study Area.

Photo No. 6	Date: 07/11/23

Direction Photo Taken:

Northwest

Description:

View of habitat and vegetation south of the dam structure at the southern boundary.

Appendix C Federal and State Database Review

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Austin Ecological Services Field Office
1505 Ferguson Lane
Austin, TX 78754-4501
Phone: (512) 937-7371

In Reply Refer To: August 09, 2023
Project Code: 2023-0114787
Project Name: Kickapoo 5

Subject: List of threatened and endangered species that may occur in your proposed project location or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF

Migratory Birds: In addition to responsibilities to protect threatened and endangered species under the Endangered Species Act (ESA), there are additional responsibilities under the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA) to protect native birds from project-related impacts. Any activity, intentional or unintentional, resulting in take of migratory birds, including eagles, is prohibited unless otherwise permitted by the U.S. Fish and Wildlife Service (50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)). For more information regarding these Acts see https://www.fws.gov/birds/policies-and-regulations.php.

The MBTA has no provision for allowing take of migratory birds that may be unintentionally killed or injured by otherwise lawful activities. It is the responsibility of the project proponent to comply with these Acts by identifying potential impacts to migratory birds and eagles within applicable NEPA documents (when there is a federal nexus) or a Bird/Eagle Conservation Plan (when there is no federal nexus). Proponents should implement conservation measures to avoid or minimize the production of project-related stressors or minimize the exposure of birds and their resources to the project-related stressors. For more information on avian stressors and recommended conservation measures see https://www.fws.gov/birds/bird-enthusiasts/threats-to-birds.php.

In addition to MBTA and BGEPA, Executive Order 13186: *Responsibilities of Federal Agencies to Protect Migratory Birds*, obligates all Federal agencies that engage in or authorize activities that might affect migratory birds, to minimize those effects and encourage conservation measures that will improve bird populations. Executive Order 13186 provides for the protection of both migratory birds and migratory bird habitat. For information regarding the implementation of Executive Order 13186, please visit https://www.fws.gov/birds/policies-and-regulations/executive-orders/e0-13186.php.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Code in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List

OFFICIAL SPECIES LIST

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

Austin Ecological Services Field Office
1505 Ferguson Lane
Austin, TX 78754-4501
(512) 937-7371

PROJECT SUMMARY

Project Code: 2023-0114787
Project Name: Kickapoo 5
Project Type: Dam - Maintenance/Modification
Project Description: Dam Rehabilitation
Project Location:

The approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@31.9621699,-100.29828768778336,14z

Counties: Coke County, Texas

ENDANGERED SPECIES ACT SPECIES

There is a total of 4 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species. Note that 2 of these species should be considered only under certain conditions.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

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1. 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.

MAMMALS

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

BIRDS

NAME	STATUS
Piping Plover *Charadrius melodus* Population: [Atlantic Coast and Northern Great Plains populations] - Wherever found, except those areas where listed as endangered. There is **final** critical habitat for this species. Your location does not overlap the critical habitat. This species only needs to be considered under the following conditions: ▪ Wind Energy Projects Species profile: https://ecos.fws.gov/ecp/species/6039	Threatened
Red Knot *Calidris canutus rufa* There is **proposed** critical habitat for this species. This species only needs to be considered under the following conditions: ▪ Wind Energy Projects Species profile: https://ecos.fws.gov/ecp/species/1864	Threatened

INSECTS

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

CRITICAL HABITATS

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

YOU ARE STILL REQUIRED TO DETERMINE IF YOUR PROJECT(S) MAY HAVE EFFECTS ON ALL ABOVE LISTED SPECIES.

IPAC USER CONTACT INFORMATION

Agency: Texas Water Development Board
Name: Payton Prather
Address: 9400 Amberglenn Blvd #E
City: Austin
State: TX
Zip: 78729
Email paytonp1776@gmail.com
Phone: 7134942044

LEAD AGENCY CONTACT INFORMATION

Lead Agency: Texas Water Development Board

Last Update: 1/4/2023

COKE COUNTY

AMPHIBIANS

Woodhouse's toad *Anaxyrus woodhousii*

Terrestrial and aquatic: A wide variety of terrestrial habitats are used by this species, including forests, grasslands, and barrier island sand dunes. Aquatic habitats are equally varied.

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: SU

BIRDS

bald eagle *Haliaeetus leucocephalus*

Found primarily near rivers and large lakes; nests in tall trees or on cliffs near water; communally roosts, especially in winter; hunts live prey, scavenges, and pirates food from other birds

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S3B,S3N

black rail *Laterallus jamaicensis*

The county distribution for this species includes geographic areas that the species may use during migration. Time of year should be factored into evaluations to determine potential presence of this species in a specific county. Salt, brackish, and freshwater marshes, pond borders, wet meadows, and grassy swamps; nests in or along edge of marsh, sometimes on damp ground, but usually on mat of previous years dead grasses; nest usually hidden in marsh grass or at base of Salicornia

Federal Status: LT	State Status: T	SGCN: Y
Endemic: N	Global Rank: G3	State Rank: S2

black-capped vireo *Vireo atricapilla*

Oak-juniper woodlands with distinctive patchy, two-layered aspect; shrub and tree layer with open, grassy spaces; requires foliage reaching to ground level for nesting cover; return to same territory, or one nearby, year after year; deciduous and broad-leaved shrubs and trees provide insects for feeding; species composition less important than presence of adequate broad-leaved shrubs, foliage to ground level, and required structure; nesting season March-late summer

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S3B

chestnut-collared longspur *Calcarius ornatus*

Occurs in open shortgrass settings especially in patches with some bare ground. Also occurs in grain sorghum fields and Conservation Reserve Program lands

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S3

COKE COUNTY

BIRDS

Franklin's gull *Leucophaeus pipixcan*

The county distribution for this species includes geographic areas that the species may use during migration. Time of year should be factored into evaluations to determine potential presence of this species in a specific county. This species is only a spring and fall migrant throughout Texas. It does not breed in or near Texas. Winter records are unusual consisting of one or a few individuals at a given site (especially along the Gulf coastline). During migration, these gulls fly during daylight hours but often come down to wetlands, lake shore, or islands to roost for the night.

Federal Status: State Status: SGCN: Y

Endemic: N Global Rank: G5 State Rank: S2N

golden eagle *Aquila chrysaetos*

Habitat description is not available at this time.

Federal Status: State Status: SGCN: Y

Endemic: N Global Rank: G5 State Rank: S3B

lark bunting *Calamospiza melanocorys*

Overall, it's a generalist in most short grassland settings including ones with some brushy component plus certain agricultural lands that include grain sorghum. Short grasses include sideoats and blue gramas, sand dropseed, prairie junegrass (Koeleria), buffalograss also with patches of bluestem and other mid-grass species. This bunting will frequent smaller patches of grasses or disturbed patches of grasses including rural yards. It also uses weedy fields surrounding playas. This species avoids urban areas and cotton fields.

Federal Status: State Status: SGCN: Y

Endemic: N Global Rank: G5 State Rank: S4B

mountain plover *Charadrius montanus*

The county distribution for this species includes geographic areas that the species may use during migration. Time of year should be factored into evaluations to determine potential presence of this species in a specific county. Breeding: nests on high plains or shortgrass prairie, on ground in shallow depression; nonbreeding: shortgrass plains and bare, dirt (plowed) fields; primarily insectivorous.

Federal Status: State Status: SGCN: Y

Endemic: N Global Rank: G3 State Rank: S2

Sprague's pipit *Anthus spragueii*

The county distribution for this species includes geographic areas that the species may use during migration. Time of year should be factored into evaluations to determine potential presence of this species in a specific county. Habitat during migration and in winter consists of pastures and weedy fields (AOU 1983), including grasslands with dense herbaceous vegetation or grassy agricultural fields.

Federal Status: State Status: SGCN: Y

Endemic: N Global Rank: G3G4 State Rank: S3N

western burrowing owl *Athene cunicularia hypugaea*

Open grasslands, especially prairie, plains, and savanna, sometimes in open areas such as vacant lots near human habitation or airports; nests and roosts in abandoned burrows

Federal Status: State Status: SGCN: Y

Endemic: N Global Rank: G4T4 State Rank: S2

white-faced ibis *Plegadis chihi*

COKE COUNTY

BIRDS

The county distribution for this species includes geographic areas that the species may use during migration. Time of year should be factored into evaluations to determine potential presence of this species in a specific county. Prefers freshwater marshes, sloughs, and irrigated rice fields, but will attend brackish and saltwater habitats; currently confined to near-coastal rookeries in so-called hog-wallow prairies. Nests in marshes, in low trees, on the ground in bulrushes or reeds, or on floating mats.

Federal Status:	State Status: T	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S4B

FISH

Guadalupe bass *Micropterus treculii*

Endemic to the streams of the northern and eastern Edwards Plateau including portions of the Brazos, Colorado, Guadalupe, and San Antonio basins; species also found outside of the Edwards Plateau streams in decreased abundance, primarily in the lower Colorado River; two introduced populations have been established in the Nueces River system. A pure population was re-established in a portion of the Blanco River in 2014. Species prefers lentic environments but commonly taken in flowing water; numerous smaller fish occur in rapids, many times near eddies; large individuals found mainly in riffle tail races; usually found in spring-fed streams having clear water and relatively consistent temperatures.

Federal Status:	State Status:	SGCN: Y
Endemic: Y	Global Rank: G3	State Rank: S3

Red River pupfish *Cyprinodon rubrofluviatilis*

Native to the upper Red River and Brazos River basins where it is typically found in saline waters of main channels and in saline springs. Introduced populations also exist in the Canadian River and Colorado River basins. River edges, channels, backwaters, over sand bottoms. Males establish spawning territories typically in shallowest waters up to 50 cm over sandy shoals and in small coves with little or no current.

Federal Status:	State Status: T	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S2

sharpnose shiner *Notropis oxyrhynchus*

Range is now restricted to upper Brazos River upstream of Possum Kingdom Lake. May be native to Red River and Colorado River basins. Typically found in turbid water over mostly silt and shifting sand substrates.

Federal Status: LE	State Status: E	SGCN: Y
Endemic: Y	Global Rank: G3	State Rank: S1S2

MAMMALS

black-tailed prairie dog *Cynomys ludovicianus*

Dry, flat, short grasslands with low, relatively sparse vegetation, including areas overgrazed by cattle; live in large family groups

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G4	State Rank: S3

COKE COUNTY

MAMMALS

cave myotis bat *Myotis velifer*

Colonial and cave-dwelling; also roosts in rock crevices, old buildings, carports, under bridges, and even in abandoned Cliff Swallow (Hirundo pyrrhonota) nests; roosts in clusters of up to thousands of individuals; hibernates in limestone caves of Edwards Plateau and gypsum cave of Panhandle during winter; opportunistic insectivore.

Federal Status: State Status: SGCN: Y

Endemic: N Global Rank: G4G5 State Rank: S2S3

eastern red bat *Lasiurus borealis*

Red bats are migratory bats that are common across Texas. They are most common in the eastern and central parts of the state, due to their requirement of forests for foliage roosting. West Texas specimens are associated with forested areas (cottonwoods). Also common along the coastline. These bats are highly mobile, seasonally migratory, and practice a type of "wandering migration". Associations with specific habitat is difficult unless specific migratory stopover sites or wintering grounds are found. Likely associated with any forested area in East, Central, and North Texas but can occur statewide.

Federal Status: State Status: SGCN: Y

Endemic: N Global Rank: G3G4 State Rank: S4

hoary bat *Lasiurus cinereus*

Hoary bats are highly migratory, high-flying bats that have been noted throughout the state. Females are known to migrate to Mexico in the winter, males tend to remain further north and may stay in Texas year-round. Commonly associated with forests (foliage roosting species) but are found in unforested parts of the state and lowland deserts. Tend to be captured over water and large, open flyways.

Federal Status: State Status: SGCN: Y

Endemic: N Global Rank: G3G4 State Rank: S4

kit fox *Vulpes macrotis*

Open desert grassland; avoids rugged, rocky terrain and wooded areas.

Federal Status: State Status: SGCN: N

Endemic: N Global Rank: G4 State Rank: S1S2

long-tailed weasel *Mustela frenata*

Includes brushlands, fence rows, upland woods and bottomland hardwoods, forest edges & rocky desert scrub. Usually live close to water.

Federal Status: State Status: SGCN: Y

Endemic: N Global Rank: G5 State Rank: S5

mountain lion *Puma concolor*

Generalist; found in a wide range of habitats statewide. Found most frequently in rugged mountains & riparian zones.

Federal Status: State Status: SGCN: Y

Endemic: N Global Rank: G5 State Rank: S2S3

pronghorn *Antilocapra americana*

Prefers hilly and plateau areas of open grassland, desert-grassland, and desert-scrub, where it frequents south-facing slopes and other sheltered areas.

COKE COUNTY

MAMMALS

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S3

tricolored bat *Perimyotis subflavus*

Forest, woodland and riparian areas are important. Caves are very important to this species.

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G3G4	State Rank: S2

western hog-nosed skunk *Conepatus leuconotus*

Habitats include woodlands, grasslands & deserts, to 7200 feet, most common in rugged, rocky canyon country; little is known about the habitat of the ssp. telmalestes

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G4	State Rank: S4

western spotted skunk *Spilogale gracilis*

Brushy canyons, rocky outcrops (rimrock) on hillsides and walls of canyons. In semi-arid brushlands in U.S., in wet tropical forests in Mexico. When inactive or bearing young, occupies den in rocks, burrow, hollow log, brush pile, or under building.

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S5

MOLLUSKS

Texas fatmucket *Lampsilis bracteata*

Reported to occur in slow to moderate current in sand, mud, and gravel substrates among large cobble, boulders, bedrock ledges, horizontal cracks in bedrock slabs, and macrophyte beds. Has also been observed inhabiting the roots of cypress trees and vegetation along steep banks. Past authorities have reported this species intolerant of reservoir conditions but recent surveys suggest it may persist in some impoundment conditions (Howells 2010c; Randklev et al. 2017b). [Mussel of Texas 2019]

Federal Status: PE	State Status: T	SGCN: Y
Endemic: Y	Global Rank: G1	State Rank: S1

Texas pimpleback *Cyclonaias petrina*

Occurs in medium-size streams to large rivers primarily in riffles and runs. Often found in substrates composed of sand, gravel, and cobble, including mud-silt or gravel-filled cracks in bedrock slabs. Considered intolerant of reservoirs (Howells 2010m; Randklev et al. 2017b). [Mussels of Texas 2019]

Federal Status: PE	State Status: T	SGCN: Y
Endemic: Y	Global Rank: G1	State Rank: S1

REPTILES

Brazos water snake *Nerodia harteri*

Aquatic: Shallow, fast-flowing water with a rocky or gravelly substrate preferred. Adults can be found in deep water with mud bottoms, such as large section fo rivers and reservoirs. Riffle habitat is particularly important for this species.

Federal Status:	State Status: T	SGCN: Y

COKE COUNTY

REPTILES

Endemic: Y Global Rank: G1 State Rank: S1

Concho water snake *Nerodia paucimaculata*

Aquatic: Shallow, fast-flowing water with a rocky or gravelly substrate preferred. Adults can be found in deep water with mud bottoms, such as large section fo rivers and reservoirs. Riffle habitat is particularly important for this species.

Federal Status: State Status: SGCN: Y

Endemic: Y Global Rank: G1 State Rank: S1

plateau spot-tailed earless lizard *Holbrookia lacerata*

Terrestrial: Habitats include moderately open prairie-brushland regions, particularly fairly flat areas free of vegetation or other obstructions (e.g., open meadows, old and new fields, graded roadways, cleared and disturbed areas, prairie savanna, and active agriculture including row crops); also, oak-juniper woodlands and mesquite-prickly pear associations (Axtell 1968, Bartlett and Bartlett 1999).

Federal Status: State Status: SGCN: Y

Endemic: Y Global Rank: GNR State Rank: S2

roundtail horned lizard *Phrynosoma modestum*

This species seems to prefer rocky or gravelly substrates in open areas that are sparsely vegetated.

Federal Status: State Status: SGCN: Y

Endemic: N Global Rank: G5 State Rank: S4

smooth softshell *Apalone mutica*

Aquatic: Large rivers and streams; in some areas also found in lakes and impoundments (Ernst and Barbour 1972). Usually in water with sandy or mud bottom and few aquatic plants. Often basks on sand bars and mudflats at edge of water. Eggs are laid in nests dug in high open sandbars and banks close to water, usually within 90 m of water (Fitch and Plummer 1975).

Federal Status: State Status: SGCN: Y

Endemic: N Global Rank: G5 State Rank: S3

Texas horned lizard *Phrynosoma cornutum*

Terrestrial: Open habitats with sparse vegetation, including grass, prairie, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive. Occurs to 6000 feet, but largely limited below the pinyon-juniper zone on mountains in the Big Bend area.

Federal Status: State Status: T SGCN: Y

Endemic: N Global Rank: G4G5 State Rank: S3

Texas map turtle *Graptemys versa*

Aquatic: Primarily a river turtle but can also be found in reservoirs. Can be found in deep and shallow water with sufficient basking sites (emergent rocks and woody debris).

Federal Status: State Status: SGCN: Y

Endemic: Y Global Rank: G4 State Rank: SU

western box turtle *Terrapene ornata*

COKE COUNTY

REPTILES

Terrestrial: Ornate or western box trutles inhabit prairie grassland, pasture, fields, sandhills, and open woodland. They are essentially terrestrial but sometimes enter slow, shallow streams and creek pools. For shelter, they burrow into soil (e.g., under plants such as yucca) (Converse et al. 2002) or enter burrows made by other species.

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S3

western hognose snake *Heterodon nasicus*

Terrestrial: Shortgrass or mixed grass prairie, with gravel or sandy soils. Often found associated with draws, floodplains, and more mesic habitats within the arid landscape. Frequently occurs in shrub encroached grasslands.

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S4

western massasauga *Sistrurus tergeminus*

Terrestrial: Shortgrass or mixed grass prairie, with gravel or sandy soils. Often found associated with draws, floodplains, and more mesic habitats within the arid landscape. Frequently occurs in shrub encroached grasslands.

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G3G4	State Rank: S3

western rattlesnake *Crotalus viridis*

Terrestrial: Dry desert and prairie grasslands, shrub desert rocky hillsides; edges of arid and semi-arid river breaks.

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S5

PLANTS

Correll's green pitaya *Echinocereus viridiflorus var. correllii*

Among grasses on rock crevices on low hills in desert or semi-desert grassland on novaculite or limestone; flowering March-May

Federal Status:	State Status:	SGCN: Y
Endemic: Y	Global Rank: G5T2	State Rank: S2

Guadalupe beardtongue *Penstemon guadalupensis*

Scattered in calcareous prairies on the Lampasas Cutplain and Edwards Plateau; Perennial; Flowering/Fruiting March-July

Federal Status:	State Status:	SGCN: Y
Endemic: Y	Global Rank: G3	State Rank: S3

Irion County wild-buckwheat *Eriogonum nealleyi*

Grasslands and shallow stony soils over limestone and indurated caliche, often collected from ungrazed but sparsely vegetated roadsides, particularly where limestone or caliche is exposed on hilltops; flowering June-September

Federal Status:	State Status:	SGCN: Y
Endemic: Y	Global Rank: G2	State Rank: S2

COKE COUNTY

PLANTS

Miller's hedgehog cactus *Echinocereus milleri*

Occurs on sandy-loam soils on rocky hills.

Federal Status:	State Status:	SGCN: Y
Endemic: Y	Global Rank: G1	State Rank: S1

Texas poppy-mallow *Callirhoe scabriuscula*

Grasslands and open oak shrublands or mesquite woodlands on deep, loose sands (Tivoli Series) of ancient and contemporary Colorado River terraces; flowering (April-) May-June; in late July the plants die back to the taproots, in late August-September basal rosettes form, in April the flowering stems bolt

Federal Status: LE	State Status: E	SGCN: Y
Endemic: Y	Global Rank: G2	State Rank: S2

E-4 Federal and State Listed Threatened and Endangered Species Assessment – FRS No. 5

Federal and State Listed Threatened and Endangered Species Assessment

Kickapoo Creek Floodwater Retarding Structure No. 5 Rehabilitation Project

Coke County, Texas

Texas State Soil and Water Conservation Board

Project number: 60630022

August 2023

Delivering a better world

Prepared for:

Texas State Soil and Water Conservation Board

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Tables

1. Background

1.1 Project description

AECOM Technical Services, Inc. (AECOM) conducted a federal and state listed threatened and endangered species habitat assessment for the proposed Kickapoo Creek Floodwater Retarding Structure (FRS) No. 5 Rehabilitation Project (Project). The proposed Project is located in Coke County, approximately 5 miles northwest of Bronte, Texas (**Appendix A, Figure 1**). A literature search and field investigations were conducted for the Project within a potential impact area encompassing approximately 198 acres (Study Area).

1.2 Purpose

The purpose of this assessment is to comply with Section 9 of the Endangered Species Act (ESA), Chapters 67 and 68 of the Texas Parks and Wildlife (TPW) Code, and Sections 65.171 - 65.176 of Title 31 of the Texas Administrative Code (TAC) to avoid ‘take’ of federal or state listed threatened or endangered species.

A list of the current United States (U.S.) Fish and Wildlife Service (USFWS) and Texas Parks and Wildlife Department (TPWD) threatened and endangered (T&E) species and their associated habitat requirements are described within this document.

2. Methodology

A literature search was conducted to identify federal and state listed T&E species of concern with the potential to occur within the Study Area. Species lists were accessed through the USFWS's Environmental Conservation Online System (ECOS) Information for Planning and Consultation (IPaC) tool and through TPWD's Rare, Threatened, and Endangered Species list for Coke County. The literature search also included a review of studies and reports related to the ecology of the area as well as a review of TPWD's Texas Natural Diversity Database (TXNDD), which was obtained via email request. The TXNDD was reviewed on July 19, 2023, to report if any rare and/or listed threatened or endangered species have been previously observed within or adjacent to the Study Area.

Field investigations were conducted on July 12, 2023, to verify previously reviewed information, document the presence of federal and state listed species and/or suitable habitat, and characterize habitat and vegetation types.

3. Regulations

3.1 U.S. Fish and Wildlife Service

3.1.1 Endangered Species Act

USFWS has legislative authority to list and monitor the status of species whose populations are considered to be imperiled. The federal legislative authority for the federal protection of threatened and endangered species issues from the ESA of 1973 and its subsequent amendments. Regulations supporting this Act are codified and regularly updated in Title 50 Code of Federal Regulations (CFR) Sections 17.11 and 17.12.

The ESA process stratifies potential candidates based upon the species' biological vulnerability. Species listed as endangered or threatened by the federal government are provided full protection under the law. This protection not only prohibits the direct possession (take) of a protected species, but also includes a prohibition of indirect take, such as destruction of habitat. Listed plant species are not protected from take on privately-owned land, although it is illegal to collect or maliciously harm them on federal land. The ESA and accompanying regulations provide the necessary authority and incentive for individual states to establish their own regulatory vehicle for the management and protection of threatened and endangered species.

3.1.2 Migratory Bird Treaty Act

USFWS has legislative authority to prohibit, unless permitted by regulations, the kill, capture, collection, possession, buying, selling, trading, or transport of any migratory bird, nest, young, feather, or egg in part or in whole. The Migratory Bird Treaty Act (MBTA) and its subsequent amendments (16 U.S. Code [USC] 703-712) give the federal legislative authority for protection of migratory bird species. Regulations supporting the MBTA are codified and regularly updated in Title 50 CFR Parts 10 and 21.

3.2 Texas Parks and Wildlife Department

TPWD prohibits the take, possession, transportation, or sale of any of the animal or plant species designated by state law as endangered or threatened without the issuance of a permit (per Chapters 67 [Nongame Species] and 68 [Endangered Species] of the TPW Code and Sections 65.171 - 65.176 [Threatened and Endangered Nongame Species] of Title 31 of the TAC. “Take” is defined in the TPW Code as to “collect, hook, net, shoot, or snare, by any means or device, and includes an attempt to take or to pursue in order to take”.

Unlike federally listed species, there is no protection of habitat afforded to species that are only listed by the state.

4. Environmental Setting

Publicly available data was reviewed to identify aquatic features, soil types, and vegetation types within the Study Area. Data resources reviewed included the U.S. Geological Survey (USGS) National Hydrography Dataset (NHD), the U.S. Department of Agriculture (USDA) NRCS Web Soil Survey, USGS 7.5' quadrangle sheets, and recent aerial photography (Google Earth 2021). This data review was used to describe the site-specific information below.

4.1 Land use

The majority of the Study Area consisted of an open water reservoir, a dam structure, an auxiliary spillway, and undeveloped land. Based on the NHD, two intermittent streams including Dry Creek and Middle Kickapoo Creek; and two open water features including the Kickapoo Creek FRS No. 5 reservoir, were mapped within the Study Area (USGS 2023).

4.2 Topography

The USGS 7.5-minute quadrangle map for Bronte, TX displays the topography of the Study Area (**Appendix A, Figure 2**). Topography within the Study Area is shaped by the current reservoir and dam system Dry Creek and Middle Kickapoo Creek. The surface gradient slopes from northeast to southwest, with the highest elevation located along the northern boundary of the Study Area at approximately 1,920 feet above mean sea level (MSL [National Geodetic Vertical Datum of 1929]). The lowest elevation is located in Middle Kickapoo Creek along the southeaster boundary of the Study Area at approximately 1,880 feet above MSL (National Geodetic Vertical Datum of 1929) (USGS 2022).

4.3 Soils

According to the USDA NRCS Web Soil Survey Report, the Study Area was mapped as being underlain by 10 soil map unit types (as shown on **Table 1** below and within **Appendix A, Figure 3**) (USDA 2021).

Table 1. NRCS Soil Mapping Units

Mapping Unit	Soil Type	Listed as Hydric by NRCS
BrA	Bronte fine sandy loam, 0 to 1 percent slopes	No
CbB	Cobb loamy fine sand, 0 to 3 percent slopes	No
CfB	Cobb fine sandy loam, dry, 1 to 3 percent slopes	No
Cm	Colorado loam, 0 to 1 percent slopes, frequently flooded	Yes
CnB	Oben and Cobb soils, 1 to 3 percent slopes	No
MmA	Miles fine sandy loam, 0 to 1 percent slopes	No
MmB	Miles fine sandy loam, 1 to 3 percent slopes	No

Mapping Unit	Soil Type	Listed as Hydric by NRCS
OcA	Sagerton clay loam, 0 to 1 percent slopes	No
SPW	Spillway	No
W	Water	Yes

4.4 Vegetation

4.4.1 Historically Mapped and Documented Vegetation Types

According to TPWD's Ecoregion data, the Study Area falls within the Southwestern Table Lands Level 3 Ecoregion and the Caprock Canyons, Badlands, and Breaks Level 4 Ecoregion.

The Study Area lies within one Land Resource Region (LRR H) and one Major Land Resource Area (MLRA 78B). LRR H denotes the Central Great Plains Winter Wheat and Range Region and consists of vegetation mainly of grasslands and agricultural land. MLRA 78B is the Central Rolling Red Plains, Western Part, which can be characterized by red soils weathered from silty sandstone, siltstone, and claystone on rolling plains with ancient stream terraces or terrace remnants associated with stream dissection. Nearly level to gently sloping and consisting of dissected plain areas with steeper slopes occurring along entrenched river and creek valleys. Broad meander belts are associated with the major streams, and wide flood plains are flanked by nearly level stream terraces. More information on LRR H and MLRA 78B can be read within USDA's Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin, Handbook 296.

According to TPWD's Ecological Mapping System of Texas (EMST), the vegetation mapped within the Study Area includes Rolling Plains: Mixedgrass Prairie; Rolling Plains: Mixedgrass Sandy Prairie; Edwards Plateau: Floodplain Hardwood Forest; Edwards Plateau: Floodplain Deciduous Shrubland; Edwards Plateau: Floodplain Herbaceous Vegetation; Edwards Plateau: Oak - Hardwood Motte and Woodland; Edwards Plateau: Ashe Juniper-Live Oak Shrubland; Edwards Plateau: Riparian Hardwood Forest; Edwards Plateau: Riparian Deciduous Shrubland; Edwards Plateau: Riparian Herbaceous Vegetation; Rolling Plains: Breaks Deciduous Shrubland; Barren; Marsh; Native Invasive: Deciduous Woodland; Native Invasive: Mesquite Shrubland; CRP / Other Improved Grassland; Open Water (**Appendix A, Figure 4**) (Elliot et al 2014).

4.4.2 Existing Conditions

Field investigations documented vegetation types throughout the Study Area. The majority of the Study Area consisted of undeveloped grassland / pasture and riparian woodlands. Common species observed within the tree and sapling/shrub stratum include:

- post oak (*Quercus stellata*),
- live oak (*Quercus fuisformis*),
- sugarberry (*Celtis laevigata*),
- American elm (*Ulmus americana*),

- cedar elm (*Ulmus crassifolia*),
- mesquite (*Prosopis glandulosa*), and
- black willow (*Salix nigra*)

Common herbaceous species observed within the Study Area include:

- buffalo grass (*Bouteloua dectyloides*),
- creek oats (*Chasmanthium latifolium*),
- western wheatgrass (*Pascopyrum smithii*),
- prairie verbena (*Glandularia bipinnatifida*),
- silverleaf nightshade (*Solanum elaeagnifolium*),
- prickly pear cactus (*Opuntia engelmannii*), and
- bermuda grass (*Cynodon dactylon*).

Vines observed within the Study Area include:

- Virginia creeper (*Parthenocissus quinquefolia*),
- poison ivy (*Toxicodendron radicans*), and
- greenbriar (*Smilax bona-nox*).

See **Appendix B** for representative photographs of the Study Area.

5. Federal and State Listed T&E Species Review

A literature search and database review were conducted to identify federal and state listed T&E species of concern with the potential to occur within the Study Area. Species lists were accessed through the USFWS ECOS IPaC tool and through TPWD's Rare, Threatened, and Endangered Species of Texas (**Appendix C**). Additionally, the literature search included a review of studies and reports related to the ecology of the area.

Two species, the piping plover (*Charadrius melodus*) and red knot (*Calidris canutus rufa*) were listed as federally threatened by the USFWS in Coke County (USFWS 2023a).

One species, the tricolored bat (*Perimyotis subflavus*) was listed by USFWS as proposed endangered in Coke County. One species, the monarch butterfly (*Danaus plexippus*) was listed by the USFWS as federal candidate species in Coke County. However, proposed to be listed and candidate species receive no statutory protection under the ESA (USFWS 2023a).

TPWD listed an additional two federally endangered species for Coke County that were not included in the USFWS IPaC list, including the federally endangered sharpnose shiner (*Notropis oxyrhynchus*) and Texas poppy-mallow (*Callirhoe scabriuscula*). TPWD also listed one federally threatened species, the black rail (*Laterallus jamaicensis*) and two potentially endangered species, Texas fatmucket (*Lampislis bracteata*) and Texas pimpleback (*Cyclonaias petrina*) for Coke County that was not included in the USFWS IPaC list (TPWD 2023a).

Two species were listed as state endangered in Coke County by TPWD. These include the sharpnose shiner and Texas poppy-mallow (TPWD 2023a).

Seven species were listed as state threatened in Coke County by TPWD. These include the black rail, white-faced ibis (*Plegadis chihi*), Brazos water snake (*Nerodia harteri*), Red River pupfish (*Notropis oxyrhynchus*), Texas fatsmucket, Texas pimpleback, and Texas horned lizard (*Phrynosoma cornutum*) (TPWD 2023a).

A summary of federal and state listed species for Coke County, their habitat requirements, and suitable habitat determinations are shown in **Table 2**.

Table 2. Federal and State Listed Threatened and Endangered Species in Coke County, Texas

Common Name	Scientific Name	Listing Status		Habitat Requirements / Species Description	Suitable Habitat within Study Area	Determination
		Federal	State*			
Birds						
Black Rail	*Laterallus jamaicensis*	PT	T	Salt, brackish, and freshwater marshes, pond borders, wet meadows, and grassy swamps; nests in or along edge of marsh; nest usually hidden in marsh grass or at the base of *Salicornia* spp.	No	Species may occur as a migrant/transient; however, marshes are not present within the Study Area. In addition, the Study Area is located outside of this species known breeding range.
Piping Plover	*Charadrius melodus*	T	T	Sand and gravel shores of rivers and lakes. Beaches, sandflats, and dunes along Gulf Coast beaches and adjacent offshore islands.	No	Species may occur as a migrant/transient; however, no sand or gravel shores of rivers or lakes are present within the Study Area.
Red Knot	*Calidris canutus rufa*	T	T	Prefers the shoreline of coast and bays and also uses mudflats during rare inland encounters.	No	Species may occur as a migrant/transient; however, coastal/bay shorelines and mudflats are not present within the Study Area.
White-faced Ibis	*Plegadis chihi*	NL	T	Prefers freshwater marshes, sloughs, and irrigated rice fields, but will attend brackish and saltwater habitats; nests in marshes, in low trees, on the ground in bulrushes or reeds, or on floating mats.	No	Species may occur as a migrant/transient; however, freshwater marshes, sloughs, irrigated rice fields, and brackish habitats are not present within the Study Area.

Common Name	Scientific Name	Listing Status		Habitat Requirements / Species Description	Suitable Habitat within Study Area	Determination
		Federal	State*			
Fishes						
Red River Pupfish	*Cyprinodon rubrofluviatilis*	NL	T	Native to the upper Red River and Brazos River basins where it is typically found in saline waters of main channels and in saline springs. Introduced populations also exist in the Canadian River and Colorado River basins. River edges, channels, backwaters, over sand bottoms. Males establish spawning territories typically in shallowest waters up to 50 cm over sandy shoals and in small coves with little or no current.	No	No suitable habitat, including saline waters and saline springs are present within the Study Area. In addition, the Study Area is located outside of the Red River and Brazos River basins.
Sharpnose Shiner	*Notropis oxyrhynchus*	E	E	This species' range is now restricted to the upper Brazos River, upstream of Possum Kingdom Lake. Habitat typically consists of turbid water over silt and shifting sand substrates.	No	The sharpnose shiner has been extirpated from this region. Possum Kingdom Lake is located approximately 127 miles northeast of the Study Area.
Insects						
Monarch Butterfly	*Danaus plexippus*	C	NL	Monarch butterflies are habitat generalists but require milkweed species (*Asclepias* spp.) as larval hosts and a nectar source for adults (TPWD 2016). Monarch butterflies complete a multi-generational migration from Mexico northward starting in Spring. Monarch butterflies fly to Texas from Mexico beginning in March and lay their eggs on milkweed species present in the state. Those monarch butterflies have completed their journey and reproduction. The eggs and resulting larvae present on milkweeds in Texas then use the milkweed as a food source to prepare for metamorphosis to their butterfly form. Those butterflies then mate and continue to lay eggs on milkweed species as they move north for the summer. In the fall, monarch butterflies start moving into the panhandle of Texas during migration to overwintering grounds in Mexico. In Texas, monarch butterflies and their eggs and larvae are present from March-June and September- October (TPWD 2016).	Yes	Green milkweed (*Asclepias viridis*), a host plant for this species, was observed in the southern portion of the Study Area. This species is a habitat generalist and suitable habitat may be present throughout the Study Area where nectar plants and/or various species of host plants in the milkweed (*Asclepiadaceae*) family occur.
Mammals						

Common Name	Scientific Name	Listing Status		Habitat Requirements / Species Description	Suitable Habitat within Study Area	Determination
		Federal	State*			
Tricolored Bat	*Perimyotis subflavus*	PE	NL	This species is federally proposed for listing as endangered. Tricolored bats roost in caves, mines and abandoned, cave-like structures during the winter. In the spring, summer, and fall, this species can be found in a variety of wooded and forested habitats throughout Texas. This species will roost under foliage of live and recently dead deciduous trees, as well as Spanish moss (*Tillandsia usneoides*) and in pine trees (*Pinus* spp.).	Yes	This species could roost within woodlands and forests in the Study Area in the Spring, Summer, and Fall months. No known caves or hibernacula are present within the Study Area.
Mollusks						
Texas Fatmucket	*Lampsilis bracteata*	PE	T	Reported to occur in slow to moderate current in sand, mud, and gravel substrates among large cobble, boulders, bedrock ledges, horizontal cracks in bedrock slabs, and macrophyte beds. Has also been observed inhabiting the roots of cypress trees and vegetation along steep banks. Past authorities have reported this species intolerant of reservoir conditions but recent surveys suggest it may persist in some impoundment conditions	No	No suitable habitat, including large cobble, boulders, bedrock ledges, horizontal cracks in bedrock slabs, and macrophyte beds are present within the Study Area. Additionally, due the area being comprised of a reservoir and its associated streams the species is not likely to occur within the Study Area.
Texas Pimpleback	*Cyclonaias petrina*	PE	T	Occurs in medium-size streams to large rivers primarily in riffles and runs. Often found in substrates composed of sand, gravel, and cobble, including mud-silt or gravel-filled cracks in bedrock slabs. Considered intolerant of reservoirs.	No	No suitable habitat, including medium-sized streams to large rivers that are not impounded, is present within the Study Area. Species is considered intolerant of reservoirs.
Plants						

Common Name	Scientific Name	Listing Status		Habitat Requirements / Species Description	Suitable Habitat within Study Area	Determination
		Federal	State*			
Texas Poppy-Mallow	*Callirhoe scabriscula*	E	E	Grasslands and open oak shrublands or mesquite woodlands on deep, loose sands (Tivoli Series) of ancient and contemporary Colorado River terraces; flowering (April-) May-June; in late July the plants die back to the taproots, in late August-September basal rosettes form, in April the flowering stems bolt.	No	No suitable habitat, Tivoli Series soils are not present within the Study Area.
Reptiles						
Brazos Water Snake	*Nerodia harteri*	NL	T	Aquatic: Shallow, fast-flowing water with a rocky or gravelly substrate preferred. Adults can be found in deep water with mud bottoms, such as large section of rivers and reservoirs. Riffle habitat is particularly important for this species.	No	No suitable habitat, fast flowing water with rocky or gravelly substrate or riffle habitat is not present within the Study Area.
Texas Horned Lizard	*Phrynosoma cornutum*	NL	T	Arid and semi-arid regions with sparse vegetation, including grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive.	Yes	Suitable habitat, including sparse vegetation, scattered brush, cactus, or scrubby trees in sandy or rocky areas, is present within the Study Area.

NL - Not Listed, T - Threatened, E - Endangered, PE - Proposed Endangered, PT - Proposed Threatened, C - Candidate

Source: USFWS, 2023a; TPWD, 2023a

**Status as returned in a county specific query, not a statewide listing*

Three listed species have the potential to regularly occur within the Study Area: the tricolored bat, monarch butterfly, and Texas horned lizard. These species are described in further detail below.

Tricolored Bat

The tricolored bat is currently proposed for listing as an endangered species by USFWS and does not yet have federal protection. However, habitat was assessed as a matter of due diligence. Based on a 12-month finding on a petition to list the tricolored bat, USFWS found that listing the species is warranted and on September 14, 2022, USFWS proposed a rule to list the tricolored bat as endangered. USFWS will make a final determination no more than 18 months from the proposed rule. This wide-ranging bat was once common across the eastern and central U.S. However, the species currently faces extinction due to white-nose syndrome, a deadly fungal disease affecting cave-dwelling bats across North America. Caves and abandoned mines are considered very important to this species for roosting in the winter months. Tricolored bats can also roost in man-made structures such as culverts and buildings. Tricolored bats use woodlands and forested areas for roosting during the spring, summer, and fall. They typically roost in the leaves of live or recently dead deciduous hardwood trees, as well as Spanish moss and pine trees (USFWS 2023b). Woodlands and forested areas, especially along riparian corridors, could provide suitable roosting and foraging habitat for this species within the Study Area in the Spring, Summer, and Fall. However, no known caves or hibernacula are present within the Study Area.

Monarch Butterfly

The monarch butterfly is currently considered a candidate species for listing by USFWS and does not yet have federal protection; however, habitat was assessed as a matter of due diligence. Monarch butterflies are habitat generalists but require milkweed species as larval hosts and a nectar source for adults. The presence of milkweed indicates suitable monarch butterfly habitat. In Texas, monarch butterflies and their eggs and larvae are present from March-June and September-October (TPWD 2016). Milkweeds and nectar plants are known to occur along roadsides and in other disturbed and open areas. One species, green milkweed, was observed in the southern portion of the Study Area (See **Appendix B**). Therefore, suitable habitat for the monarch butterfly may be present throughout the Study Area where milkweed and nectar plants are present.

Texas Horned Lizard

Suitable habitat for the state threatened Texas horned lizard were identified within the Study Area, surrounding the Kickapoo Creek FRS No. 5 structure, reservoir, and habitat surrounding up ad downstream areas. This species prefers open habitats with sparse vegetation including; grass, prairie, cactus, scattered brush or scrubby trees, soil varying from sandy to rocky, and harverster ants as a food source. Harvester ant mounds and suitable vegetation and soil types were observed within the Study Area. (See **Appendix B**). Therefore, the Study Area could provide suitable habitat for the Texas horned lizard.

5.1 TXNDD Element Occurrence Review and Critical Habitat

A review of USFWS Critical Habitat was performed for the vicinity of the Study Area. No critical habitat for federally listed species was mapped within or immediately adjacent to the Study Area (USFWS 2022).

Additionally, TPWD's TXNDD was reviewed on July 19, 2023 to assess if any rare and/or listed endangered and threatened species have been previously observed within or adjacent to the

Study Area. No elements of occurrence (EOs) were reported within the limits of the Study Area. Additionally, no EO's were reported within five miles of the Study Area (TPWD 2023b).

No recorded EOs for species does not mean that there is an absence of endangered, threatened, or rare species and should not be solely used for presence/absence determinations.

6. Conclusions

This assessment found that suitable habitat for one federally proposed endangered species, the tricolored bat; one federal candidate species, the monarch butterfly; and one state threatened species, the Texas horned lizard, is present within the Study Area and these species may be affected by Project activities. No additional federal or stated listed T&E species were determined to have suitable habitat within the Study Area and are not likely to be impacted by the proposed Project. Coordination with USFWS and TPWD may be required to avoid potential impacts to protected species and comply with general requirements under federal and state protected species regulations.

No USFWS Critical Habitat was mapped within the Study Area. Additionally, no TXNDD EO’s for federal or state listed T&E species were recorded within the Study Area or within five miles of the Study Area.

Depending on the timing of construction and amount of tree/shrub clearing required for construction activities, migratory birds could potentially be impacted by the Project. If clearing of trees and shrubs is necessary, then AECOM recommends conducting nest surveys prior to clearing activities. In accordance with the MBTA, construction activities and any vegetation clearing should be conducted outside peak-nesting seasons (March-August) to avoid any adverse effects to migratory birds and their habitats. Should construction and vegetation clearing occur from March through August, active bird nest surveys should be conducted by a biologist no more than 5 days prior to construction.

7. References

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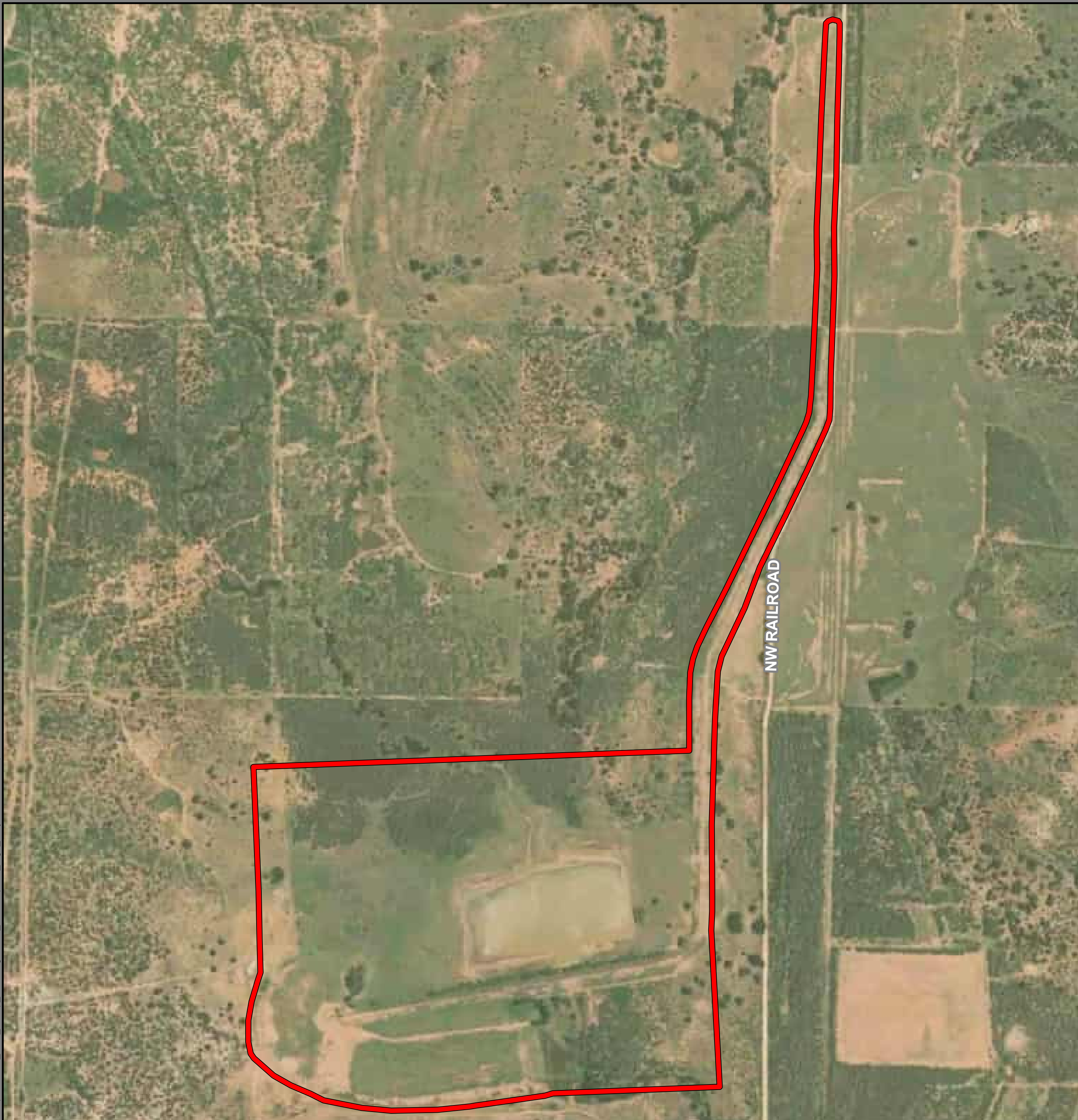
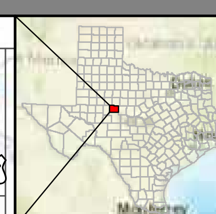
Appendix A Figures



Study Area



Project Location Map

Kickapoo Creek FRS No. 5
Coke County, Texas

N
W E
S

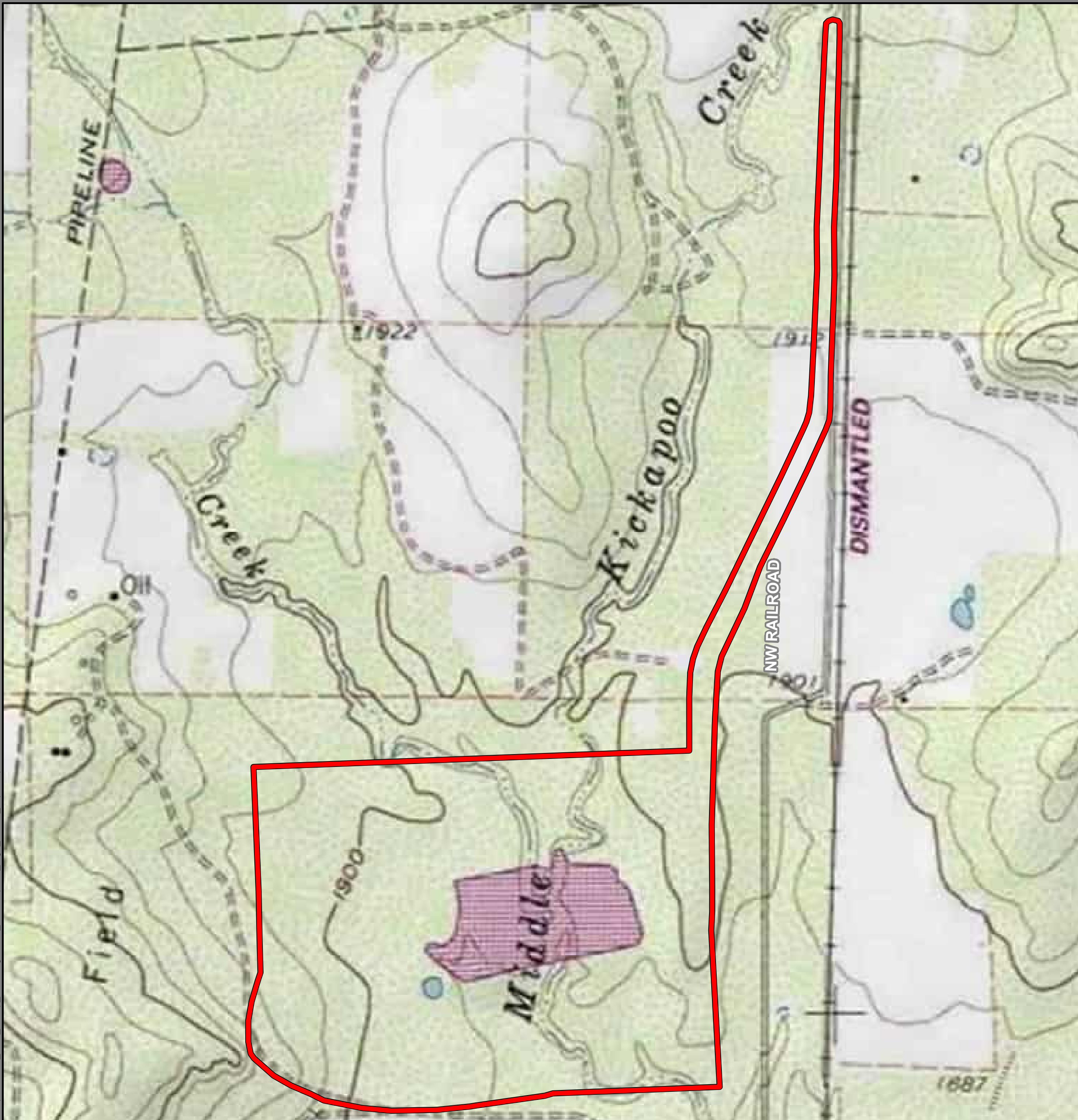
0 500 1000
Feet

Data Sources: Roads - TxDOT 2023; County Boundaries - TIGER 2021
Basemap: Maxar 6/12/2021

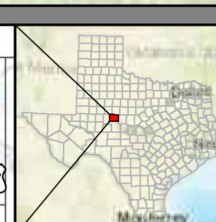
AECOM

July 2023

Figure 1



Study Area



USGS Topographic Map

Kickapoo Creek FRS No. 5
Coke County, Texas

N
W E
S

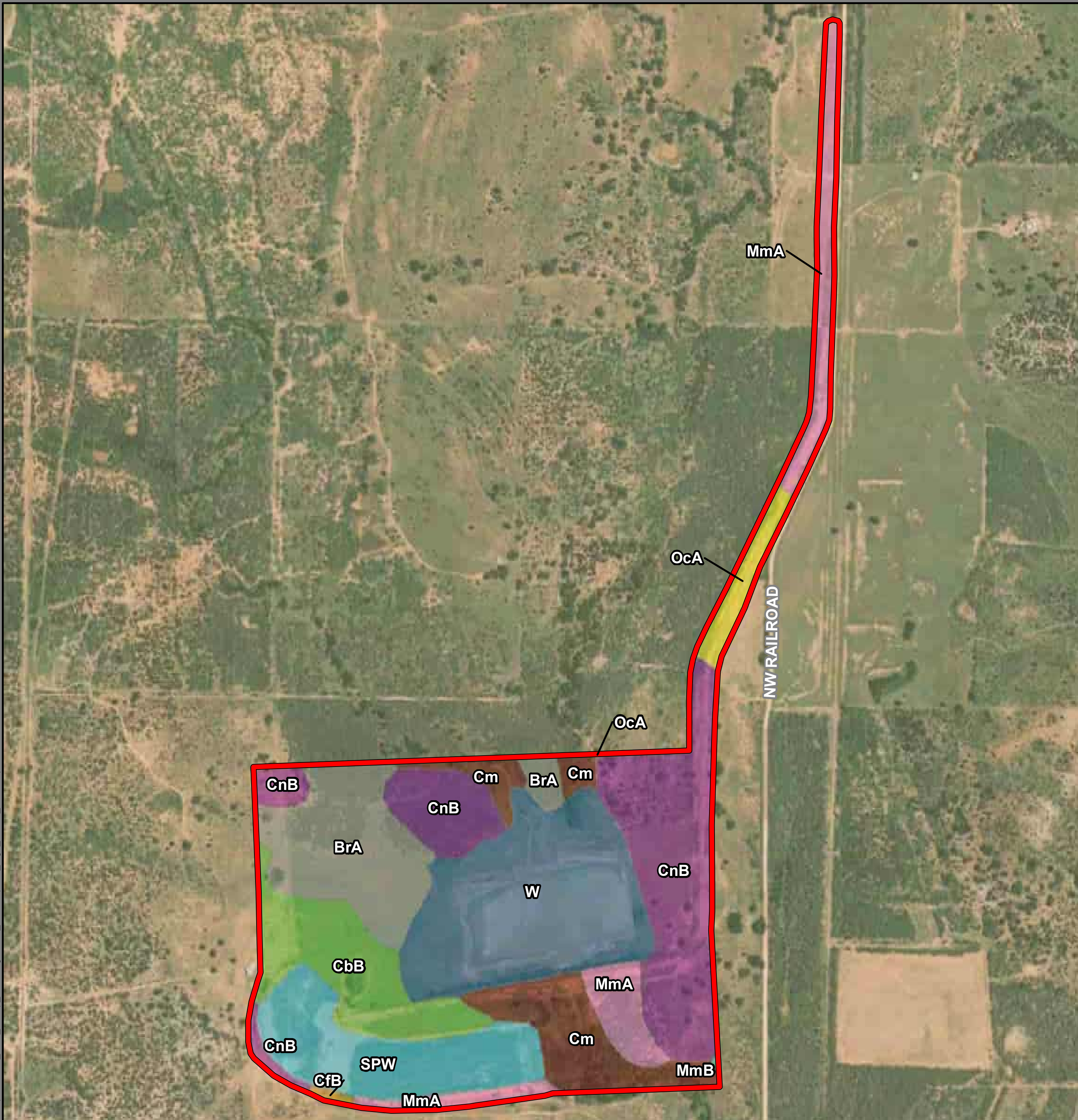
0 500 1000
Feet

Data Sources: Roads - TxDOT 2023; County Boundaries - TIGER 2021
Basemap: USGS 7.5-minute Topographic Maps: Bronte Quadrangle

AECOM

July 2023

Figure 2



Study Area

NRCS Soil Types

- BrA: Bronte fine sandy loam, 0 to 1 percent slopes
- CbB: Cobb loamy fine sand, 0 to 3 percent slopes
- CfB: Cobb fine sandy loam, dry, 1 to 3 percent slopes
- Cm: Colorado loam, 0 to 1 percent slopes, frequently flooded
- CnB: Oben and Cobb soils, 1 to 3 percent slopes
- MmA: Miles fine sandy loam, 0 to 1 percent slopes
- MmB: Miles fine sandy loam, 1 to 3 percent slopes
- OcA: Sagerton clay loam, 0 to 1 percent slopes
- SPW: Spillway
- W: Water

NRCS Soils Map

Kickapoo Creek FRS No. 5
Coke County, Texas

N W E S

0 500 1000
Feet

Data Sources: Soils - USDA NRCS 2018; Roads - TxDOT 2023; County Boundaries - TIGER 2021
Basemap: Maxar 6/12/2021

AECOM

July 2023

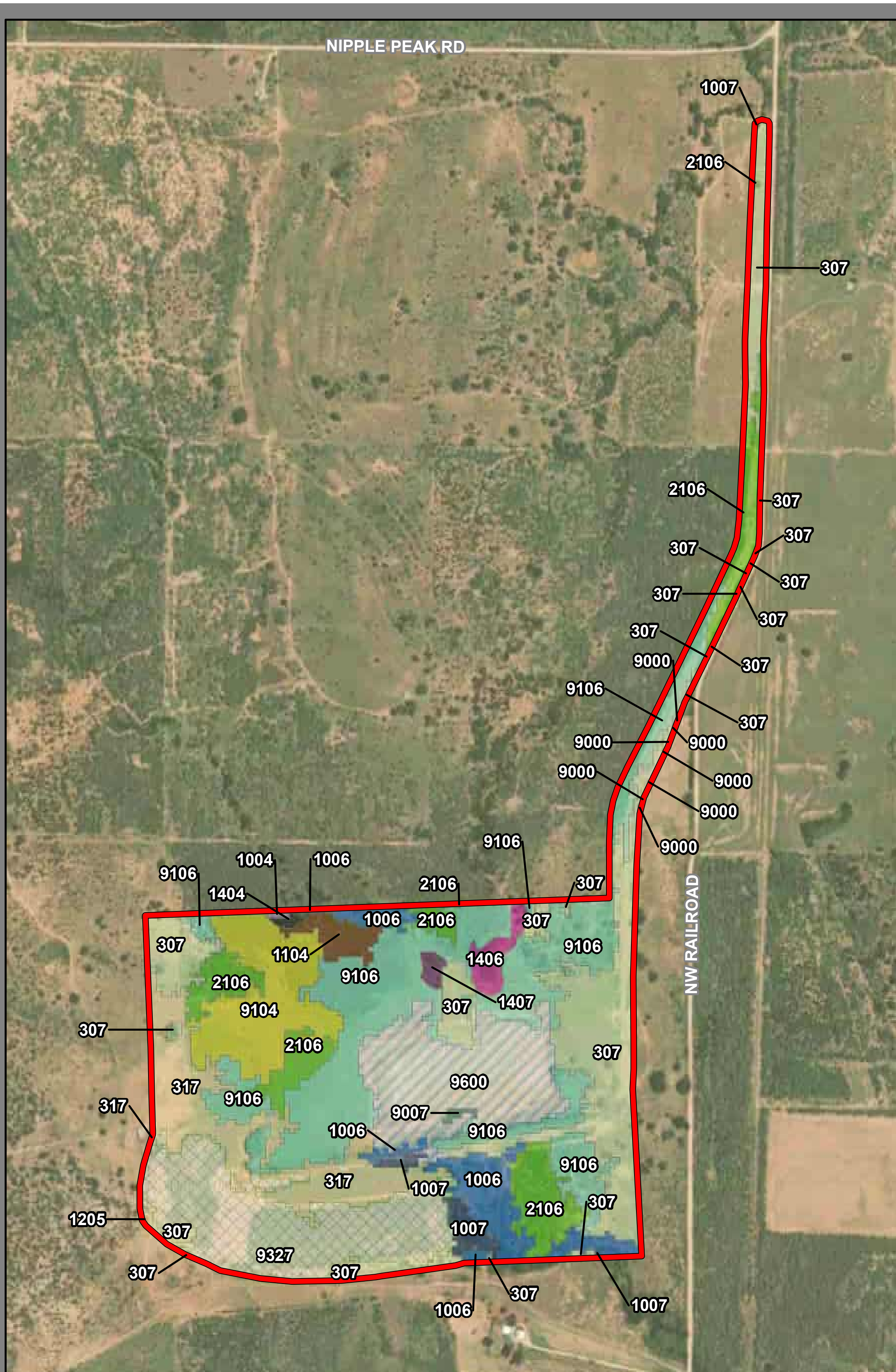
Figure 3

Author: helen.potter; Document Path: M:\Dallas_GIS\Projects\TSSWCB\KickapooCreek_FRS_5\Map_Docs\Figures\T_E\Kickapoo5_Fig3_NRCS_SoilsMap.mxd

Study Area

EMST Vegetation Types

- 307 - Rolling Plains: Mixedgrass Prairie
- 317 - Rolling Plains: Mixedgrass Sandy Prairie
- 1004 - Edwards Plateau: Floodplain Hardwood Forest
- 1006 - Edwards Plateau: Floodplain Deciduous Shrubland
- 1007 - Edwards Plateau: Floodplain Herbaceous Vegetation
- 1104 - Edwards Plateau: Oak -- Hardwood Motte and Woodland
- 1205 - Edwards Plateau: Ashe Juniper-Live Oak Shrubland
- 1404 - Edwards Plateau: Riparian Hardwood Forest
- 1406 - Edwards Plateau: Riparian Deciduous Shrubland
- 1407 - Edwards Plateau: Riparian Herbaceous Vegetation
- 2106 - Rolling Plains: Breaks Deciduous Shrubland
- 9000 - Barren
- 9007 - Marsh
- 9104 - Native Invasive: Deciduous Woodland
- 9106 - Native Invasive: Mesquite Shrubland
- 9327 - CRP / Other Improved Grassland
- 9600 - Open Water



Ecological Mapping Systems of Texas (EMST) Map

Kickapoo Creek FRS No. 5
Coke County, Texas

N W E S

0 500 1000
Feet

Data Sources: EMST - TPWD 2023; Roads - TxDOT 2023; County Boundaries - TIGER 2021
Basemap: Maxar 6/12/2021

AECOM

July 2023

Figure 4

Author: helen.potter; Document Path: M:\Dallas_GIS\Projects\TSSWCB\KickapooCreek_FRS_5\Map_Docs\Figures\T_E\Kickapoo5_Fig4_EMST_Map.mxd

Appendix B Photographic Log

AECOM

PHOTOGRAPHIC LOG

Site Name: Kickapoo Creek FRS No. 5	Site Location: Coke County, TX	Project No. 60630022

Photo No.	Date:
1	07/12/23

Direction Photo Taken:

Northwest

Description:

View of Kickapoo Creek Flood Retarding Structure (FRS) No. 5 reservoir (WB01) in the central portion of the Study Area.

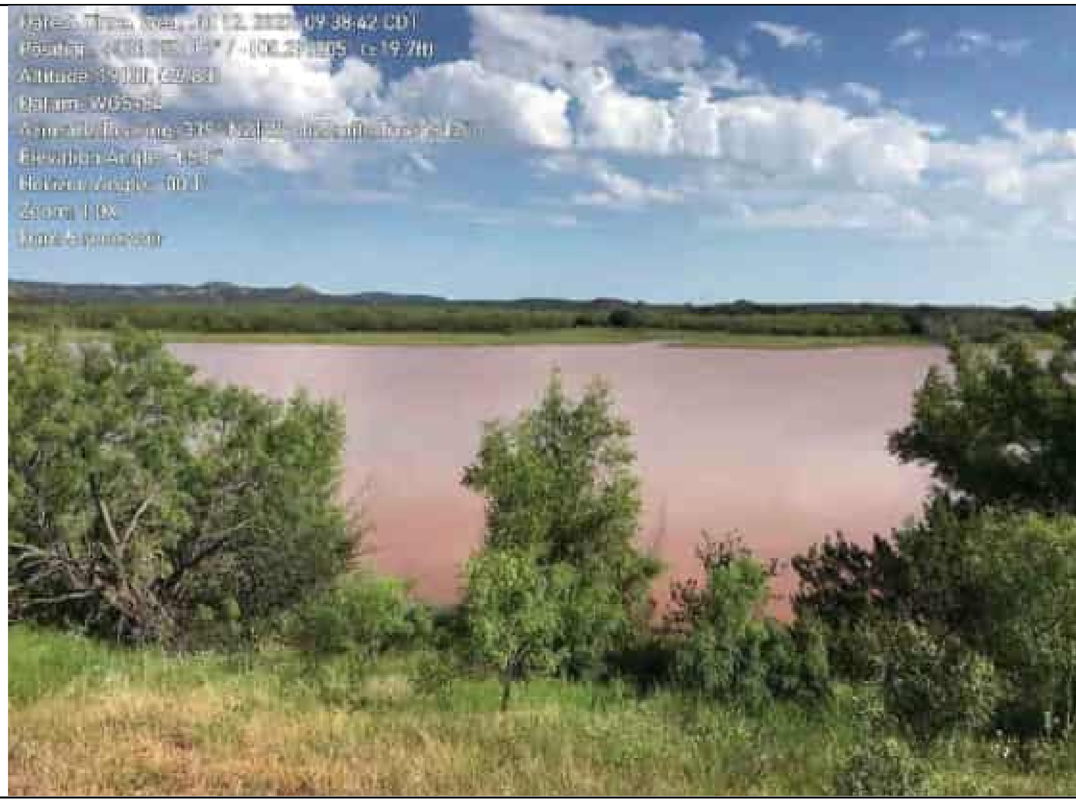


Photo No.	Date:
2	07/12/23

Direction Photo Taken:

Southeast

Description:

View of Kickapoo Creek FRS No. 5 reservoir (WB01) in the central portion of the Study Area.

Site Name: Kickapoo Creek FRS No. 5	Site Location: Coke County, TX	Project No. 60630022

Photo No. 3	Date: 07/12/23
Direction Photo Taken: Northeast	
Description: View of vegetation surrounding Kickapoo Creek FRS No. 5 reservoir in the central portion of the Study Area.	

Photo No. 4	Date: 07/12/23
Direction Photo Taken: Northwest	
Description: View of harvester ant mound located within the Study Area.	

Site Name: Kickapoo Creek FRS No. 5	Site Location: Coke County, TX	Project No. 60630022

Photo No.	Date:
5	07/12/23

Direction Photo Taken:

Northwest

Description:

View of habitat and vegetation surrounding Kickapoo Creek FRS No. 5 reservoir in the central portion of the Study Area.

Photo No.	Date:
6	07/12/23

Direction Photo Taken:

Northwest

Description:

View of habitat and vegetation surrounding Kickapoo Creek FRS No. 5 reservoir in the central portion of the Study Area

Appendix C Federal and State Database Review

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Austin Ecological Services Field Office
1505 Ferguson Lane
Austin, TX 78754-4501
Phone: (512) 937-7371

In Reply Refer To: August 09, 2023
Project Code: 2023-0114787
Project Name: Kickapoo 5

Subject: List of threatened and endangered species that may occur in your proposed project location or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF

Migratory Birds: In addition to responsibilities to protect threatened and endangered species under the Endangered Species Act (ESA), there are additional responsibilities under the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA) to protect native birds from project-related impacts. Any activity, intentional or unintentional, resulting in take of migratory birds, including eagles, is prohibited unless otherwise permitted by the U.S. Fish and Wildlife Service (50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)). For more information regarding these Acts see https://www.fws.gov/birds/policies-and-regulations.php.

The MBTA has no provision for allowing take of migratory birds that may be unintentionally killed or injured by otherwise lawful activities. It is the responsibility of the project proponent to comply with these Acts by identifying potential impacts to migratory birds and eagles within applicable NEPA documents (when there is a federal nexus) or a Bird/Eagle Conservation Plan (when there is no federal nexus). Proponents should implement conservation measures to avoid or minimize the production of project-related stressors or minimize the exposure of birds and their resources to the project-related stressors. For more information on avian stressors and recommended conservation measures see https://www.fws.gov/birds/bird-enthusiasts/threats-to-birds.php.

In addition to MBTA and BGEPA, Executive Order 13186: *Responsibilities of Federal Agencies to Protect Migratory Birds*, obligates all Federal agencies that engage in or authorize activities that might affect migratory birds, to minimize those effects and encourage conservation measures that will improve bird populations. Executive Order 13186 provides for the protection of both migratory birds and migratory bird habitat. For information regarding the implementation of Executive Order 13186, please visit https://www.fws.gov/birds/policies-and-regulations/executive-orders/e0-13186.php.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Code in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List

OFFICIAL SPECIES LIST

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

Austin Ecological Services Field Office
1505 Ferguson Lane
Austin, TX 78754-4501
(512) 937-7371

PROJECT SUMMARY

Project Code: 2023-0114787
Project Name: Kickapoo 5
Project Type: Dam - Maintenance/Modification
Project Description: Dam Rehabilitation
Project Location:

The approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@31.9621699,-100.29828768778336,14z

Counties: Coke County, Texas

ENDANGERED SPECIES ACT SPECIES

There is a total of 4 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species. Note that 2 of these species should be considered only under certain conditions.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

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1. 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.

MAMMALS

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

BIRDS

NAME	STATUS
Piping Plover *Charadrius melodus* Population: [Atlantic Coast and Northern Great Plains populations] - Wherever found, except those areas where listed as endangered. There is **final** critical habitat for this species. Your location does not overlap the critical habitat. This species only needs to be considered under the following conditions: ▪ Wind Energy Projects Species profile: https://ecos.fws.gov/ecp/species/6039	Threatened
Red Knot *Calidris canutus rufa* There is **proposed** critical habitat for this species. This species only needs to be considered under the following conditions: ▪ Wind Energy Projects Species profile: https://ecos.fws.gov/ecp/species/1864	Threatened

INSECTS

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

CRITICAL HABITATS

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

YOU ARE STILL REQUIRED TO DETERMINE IF YOUR PROJECT(S) MAY HAVE EFFECTS ON ALL ABOVE LISTED SPECIES.

IPAC USER CONTACT INFORMATION

Agency: Texas Water Development Board
Name: Payton Prather
Address: 9400 Amberglenn Blvd #E
City: Austin
State: TX
Zip: 78729
Email paytonp1776@gmail.com
Phone: 7134942044

LEAD AGENCY CONTACT INFORMATION

Lead Agency: Texas Water Development Board

Last Update: 1/4/2023

COKE COUNTY

AMPHIBIANS

Woodhouse's toad *Anaxyrus woodhousii*

Terrestrial and aquatic: A wide variety of terrestrial habitats are used by this species, including forests, grasslands, and barrier island sand dunes. Aquatic habitats are equally varied.

Federal Status: State Status: SGCN: Y

Endemic: N Global Rank: G5 State Rank: SU

BIRDS

bald eagle *Haliaeetus leucocephalus*

Found primarily near rivers and large lakes; nests in tall trees or on cliffs near water; communally roosts, especially in winter; hunts live prey, scavenges, and pirates food from other birds

Federal Status: State Status: SGCN: Y

Endemic: N Global Rank: G5 State Rank: S3B,S3N

black rail *Laterallus jamaicensis*

The county distribution for this species includes geographic areas that the species may use during migration. Time of year should be factored into evaluations to determine potential presence of this species in a specific county. Salt, brackish, and freshwater marshes, pond borders, wet meadows, and grassy swamps; nests in or along edge of marsh, sometimes on damp ground, but usually on mat of previous years dead grasses; nest usually hidden in marsh grass or at base of Salicornia

Federal Status: LT State Status: T SGCN: Y

Endemic: N Global Rank: G3 State Rank: S2

black-capped vireo *Vireo atricapilla*

Oak-juniper woodlands with distinctive patchy, two-layered aspect; shrub and tree layer with open, grassy spaces; requires foliage reaching to ground level for nesting cover; return to same territory, or one nearby, year after year; deciduous and broad-leaved shrubs and trees provide insects for feeding; species composition less important than presence of adequate broad-leaved shrubs, foliage to ground level, and required structure; nesting season March-late summer

Federal Status: State Status: SGCN: Y

Endemic: N Global Rank: G5 State Rank: S3B

chestnut-collared longspur *Calcarius ornatus*

Occurs in open shortgrass settings especially in patches with some bare ground. Also occurs in grain sorghum fields and Conservation Reserve Program lands

Federal Status: State Status: SGCN: Y

Endemic: N Global Rank: G5 State Rank: S3

COKE COUNTY

BIRDS

Franklin's gull *Leucophaeus pipixcan*

The county distribution for this species includes geographic areas that the species may use during migration. Time of year should be factored into evaluations to determine potential presence of this species in a specific county. This species is only a spring and fall migrant throughout Texas. It does not breed in or near Texas. Winter records are unusual consisting of one or a few individuals at a given site (especially along the Gulf coastline). During migration, these gulls fly during daylight hours but often come down to wetlands, lake shore, or islands to roost for the night.

Federal Status: State Status: SGCN: Y

Endemic: N Global Rank: G5 State Rank: S2N

golden eagle *Aquila chrysaetos*

Habitat description is not available at this time.

Federal Status: State Status: SGCN: Y

Endemic: N Global Rank: G5 State Rank: S3B

lark bunting *Calamospiza melanocorys*

Overall, it's a generalist in most short grassland settings including ones with some brushy component plus certain agricultural lands that include grain sorghum. Short grasses include sideoats and blue gramas, sand dropseed, prairie junegrass (Koeleria), buffalograss also with patches of bluestem and other mid-grass species. This bunting will frequent smaller patches of grasses or disturbed patches of grasses including rural yards. It also uses weedy fields surrounding playas. This species avoids urban areas and cotton fields.

Federal Status: State Status: SGCN: Y

Endemic: N Global Rank: G5 State Rank: S4B

mountain plover *Charadrius montanus*

The county distribution for this species includes geographic areas that the species may use during migration. Time of year should be factored into evaluations to determine potential presence of this species in a specific county. Breeding: nests on high plains or shortgrass prairie, on ground in shallow depression; nonbreeding: shortgrass plains and bare, dirt (plowed) fields; primarily insectivorous.

Federal Status: State Status: SGCN: Y

Endemic: N Global Rank: G3 State Rank: S2

Sprague's pipit *Anthus spragueii*

The county distribution for this species includes geographic areas that the species may use during migration. Time of year should be factored into evaluations to determine potential presence of this species in a specific county. Habitat during migration and in winter consists of pastures and weedy fields (AOU 1983), including grasslands with dense herbaceous vegetation or grassy agricultural fields.

Federal Status: State Status: SGCN: Y

Endemic: N Global Rank: G3G4 State Rank: S3N

western burrowing owl *Athene cunicularia hypugaea*

Open grasslands, especially prairie, plains, and savanna, sometimes in open areas such as vacant lots near human habitation or airports; nests and roosts in abandoned burrows

Federal Status: State Status: SGCN: Y

Endemic: N Global Rank: G4T4 State Rank: S2

white-faced ibis *Plegadis chihi*

COKE COUNTY

BIRDS

The county distribution for this species includes geographic areas that the species may use during migration. Time of year should be factored into evaluations to determine potential presence of this species in a specific county. Prefers freshwater marshes, sloughs, and irrigated rice fields, but will attend brackish and saltwater habitats; currently confined to near-coastal rookeries in so-called hog-wallow prairies. Nests in marshes, in low trees, on the ground in bulrushes or reeds, or on floating mats.

Federal Status: State Status: T SGCN: Y

Endemic: N Global Rank: G5 State Rank: S4B

FISH

Guadalupe bass *Micropterus treculii*

Endemic to the streams of the northern and eastern Edwards Plateau including portions of the Brazos, Colorado, Guadalupe, and San Antonio basins; species also found outside of the Edwards Plateau streams in decreased abundance, primarily in the lower Colorado River; two introduced populations have been established in the Nueces River system. A pure population was re-established in a portion of the Blanco River in 2014. Species prefers lentic environments but commonly taken in flowing water; numerous smaller fish occur in rapids, many times near eddies; large individuals found mainly in riffle tail races; usually found in spring-fed streams having clear water and relatively consistent temperatures.

Federal Status: State Status: SGCN: Y

Endemic: Y Global Rank: G3 State Rank: S3

Red River pupfish *Cyprinodon rubrofluviatilis*

Native to the upper Red River and Brazos River basins where it is typically found in saline waters of main channels and in saline springs. Introduced populations also exist in the Canadian River and Colorado River basins. River edges, channels, backwaters, over sand bottoms. Males establish spawning territories typically in shallowest waters up to 50 cm over sandy shoals and in small coves with little or no current.

Federal Status: State Status: T SGCN: Y

Endemic: N Global Rank: G5 State Rank: S2

sharpnose shiner *Notropis oxyrhynchus*

Range is now restricted to upper Brazos River upstream of Possum Kingdom Lake. May be native to Red River and Colorado River basins. Typically found in turbid water over mostly silt and shifting sand substrates.

Federal Status: LE State Status: E SGCN: Y

Endemic: Y Global Rank: G3 State Rank: S1S2

MAMMALS

black-tailed prairie dog *Cynomys ludovicianus*

Dry, flat, short grasslands with low, relatively sparse vegetation, including areas overgrazed by cattle; live in large family groups

Federal Status: State Status: SGCN: Y

Endemic: N Global Rank: G4 State Rank: S3

COKE COUNTY

MAMMALS

cave myotis bat *Myotis velifer*

Colonial and cave-dwelling; also roosts in rock crevices, old buildings, carports, under bridges, and even in abandoned Cliff Swallow (Hirundo pyrrhonota) nests; roosts in clusters of up to thousands of individuals; hibernates in limestone caves of Edwards Plateau and gypsum cave of Panhandle during winter; opportunistic insectivore.

Federal Status: State Status: SGCN: Y

Endemic: N Global Rank: G4G5 State Rank: S2S3

eastern red bat *Lasiurus borealis*

Red bats are migratory bats that are common across Texas. They are most common in the eastern and central parts of the state, due to their requirement of forests for foliage roosting. West Texas specimens are associated with forested areas (cottonwoods). Also common along the coastline. These bats are highly mobile, seasonally migratory, and practice a type of "wandering migration". Associations with specific habitat is difficult unless specific migratory stopover sites or wintering grounds are found. Likely associated with any forested area in East, Central, and North Texas but can occur statewide.

Federal Status: State Status: SGCN: Y

Endemic: N Global Rank: G3G4 State Rank: S4

hoary bat *Lasiurus cinereus*

Hoary bats are highly migratory, high-flying bats that have been noted throughout the state. Females are known to migrate to Mexico in the winter, males tend to remain further north and may stay in Texas year-round. Commonly associated with forests (foliage roosting species) but are found in unforested parts of the state and lowland deserts. Tend to be captured over water and large, open flyways.

Federal Status: State Status: SGCN: Y

Endemic: N Global Rank: G3G4 State Rank: S4

kit fox *Vulpes macrotis*

Open desert grassland; avoids rugged, rocky terrain and wooded areas.

Federal Status: State Status: SGCN: N

Endemic: N Global Rank: G4 State Rank: S1S2

long-tailed weasel *Mustela frenata*

Includes brushlands, fence rows, upland woods and bottomland hardwoods, forest edges & rocky desert scrub. Usually live close to water.

Federal Status: State Status: SGCN: Y

Endemic: N Global Rank: G5 State Rank: S5

mountain lion *Puma concolor*

Generalist; found in a wide range of habitats statewide. Found most frequently in rugged mountains & riparian zones.

Federal Status: State Status: SGCN: Y

Endemic: N Global Rank: G5 State Rank: S2S3

pronghorn *Antilocapra americana*

Prefers hilly and plateau areas of open grassland, desert-grassland, and desert-scrub, where it frequents south-facing slopes and other sheltered areas.

COKE COUNTY

MAMMALS

Federal Status: State Status: SGCN: Y

Endemic: N Global Rank: G5 State Rank: S3

tricolored bat *Perimyotis subflavus*

Forest, woodland and riparian areas are important. Caves are very important to this species.

Federal Status: State Status: SGCN: Y

Endemic: N Global Rank: G3G4 State Rank: S2

western hog-nosed skunk *Conepatus leuconotus*

Habitats include woodlands, grasslands & deserts, to 7200 feet, most common in rugged, rocky canyon country; little is known about the habitat of the ssp. telmalestes

Federal Status: State Status: SGCN: Y

Endemic: N Global Rank: G4 State Rank: S4

western spotted skunk *Spilogale gracilis*

Brushy canyons, rocky outcrops (rimrock) on hillsides and walls of canyons. In semi-arid brushlands in U.S., in wet tropical forests in Mexico. When inactive or bearing young, occupies den in rocks, burrow, hollow log, brush pile, or under building.

Federal Status: State Status: SGCN: Y

Endemic: N Global Rank: G5 State Rank: S5

MOLLUSKS

Texas fatmucket *Lampsilis bracteata*

Reported to occur in slow to moderate current in sand, mud, and gravel substrates among large cobble, boulders, bedrock ledges, horizontal cracks in bedrock slabs, and macrophyte beds. Has also been observed inhabiting the roots of cypress trees and vegetation along steep banks. Past authorities have reported this species intolerant of reservoir conditions but recent surveys suggest it may persist in some impoundment conditions (Howells 2010c; Randklev et al. 2017b). [Mussel of Texas 2019]

Federal Status: PE State Status: T SGCN: Y

Endemic: Y Global Rank: G1 State Rank: S1

Texas pimpleback *Cyclonaias petrina*

Occurs in medium-size streams to large rivers primarily in riffles and runs. Often found in substrates composed of sand, gravel, and cobble, including mud-silt or gravel-filled cracks in bedrock slabs. Considered intolerant of reservoirs (Howells 2010m; Randklev et al. 2017b). [Mussels of Texas 2019]

Federal Status: PE State Status: T SGCN: Y

Endemic: Y Global Rank: G1 State Rank: S1

REPTILES

Brazos water snake *Nerodia harteri*

Aquatic: Shallow, fast-flowing water with a rocky or gravelly substrate preferred. Adults can be found in deep water with mud bottoms, such as large section fo rivers and reservoirs. Riffle habitat is particularly important for this species.

Federal Status: State Status: T SGCN: Y

COKE COUNTY

REPTILES

Endemic: Y | Global Rank: G1 | State Rank: S1

Concho water snake *Nerodia paucimaculata*

Aquatic: Shallow, fast-flowing water with a rocky or gravelly substrate preferred. Adults can be found in deep water with mud bottoms, such as large section fo rivers and reservoirs. Riffle habitat is particularly important for this species.

Federal Status: | State Status: | SGCN: Y

Endemic: Y | Global Rank: G1 | State Rank: S1

plateau spot-tailed earless lizard *Holbrookia lacerata*

Terrestrial: Habitats include moderately open prairie-brushland regions, particularly fairly flat areas free of vegetation or other obstructions (e.g., open meadows, old and new fields, graded roadways, cleared and disturbed areas, prairie savanna, and active agriculture including row crops); also, oak-juniper woodlands and mesquite-prickly pear associations (Axtell 1968, Bartlett and Bartlett 1999).

Federal Status: | State Status: | SGCN: Y

Endemic: Y | Global Rank: GNR | State Rank: S2

roundtail horned lizard *Phrynosoma modestum*

This species seems to prefer rocky or gravelly substrates in open areas that are sparsely vegetated.

Federal Status: | State Status: | SGCN: Y

Endemic: N | Global Rank: G5 | State Rank: S4

smooth softshell *Apalone mutica*

Aquatic: Large rivers and streams; in some areas also found in lakes and impoundments (Ernst and Barbour 1972). Usually in water with sandy or mud bottom and few aquatic plants. Often basks on sand bars and mudflats at edge of water. Eggs are laid in nests dug in high open sandbars and banks close to water, usually within 90 m of water (Fitch and Plummer 1975).

Federal Status: | State Status: | SGCN: Y

Endemic: N | Global Rank: G5 | State Rank: S3

Texas horned lizard *Phrynosoma cornutum*

Terrestrial: Open habitats with sparse vegetation, including grass, prairie, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive. Occurs to 6000 feet, but largely limited below the pinyon-juniper zone on mountains in the Big Bend area.

Federal Status: | State Status: T | SGCN: Y

Endemic: N | Global Rank: G4G5 | State Rank: S3

Texas map turtle *Graptemys versa*

Aquatic: Primarily a river turtle but can also be found in reservoirs. Can be found in deep and shallow water with sufficient basking sites (emergent rocks and woody debris).

Federal Status: | State Status: | SGCN: Y

Endemic: Y | Global Rank: G4 | State Rank: SU

western box turtle *Terrapene ornata*

COKE COUNTY

REPTILES

Terrestrial: Ornate or western box trutles inhabit prairie grassland, pasture, fields, sandhills, and open woodland. They are essentially terrestrial but sometimes enter slow, shallow streams and creek pools. For shelter, they burrow into soil (e.g., under plants such as yucca) (Converse et al. 2002) or enter burrows made by other species.

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S3

western hognose snake *Heterodon nasicus*

Terrestrial: Shortgrass or mixed grass prairie, with gravel or sandy soils. Often found associated with draws, floodplains, and more mesic habitats within the arid landscape. Frequently occurs in shrub encroached grasslands.

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S4

western massasauga *Sistrurus tergeminus*

Terrestrial: Shortgrass or mixed grass prairie, with gravel or sandy soils. Often found associated with draws, floodplains, and more mesic habitats within the arid landscape. Frequently occurs in shrub encroached grasslands.

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G3G4	State Rank: S3

western rattlesnake *Crotalus viridis*

Terrestrial: Dry desert and prairie grasslands, shrub desert rocky hillsides; edges of arid and semi-arid river breaks.

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S5

PLANTS

Correll's green pitaya *Echinocereus viridiflorus var. correllii*

Among grasses on rock crevices on low hills in desert or semi-desert grassland on novaculite or limestone; flowering March-May

Federal Status:	State Status:	SGCN: Y
Endemic: Y	Global Rank: G5T2	State Rank: S2

Guadalupe beardtongue *Penstemon guadalupensis*

Scattered in calcareous prairies on the Lampasas Cutplain and Edwards Plateau; Perennial; Flowering/Fruiting March-July

Federal Status:	State Status:	SGCN: Y
Endemic: Y	Global Rank: G3	State Rank: S3

Irion County wild-buckwheat *Eriogonum nealleyi*

Grasslands and shallow stony soils over limestone and indurated caliche, often collected from ungrazed but sparsely vegetated roadsides, particularly where limestone or caliche is exposed on hilltops; flowering June-September

Federal Status:	State Status:	SGCN: Y
Endemic: Y	Global Rank: G2	State Rank: S2

COKE COUNTY

PLANTS

Miller's hedgehog cactus *Echinocereus milleri*

Occurs on sandy-loam soils on rocky hills.

Federal Status:	State Status:	SGCN: Y
Endemic: Y	Global Rank: G1	State Rank: S1

Texas poppy-mallow *Callirhoe scabriuscula*

Grasslands and open oak shrublands or mesquite woodlands on deep, loose sands (Tivoli Series) of ancient and contemporary Colorado River terraces; flowering (April-) May-June; in late July the plants die back to the taproots, in late August-September basal rosettes form, in April the flowering stems bolt

Federal Status: LE	State Status: E	SGCN: Y
Endemic: Y	Global Rank: G2	State Rank: S2

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E-5 Investigation of Potentially Jurisdictional Waters of the United States – FRS No. 5

AECOM

Investigation of Potentially Jurisdictional Waters of the United States

Kickapoo Creek Floodwater Retarding Structure No. 5 Rehabilitation Project

Coke County, Texas

Texas State Soil and Water Conservation Board

Project number : 60630022

August 2023

Delivering a better world

Prepared for:

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1. Introduction

AECOM Technical Services, Inc. (AECOM) conducted an investigation of potentially jurisdictional waters of the United States (U.S.) (WOTUS), including wetlands, for the proposed Kickapoo Creek Floodwater Retarding Structure (FRS) No. 5 Rehabilitation Project (Project). The proposed Project is located in Coke County, approximately 5 miles northwest of Bronte, Texas (**Appendix A, Figure 1**). A data review and field investigations were conducted for the Project within a study area encompassing approximately 198 acres (Study Area).

The purpose of the investigation was to identify and delineate water resources within the Study Area that exhibit characteristics meeting the regulatory definition of WOTUS. These resources were then assessed for their potential to be considered jurisdictional WOTUS subject to regulation by the U.S. Army Corps of Engineers (USACE) Fort Worth District under jurisdiction of Section 404 of the Clean Water Act (CWA).

Publicly available data was reviewed to identify potentially jurisdictional streams, waterbodies, wetlands, soil types, and vegetation types within the Study Area. Data resources reviewed included the U.S. Fish and Wildlife Service (USFWS) National Wetland Inventory (NWI) maps, the U.S. Geological Survey (USGS) National Hydrography Dataset (NHD), the U.S. Department of Agriculture (USDA) NRCS Web Soil Survey, USGS 7.5' quadrangle sheets, Federal Emergency Management Agency (FEMA) floodplain maps, and recent aerial photography. This data review was used to describe the site-specific information below.

1.1 Land Use

The majority of the Study Area consisted of an open water reservoir, a dam structure, an auxiliary spillway, and undeveloped land. Based on the NHD, two intermittent streams including Dry Creek and Middle Kickapoo Creek, and two open water features including the Kickapoo Creek FRS No. 5 reservoir, were mapped within the Study Area (USGS 2023).

1.2 Topography

The USGS 7.5-minute quadrangle map for Bronte, TX displays the topography of the Study Area (**Appendix A, Figure 2**). Topography within the Study Area is shaped by the current reservoir and dam system Dry Creek and Middle Kickapoo Creek. The surface gradient slopes from northeast to southwest, with the highest elevation located along the northern boundary of the Study Area at approximately 1,920 feet above mean sea level (MSL [National Geodetic Vertical Datum of 1929]). The lowest elevation is located in Middle Kickapoo Creek along the southeaster boundary of the Study Area at approximately 1,880 feet above MSL (National Geodetic Vertical Datum of 1929) (USGS 2022).

1.3 Soils

According to the USDA NRCS Web Soil Survey Report, the Study Area is mapped as being underlain by 10 soil map unit types (as shown on **Table 1** below and within **Appendix A, Figure 3**) (USDA 2020).

Table 1. NRCS Soil Mapping Units

Mapping Unit	Soil Type	Listed as Hydric by NRCS
BrA	Bronte fine sandy loam, 0 to 1 percent slopes	No

Mapping Unit	Soil Type	Listed as Hydric by NRCS
CbB	Cobb loamy fine sand, 0 to 3 percent slopes	No
CfB	Cobb fine sandy loam, dry, 1 to 3 percent slopes	No
Cm	Colorado loam, 0 to 1 percent slopes, frequently flooded	Yes
CnB	Oben and Cobb soils, 1 to 3 percent slopes	No
MmA	Miles fine sandy loam, 0 to 1 percent slopes	No
MmB	Miles fine sandy loam, 1 to 3 percent slopes	No
OcA	Sagerton clay loam, 0 to 1 percent slopes	No
SPW	Spillway	No
W	Water	Yes

1.4 Hydrology

The Study Area lies within the Upper Colorado watershed (8-Digit Hydrologic Unit Code [HUC] 12080008) and the Kickapoo Creek subwatershed (12-Digit HUC 120800080407).

The USGS NHD was reviewed to gather information on the potential locations of areas that may exhibit characteristics of WOTUS. Three NHD features including Middle Kickapoo Creek, Dry Creek, and Kickapoo Creek FRS No. 5 Reservoir were identified and are shown on **Appendix A, Figure 4**.

USFWS NWI maps and associated geographic information system (GIS) data were reviewed to gather information on the potential location of areas that may exhibit characteristics of wetlands. According to the NWI data, five features associated with Middle Kickapoo Creek and Kickapoo Creek FRS No. 5 Reservoir are located within the Study Area (**Appendix A, Figure 4**). Documented NWI wetland types include Riverine, Surface Flooding, Seasonal (R4SBC); Riverine, Intermittent, Streambed, Temporary Flooded (R4SBA); Palustrine, Forested, Broad-leaved Deciduous, Temporarily Flooded (PFO1A); Lacustrine, Littoral, Unconsolidated Shore, Temporary Flooded, Diked/Impounded (L2USAh); and Lacustrine, Limnetic, Unconsolidated Bottom, Diked/Impounded (L1UBHh).

1.4.1 Floodplain

Based on a review of the FEMA digital flood insurance rate map, floodplains are unmapped in the Study Area.

1.4.2 Vegetation

Historically Mapped and Documented Vegetation Types

According to TPWD's Ecoregion data, the Study Area falls within the Southwestern Table Lands Level 3 Ecoregion and the Caprock Canyons, Badlands, and Breaks Level 4 Ecoregion.

The Study Area lies within one Land Resource Region (LRR H) and one Major Land Resource Area (MLRA 78B). LRR H denotes the Central Great Plains Winter Wheat and Range Region and consists of vegetation mainly of grasslands and agricultural land. MLRA 78B is the Central

Rolling Red Plains, Western Part, which can be characterized by red soils weathered from silty sandstone, siltstone, and claystone on rolling plains with ancient stream terraces or terrace remnants associated with stream dissection. Nearly level to gently sloping and consisting of dissected plain areas with steeper slopes occurring along entrenched river and creek valleys. Broad meander belts are associated with the major streams, and wide flood plains are flanked by nearly level stream terraces. More information on LRR H and MLRA 78B can be read within USDA's Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin, Handbook 296.

According to TPWD's Ecological Mapping System of Texas (EMST), the vegetation mapped within the Study Area includes Rolling Plains: Mixedgrass Prairie; Rolling Plains: Mixedgrass Sandy Prairie; Edwards Plateau: Floodplain Hardwood Forest; Edwards Plateau: Floodplain Deciduous Shrubland; Edwards Plateau: Floodplain Herbaceous Vegetation; Edwards Plateau: Oak - Hardwood Motte and Woodland; Edwards Plateau: Ashe Juniper-Live Oak Shrubland; Edwards Plateau: Riparian Hardwood Forest; Edwards Plateau: Riparian Deciduous Shrubland; Edwards Plateau: Riparian Herbaceous Vegetation; Rolling Plains: Breaks Deciduous Shrubland; Barren; Marsh; Native Invasive: Deciduous Woodland; Native Invasive: Mesquite Shrubland; CRP / Other Improved Grassland; Open Water (**Appendix A, Figure 4**) (Elliot et al 2014).

Existing Conditions

Field investigations documented vegetation types throughout the Study Area. The majority of the Study Area consisted of undeveloped grassland / pasture and riparian woodlands. Common species observed within the tree and sapling/shrub stratum include:

- post oak (*Quercus stellata*),
- live oak (*Quercus fuisformis*),
- sugarberry (*Celtis laevigata*),
- American elm (*Ulmus americana*),
- cedar elm (*Ulmus crassifolia*),
- mesquite (*Prosopis glandulosa*), and
- black willow (*Salix nigra*)

Common herbaceous species observed within the Study Area include:

- buffalo grass (*Bouteloua dectyloides*),
- creek oats (*Chasmanthium latifolium*),
- western wheatgrass (*Pascopyrum smithii*),
- prairie verbena (*Glandularia bipinnatifida*),
- silverleaf nightshade (*Solanum elaeagnifolium*),
- prickly pear cactus (*Opuntia engelmannii*), and
- bermuda grass (*Cynodon dactylon*).

Vines observed within the Study Area include:

- Virginia creeper (*Parthenocissus quinquefolia*),
- poison ivy (*Toxicodendron radicans*), and

- greenbriar (*Smilax bona-nox*).

See **Appendix B** for representative photographs of the Study Area.

2. Potentially Jurisdictional Waters of the U.S.

2.1 USACE Regulatory Authority

The USACE, acting under Section 404 of the CWA and Section 10 of the Rivers and Harbors Act of 1899, regulates certain activities occurring within WOTUS. Under Section 404 of the CWA, authorization must be obtained from the USACE for discharges of dredged and fill material into jurisdictional WOTUS, including wetlands. The USACE's regulatory authority over WOTUS includes jurisdictional determinations and permitting under Section 404 of the CWA. In addition, under Section 10 of the Rivers and Harbors Act of 1899, the USACE regulates any work in or affecting navigable WOTUS (Environmental Protection Agency [EPA], 2015). The proposed project is regulated in accordance with the CWA by the Fort Worth District of the USACE.

2.2 Field Delineation Methodology

The USACE asserts jurisdiction over the following categories of water bodies: 1) traditionally navigable waters (TNWs); 2) wetlands adjacent to TNWs; 3) relatively permanent waters (RPWs) (i.e., waters that typically flow year round or have continuous flow at least seasonally); 4) non-RPWs with a significant nexus to TNWs; 5) wetlands directly abutting RPWs; 6) wetlands adjacent to but not directly abutting RPWs; and 7) wetlands adjacent to non-RPWs with a significant nexus to TNWs (USACE, 2007; EPA, 2023).

The limit of jurisdiction for non-tidal jurisdictional WOTUS extends to the ordinary high-water mark (OHWM), the limit of adjacent wetlands, or the limit of other special aquatic sites (SAS). SAS include sanctuaries and refuges, wetlands, mud flats, vegetated shallows, coral reefs, and riffle and pool complexes (40 CFR Section 230.10(a)(3) of the CWA). The OHWM is determined by signs of natural lines impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, presence of litter and debris, wracking, vegetation matted down, bent, or absent, sediment sorting, leaf litter disturbed or washed away, scour, deposition, multiple observed flow events, bed and banks, water staining, change in plant community; and/or other appropriate means that consider the characteristics of the surrounding areas.

The USACE's determination of a jurisdictional wetland is based on the wetland criteria of the 1987 Corps of Engineers Wetland Delineation Manual (Environmental Laboratory 1987), as amended by USACE memoranda dated August 23 and 27, 1991, and March 6, 1992; Questions and Answers to the 1987 Manual (October 7, 1991); and the Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Great Plains Region (Version 2.0, March 2010) (USACE 2010). Wetlands are based on three criteria: hydrophytic vegetation, hydric soils, and wetland hydrology. All three criteria must be present for an area to qualify as a wetland; however, some exceptions can occur in disturbed areas or in newly formed wetlands, where one indicator (such as hydric soils) might be lacking.

Field investigations were conducted on July 12 2023. AECOM used a Trimble Geo7X Global Positioning System (GPS), capable of sub-meter accuracy, to collect geographically-referenced features, such as OHWMs, wetland boundaries, and soil station data points. The field data was then transferred to GIS software (ESRI ArcMap 10.5) to analyze identified features, calculate areas and lengths, and generate the figure provided in **Appendix A, Figure 6.**

Appendix B contains a detailed photo log showing conditions of each feature as documented within the Study Area.

2.3 Potentially Jurisdictional WOTUS (Non-Wetland)

Kickapoo Creek FRS No. 5 Reservoir (WB01) is approximately 26.83 acres in areal extent within the Study Area. This reservoir captures hydrologic flow from Middle Kickapoo Creek and Dry Creek then discharges below the dam (via spillway) to connect Middle Kickapoo Creek back to its natural channel. Middle Kickapoo Creek then flows away from the Kickapoo Creek FRS No. 5 Reservoir in a southeastern direction for approximately 3.25 mile before discharging into Kickapoo Creek, followed by the Colorado River (a TNW), and then ultimately discharging into the Gulf of Mexico at the Texas Gulf Coast. Based on NHD, desktop investigations, and field investigations, this is a perennial water feature that maintains year-round flow from groundwater and upstream hydrologic flow. This feature has a significant nexus to a TNW and can be considered potentially jurisdictional per USACE WOTUS classification. Refer to **Appendix B, Photos 1-2** for conditions documented during the field investigation.

Dry Creek (S01) spans approximately 900 linear feet (LF) (0.25 acres in areal extent) within the Study Area. The average OHWM width was approximately 12 feet. OHWM indicators observed include bed and bank, shelving, natural lines impressed on the bank, litter disturbed or washed away, and scour. Dry Creek enters Kickapoo Creek FRS No. 5 Reservoir then discharges into Middle Kickapoo Creek (S02) flowing approximately 3.25 mile before discharging into Kickapoo Creek, followed by the Colorado River (a TNW), and then ultimately discharging into the Gulf of Mexico at the Texas Gulf Coast. Based on NHD, desktop investigations, and field investigations, Salt Creek can be considered an intermittent stream as a result of groundwater and upstream hydrologic contribution. This feature has a significant nexus to a TNW and can be considered potentially jurisdictional per USACE WOTUS classification. Refer to **Appendix B, Photos 3-4** for conditions documented during the field investigation.

Middle Kickapoo Creek (S02) spans approximately 1,923 LF (0.48 acres in areal extent) within the Study Area. The average OHWM width was approximately 26 feet. OHWM indicators observed include bed and bank, shelving, natural lines impressed on the bank, litter disturbed or washed away, and scour. Middle Kickapoo Creek (S02) enters Kickapoo Creek FRS No. 5 Reservoir, then discharges downstream back into Middle Kickapoo Creek. Middle Kickapoo Creek leaves Kickapoo Creek FRS No. 5 Reservoir flowing approximately 3.25 mile before discharging into Kickapoo Creek, followed by the Colorado River (a TNW) and then ultimately discharging into the Gulf of Mexico at the Texas Gulf Coast. Based on NHD, desktop investigations, and field investigations, Middle Kickapoo Creek (S02) can be considered an intermittent stream as a result of groundwater and upstream hydrologic contribution. This feature has a significant nexus to a TNW and can be considered potentially jurisdictional per USACE WOTUS classification. Refer to **Appendix B, Photos 5-8** for conditions documented during the field investigation.

Table 2 below summarizes potentially jurisdictional WOTUS (non-wetlands) within the Study Area.

Table 2. Potentially Jurisdictional WOTUS (Non-Wetlands) within the Study Area

Name	USACE Classification	Flow Regime	Length (LF)	Average Width (feet)	Area within Study Area (acre)
Kickapoo Creek FRS No. 5 Reservoir (WB01)	Potentially Jurisdictional	Perennial	N/A	N/A	26.83
Dry Creek (S01)	Potentially Jurisdictional	Intermittent	900	12	0.25

Name	USACE Classification	Flow Regime	Length (LF)	Average Width (feet)	Area within Study Area (acre)
Middle Kickapoo Creek (S02)	Potentially Jurisdictional	Intermittent	1,923	26	0.48
		Total	**2,823**	**--**	**27.56**

2.4 Potentially Jurisdictional Wetlands

No potentially jurisdictional wetlands were observed within the Study Area.

2.5 Non-Jurisdictional Features

No potentially non-jurisdictional features were observed within the Study Area.

3. Conclusions

In AECOM's professional opinion, potentially jurisdictional WOTUS identified within the Study Area include Kickapoo Creek FRS No. 5 Reservoir (WB01), Dry Creek (S01), and Middle Kickapoo Creek (S02).

Based on the findings from data analysis and field investigations, three potentially jurisdictional WOTUS (non-wetland) totaling 2,823 LF (28 acres) were identified and mapped within the Study Area (as shown on **Table 3** below, and within **Appendix A, Figure 6**).

Table 3. Potentially Jurisdictional WOTUS within the Study Area

Name	USACE Classification	Flow Regime	Length (LF)	Area within Study Area (acres)
Waterbodies				
Kickapoo Creek FRS No. 5 Reservoir (WB01)	Potentially Jurisdictional	Perennial	N/A	26.83
Dry Creek (S01)	Potentially Jurisdictional	Intermittent	900	0.25
Middle Kickapoo Creek (S02)	Potentially Jurisdictional	Intermittent	1,923	0.48
		Total	**2,823**	**27.56**

These features are subject to regulation by the USACE, Fort Worth District, under Section 404 of the CWA and would require permit authorization if proposed project activities involve the discharge of dredged or fill material into these identified WOTUS.

The USACE is the official regulatory agency to make the final jurisdictional determination of WOTUS and associated wetlands.

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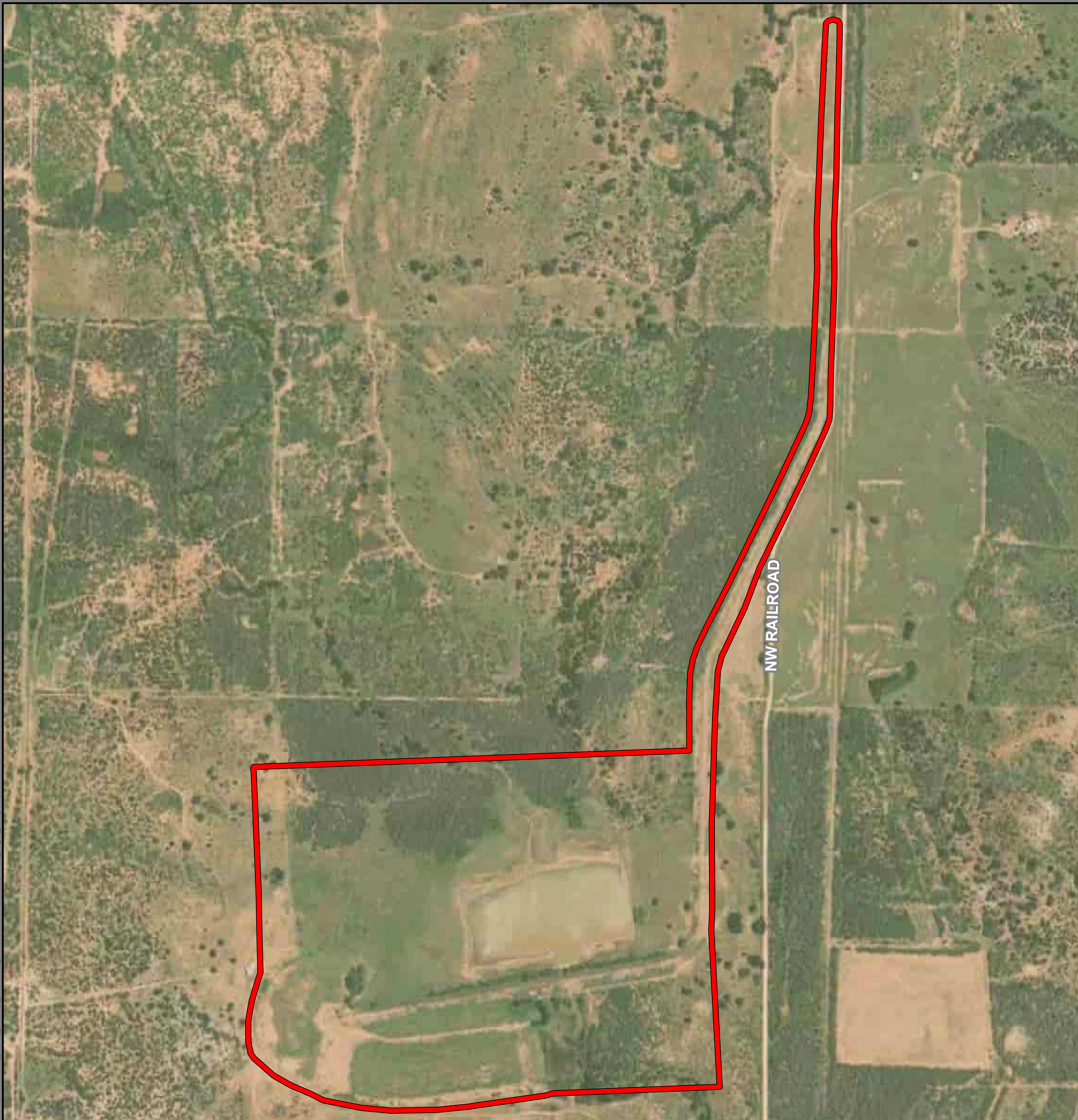
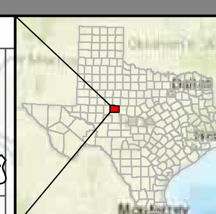
—. 2022. 7.5-Minute Quarter Quadrangle, Bronte, Texas. 2022

Appendix A Figures



Study Area



Project Location Map

Kickapoo Creek FRS No. 5
Coke County, Texas

N
W E
S

0 500 1000
Feet

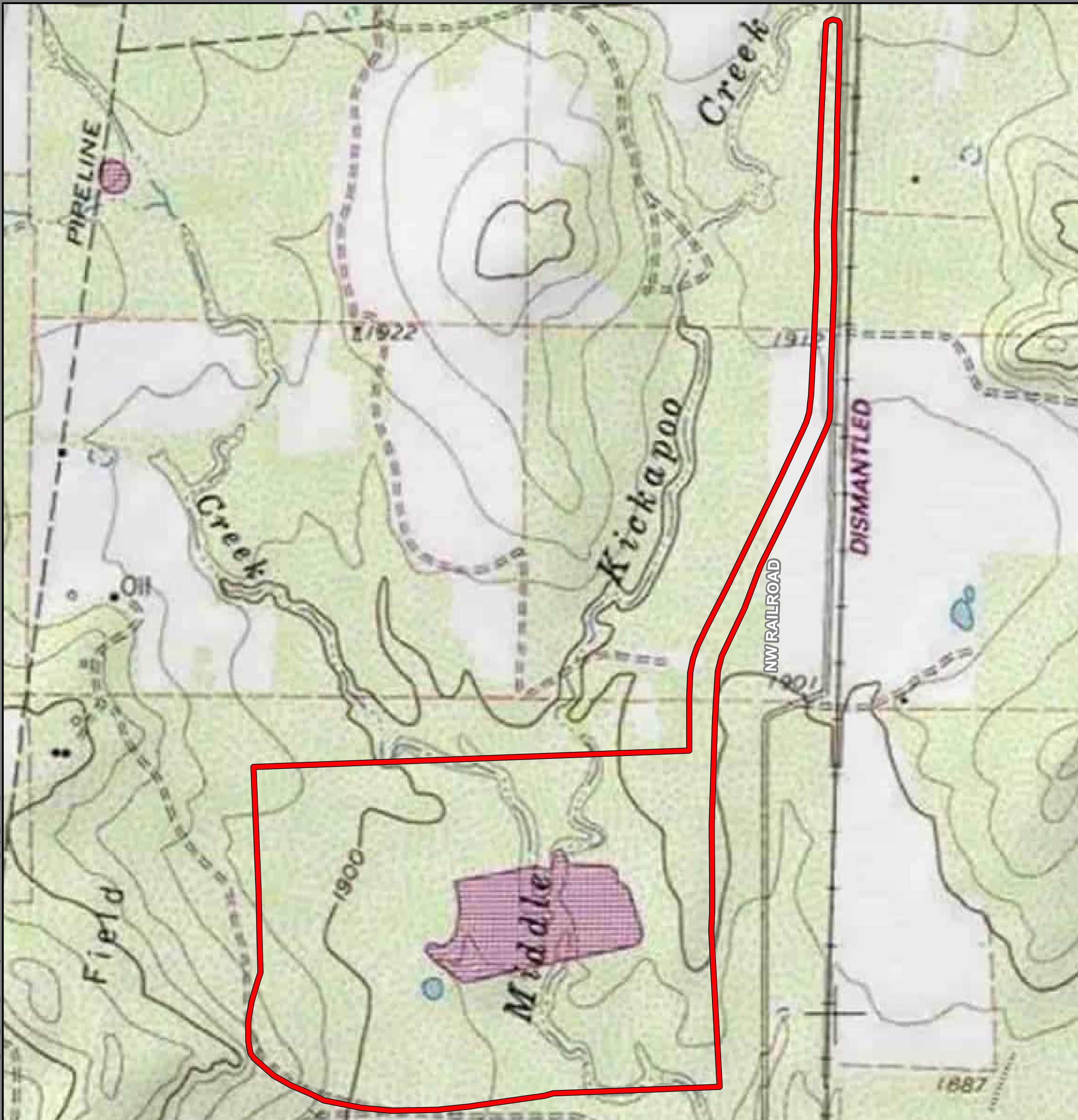
Data Sources: Roads - TxDOT 2023; County Boundaries - TIGER 2021
Basemap: Maxar 6/12/2021

AECOM

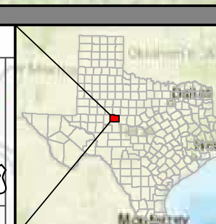
July 2023

Figure 1

Author: helen.potter; Document Path: M:\Dallas_GIS\Projects\TSSWCB\KickapooCreek_FRS_5\Map_Docs\Figures\Waters\Kickapoo5_Fig1_ProjectLocationMap.mxd



Study Area



USGS Topographic Map

Kickapoo Creek FRS No. 5
Coke County, Texas

N W E S

0 500 1000
Feet

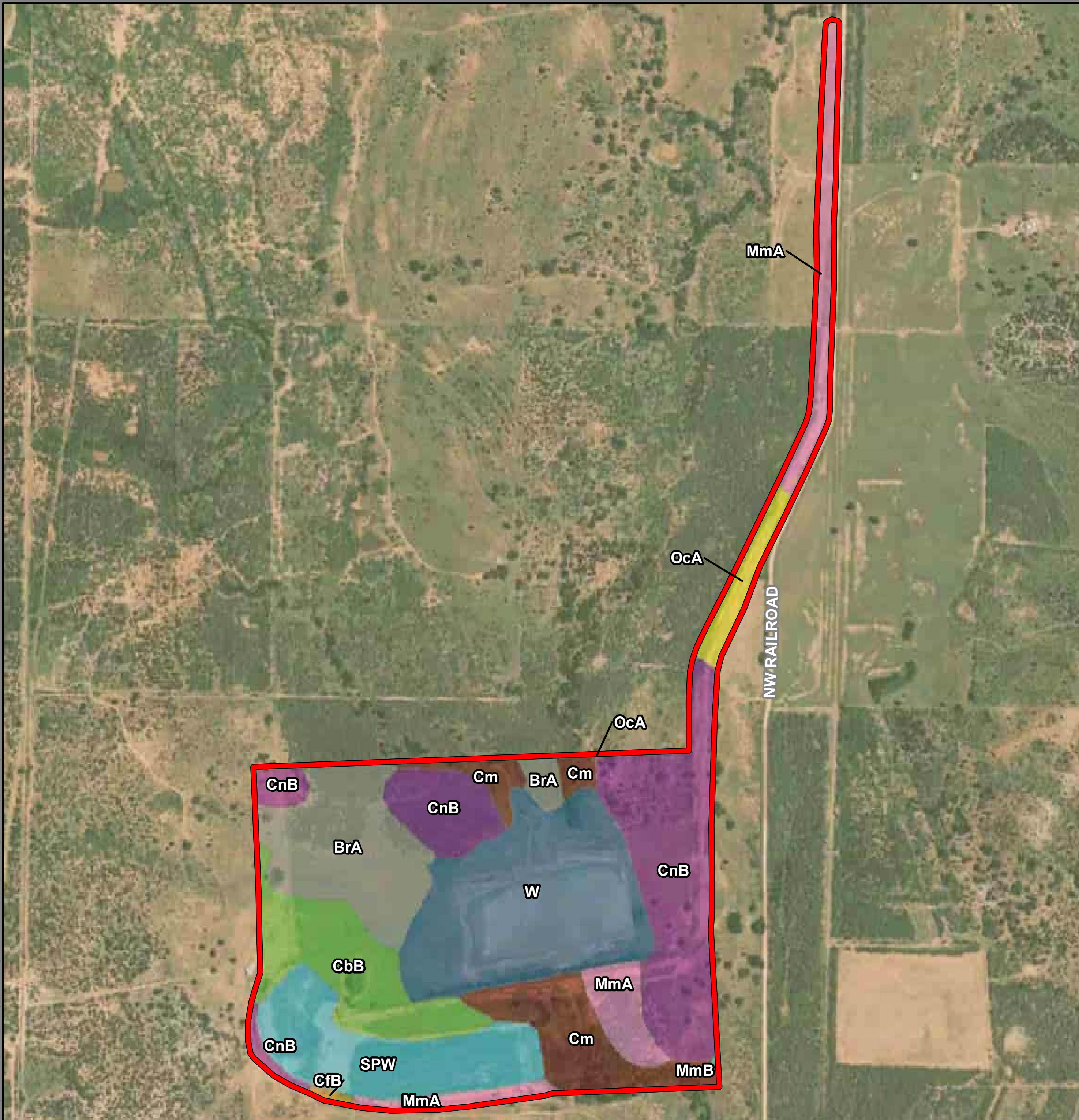
Data Sources: Roads - TxDOT 2023; County Boundaries - TIGER 2021
Basemap: USGS 7.5-minute Topographic Maps: Bronte Quadrangle

AECOM

July 2023

Figure 2

Author: helen.potter; Document Path: M:\Dallas_GIS\Projects\TSSWCB\KickapooCreek_FRS_5\Map_Docs\Figures\Waters\Kickapoo5_Fig2_USGS_TopoMap.mxd



Study Area

NRCS Soil Types

- BrA: Bronte fine sandy loam, 0 to 1 percent slopes
- CbB: Cobb loamy fine sand, 0 to 3 percent slopes
- CfB: Cobb fine sandy loam, dry, 1 to 3 percent slopes
- Cm: Colorado loam, 0 to 1 percent slopes, frequently flooded
- CnB: Oben and Cobb soils, 1 to 3 percent slopes
- MmA: Miles fine sandy loam, 0 to 1 percent slopes
- MmB: Miles fine sandy loam, 1 to 3 percent slopes
- OcA: Sagerton clay loam, 0 to 1 percent slopes
- SPW: Spillway
- W: Water

NRCS Soils Map

Kickapoo Creek FRS No. 5
Coke County, Texas

N W E S

0 500 1000
Feet

Data Sources: Soils - USDA NRCS 2018; Roads - TxDOT 2023; County Boundaries - TIGER 2021
Basemap: Maxar 6/12/2021

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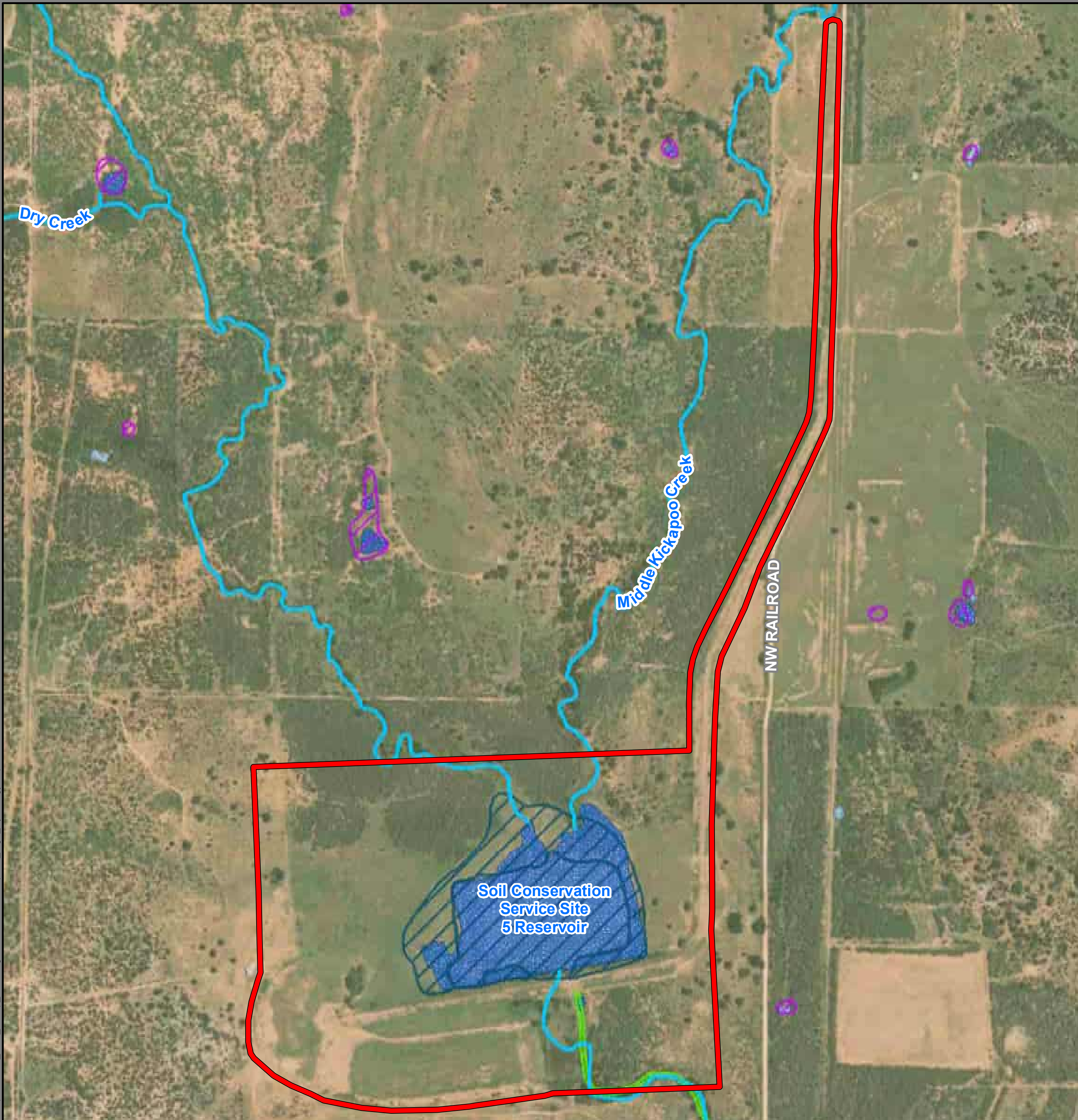
July 2023

Figure 3

Author: helen.potter; Document Path: M:\Dallas_GIS\Projects\TSSWCB\KickapooCreek_FRS_5\Map_Docs\Figures\Waters\Kickapoo5_Fig3_NRCS_SoilsMap.mxd



Study Area

National Hydrography Dataset (NHD)

Stream/River: Intermittent

Lake/Pond: Perennial

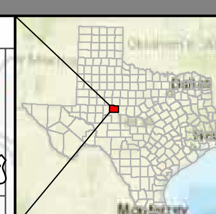
Lake/Pond: Intermittent

National Wetlands Inventory (NWI)

Lake

Freshwater Pond

Freshwater Forested/Shrub Wetland



Hydrology Map

Kickapoo Creek FRS No. 5
Coke County, Texas

N W E S

0 500 1000
Feet

Data Sources: NHD - USGS 2023; NWI: USFWS 2023; Flood Zones - FEMA 2023; Roads - TxDOT 2023; County Boundaries - TIGER 2021
Basemap: Maxar 6/12/2021

AECOM

July 2023

Figure 4

Author: helen.potter; Document Path: M:\Dallas_GIS\Projects\TSSWCB\KickapooCreek_FRS_5\Map_Docs\Figures\Waters\Kickapoo5_Fig4_HydrologyMap.mxd

Study Area

EMST Vegetation Types

307 - Rolling Plains: Mixedgrass Prairie

317 - Rolling Plains: Mixedgrass Sandy Prairie

1004 - Edwards Plateau: Floodplain Hardwood Forest

1006 - Edwards Plateau: Floodplain Deciduous Shrubland

1007 - Edwards Plateau: Floodplain Herbaceous Vegetation

1104 - Edwards Plateau: Oak -- Hardwood Motte and Woodland

1205 - Edwards Plateau: Ashe Juniper-Live Oak Shrubland

1404 - Edwards Plateau: Riparian Hardwood Forest

1406 - Edwards Plateau: Riparian Deciduous Shrubland

1407 - Edwards Plateau: Riparian Herbaceous Vegetation

2106 - Rolling Plains: Breaks Deciduous Shrubland

9000 - Barren

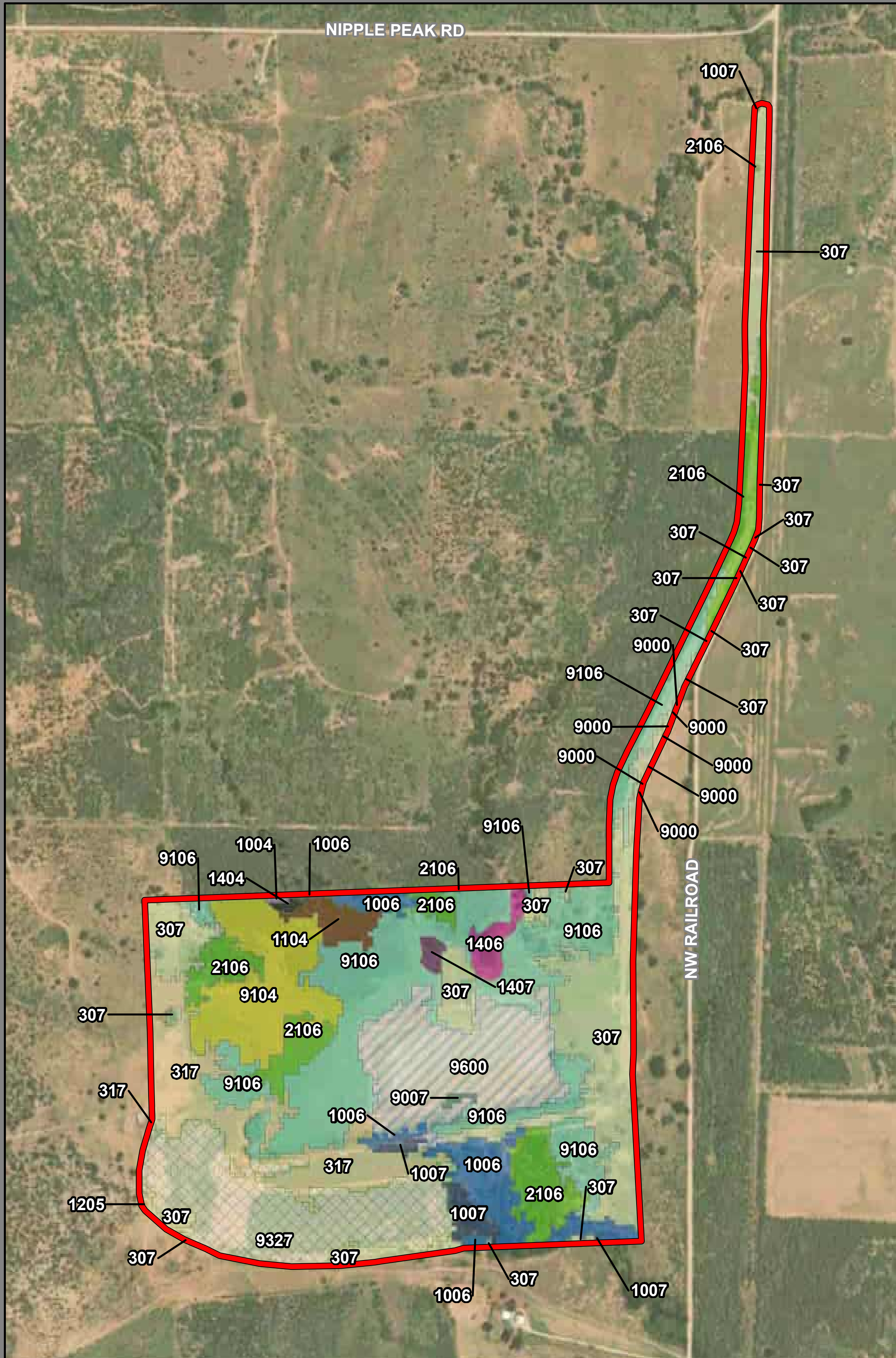
9007 - Marsh

9104 - Native Invasive: Deciduous Woodland

9106 - Native Invasive: Mesquite Shrubland

9327 - CRP / Other Improved Grassland

9600 - Open Water



Ecological Mapping Systems of Texas (EMST) Map

Kickapoo Creek FRS No. 5
Coke County, Texas

N W E S

0 500 1000
Feet

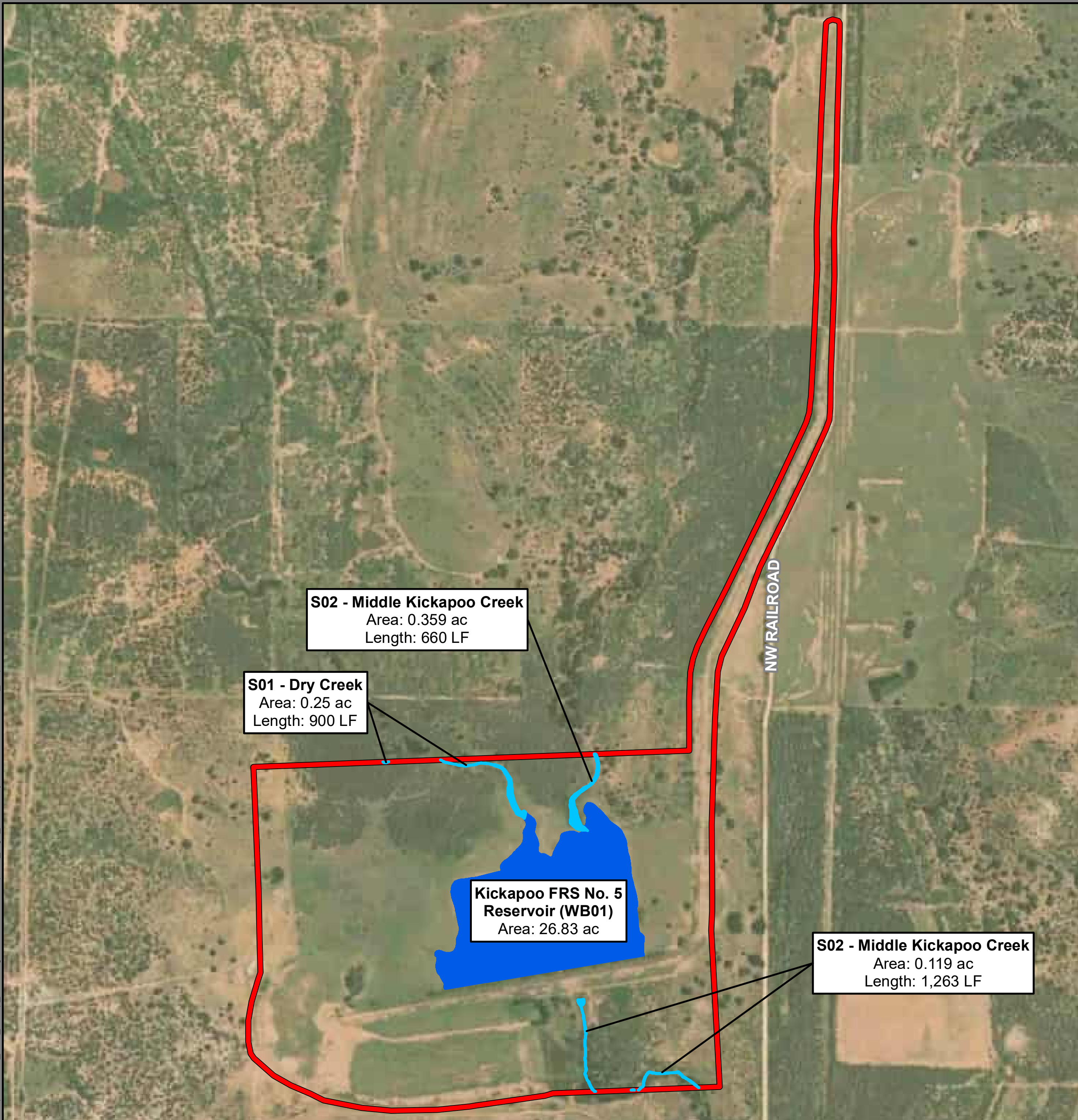
Data Sources: EMST - TPWD 2023; Roads - TxDOT 2023; County Boundaries - TIGER 2021
Basemap: Maxar 6/12/2021

AECOM

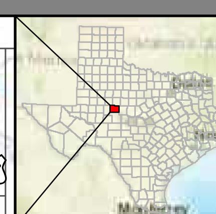
July 2023

Figure 5

Author: helen.potter; Document Path: M:\Dallas_GIS\Projects\TSSWCB\KickapooCreek_FRS_5\Map_Docs\Figures\Waters\Kickapoo5_Fig5_EMST_Map.mxd



Study Area
Stream
Waterbody



Potentially Jurisdictional Waters of the U.S. Map

Kickapoo Creek FRS No. 5
Coke County, Texas

N
W E
S
0 500 1000
Feet

Data Sources: AECOM Field Surveys July 2023; Roads - TxDOT 2023; County Boundaries - TIGER 2021
Basemap: Maxar 6/12/2021

AECOM

August 2023

Figure 6

Author: helen.potter; Document Path: M:\Dallas_GIS\Projects\TSSWCB\KickapooCreek_FRS_5\Map_Docs\Figures\Waters\Kickapoo5_Fig6_PotentiallyJurisdictionalWOTUS_Map.mxd

Appendix B Photographic Log

AECOM

PHOTOGRAPHIC LOG

Site Name: Kickapoo Creek FRS No. 5	Site Location: Coke County, TX	Project No. 60630022

Photo No. 1

Date: 07/12/23

Direction Photo Taken:

Northwest

Description:

View of Kickapoo Creek Flood Retarding Structure (FRS) No. 5 reservoir (WB01) in the central portion of the Study Area.

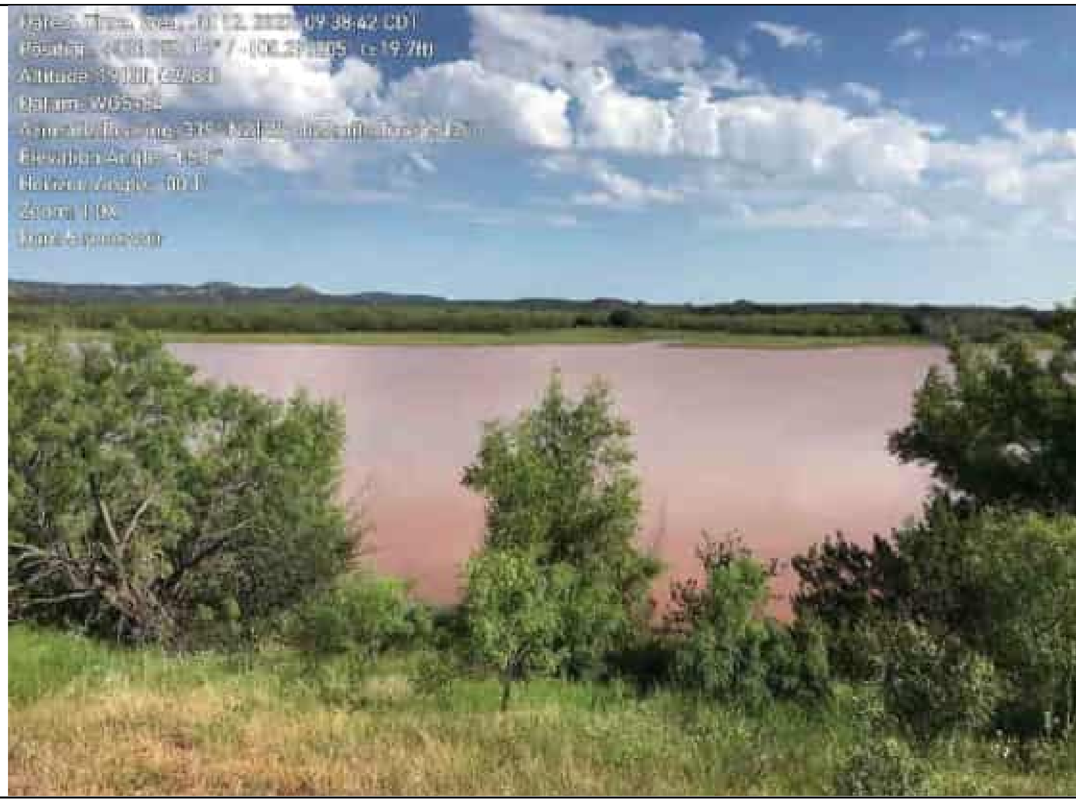


Photo No. 2

Date: 07/12/23

Direction Photo Taken:

Southeast

Description:

View of Kickapoo Creek FRS No. 5 reservoir (WB01) in the central portion of the Study Area.

Site Name: Kickapoo Creek FRS No. 5	Site Location: Coke County, TX	Project No. 60630022

Photo No.	Date:
3	07/12/23

Direction Photo Taken:

Southeast

Description:

Upstream view of Dry Creek (S01) in the northern portion of the Study Area.

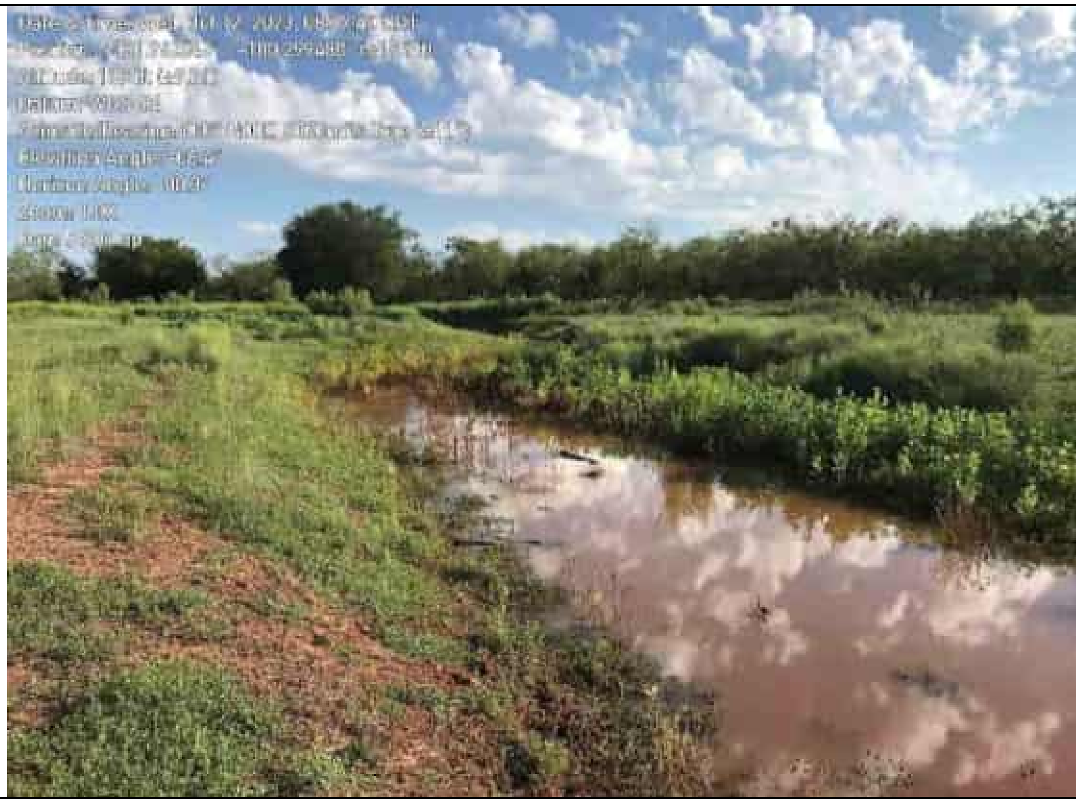


Photo No.	Date:
4	07/12/23

Direction Photo Taken:

Southeast

Description:

Downstream view of Dry Creek (S01) in the northern portion of the Study Area.

AECOM

PHOTOGRAPHIC LOG

Site Name: Kickapoo Creek FRS No. 5	Site Location: Coke County, TX	Project No. 60630022

Photo No. 5

Date: 07/12/23

Direction Photo Taken:

Northeast

Description:

Downstream view of Middle Kickapoo Creek (S02) in the northern portion of the Study Area.

Photo No. 6

Date: 07/12/23

Direction Photo Taken:

Northwest

Description:

Upstream view of Middle Kickapoo Creek (S02) in the northern portion of the Study Area.

Site Name: Kickapoo Creek FRS No. 5	Site Location: Coke County, TX	Project No. 60630022

Photo No. 7	Date: 07/12/23
Direction Photo Taken: Southeast	
Description: Downstream view of Middle Kickapoo Creek (S02) in the southern portion of the Study Area downstream from the dam structure.	

Photo No. 8	Date: 07/12/23
Direction Photo Taken: Northwest	
Description: Downstream view of Middle Kickapoo Creek (S02) in the southern portion of the Study Area downstream from the dam structure.	

E-6 Cultural Resources Survey in Support of the Supplemental Watershed Plan for The Rehabilitation of the Kickapoo Creek Watershed FRS No. 4 and FRS No. 5

AECOM

Cultural Resources Survey in Support of the Supplemental Watershed Plan for the Rehabilitation of Kickapoo Creek Watershed Floodwater Retarding Structures 4 and 5, Coke County, Texas

Prepared by
Shelley Hartsfield
Andrew Parkyn
Steve Ahr
Beth Reed
Lucy Harrington
Kyle Johnson

Prepared for
Texas State Soil and Water Conservation Board

Principal Investigator
Steve Ahr, PhD, RPA

Texas Antiquities Permit No. 30086

October 2021

Cultural Resources Survey in Support of the Supplemental Watershed Plan for the Rehabilitation of Kickapoo Creek Watershed Floodwater Retarding Structures 4 and 5, Coke County, Texas

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Texas Antiquities Permit No. 30086

October 2021

Table of Contents

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Management Summary

The Texas State Soil and Water Conservation Board (TSSWCB) and local sponsors, including the Coke County Soil and Water Conservation District and the Kickapoo Water Control and Improvement District #1 are preparing a Supplemental Watershed Plan in order to evaluate rehabilitation alternatives for Kickapoo Creek Watershed Floodwater Retarding Structures (FRSs) 4 and 5 (FRS No. 4 and FRS No. 5) in Coke County, Texas.

AECOM Technical Services, Inc. (AECOM) conducted a cultural resources survey of the Study Area for each FRS from April 8 – 13, 2021, under Texas Antiquities Permit Number 30086, requiring approximately 96 person hours to complete. The survey consisted of a pedestrian visual inspection supplemented with the excavation of 159 shovel tests. Three prehistoric archeological sites (41CK333, 41CK334, and 41CK335), three historic resources (Resource 001, Resource 002, and Resource 003), and four isolated finds (IF) were identified during the survey. Each of the archeological sites has been variably impacted from the construction and continued use of the dam facilities, erosion and natural weathering, and the site components were found to be resting on the disturbed and eroded surfaces or within very shallow soils. Based on field results, these sites do not exhibit integrity and are therefore not likely to yield information important to prehistory. AECOM recommends that the portions of these sites within the Study Area are Not Eligible for listing in the National Register of Historic Places (NRHP) and do not merit designation as State Antiquities Landmarks (SALs). Three historic-age resources, including FRS No. 4 (Resource 001), FRS No. 5 (Resource 002), and a livestock shelter and corral (Resource 003) were also identified. Based on a review by an architectural historian, these three resources do not meet the NRHP criteria of eligibility and are therefore recommended as Not Eligible for listing in the NRHP. Four prehistoric isolated finds (IF-1 through IF-4) were also identified during the survey and are recommended as Not Eligible for the NRHP or for SAL designation. A geomorphological assessment revealed that neither Study Area exhibits the potential to contain deeply buried archeological materials, and as such, no backhoe trenching is recommended.

Based on the results of the survey, AECOM recommends future rehabilitation efforts within the Study Area at FRS No. 4 and FRS No. 5 should have No Effect on properties included in, or eligible for inclusion in, the NRHP, or that merit designation as SALs, and construction can proceed without further investigations. If the dimensions of the project area change, additional archeological and historical investigations may be warranted.

If any unmarked prehistoric or historic human remains or burials are encountered at any point during the project, the area of the remains is considered a cemetery under current Texas law and all construction activities must cease immediately to avoid impacting the remains. The THC must be notified immediately by contacting the Archeology Division at (512) 463-6096. All cemeteries are protected under State law and cannot be disturbed. Further protection is provided in Section 28.03(f) of the Texas Penal Code, which provides that intentional damage or destruction inflicted on a human burial site is a state jail felony.

No artifacts were collected during the survey. All project notes, maps, photographs, and other documentary records were prepared for permanent curation at the Texas Archeological Research Laboratory.

1 Introduction

The Texas State Soil and Water Conservation Board (TSSWCB) and local sponsors, including the Coke County Soil and Water Conservation District (SWCD) and the Kickapoo Water Control and Improvement District #1, are preparing a Supplemental Watershed Plan (SWP) in order to evaluate rehabilitation alternatives for Kickapoo Creek Watershed Floodwater Retarding Structures (FRSs) 4 and 5 in Coke County, Texas (Project) (**Figure 1**).

Kickapoo Creek FRS No. 4 is a single purpose dam that was constructed in 1962 as a Significant Hazard dam across middle Kickapoo Creek, approximately 8 miles north of Bronte, Texas, and 1.5 miles southwest of the intersection of US 277 and Texas-70. The dam is a homogeneous earthen embankment with an impervious core of compacted earth fill. Breach studies indicate that several residences along NW Railroad Road would be flooded by a breach of FRS No. 4. The Natural Resources Conservation Service (NRCS) and the Texas Commission on Environmental Quality (TCEQ) have categorized FRS No. 4 as High Hazard. The current design does not meet the current safety requirements for this High Hazard classification.

Kickapoo Creek FRS No. 5 is a single purpose dam that was constructed in 1963 as a Significant Hazard dam across a tributary of Kickapoo Creek, approximately 4.4 miles north of Bronte, Texas, and 1.3 miles west of US 277. The dam is a homogeneous earthen embankment with an impervious core of compacted earth fill. Breach studies indicate that at least 62 residences, 16 commercial structures, US 277, NW Railroad Road, and E. Oliver Avenue would be flooded by a breach of FRS No. 5. The NRCS and TCEQ have categorized the FRS No. 5 dam as a High Hazard dam due to the risk of loss of life downstream should the dam breach. The current design does not meet the current safety requirements for this High Hazard classification.

Detailed design plans for the structural rehabilitation of each dam are not yet available. However, rehabilitation alternatives typically include one or more of the following components: replace or upgrade the inlet/outlet principal spillway structures, raise and/or modify the dam; and widen or modify the auxiliary spillway. Structural rehabilitation modifications would be confined to an estimated 39-acre Study Area at FRS No. 4 (**Figure 2**), and a 94-acre Study Area at FRS No. 5 (**Figure 3**). Based on the Prototype Programmatic Agreement between the United States Department of Agriculture (USDA), Texas NRCS State Office, and the Texas State Historic Preservation Officer (SHPO), the Area of Potential Effects (APE) for cultural resources consists of all areas of new disturbance that will take place. Since the exact areas of new disturbance will be determined in the subsequent design phase, the APE is currently assumed to be equivalent to the Study Area at each dam.

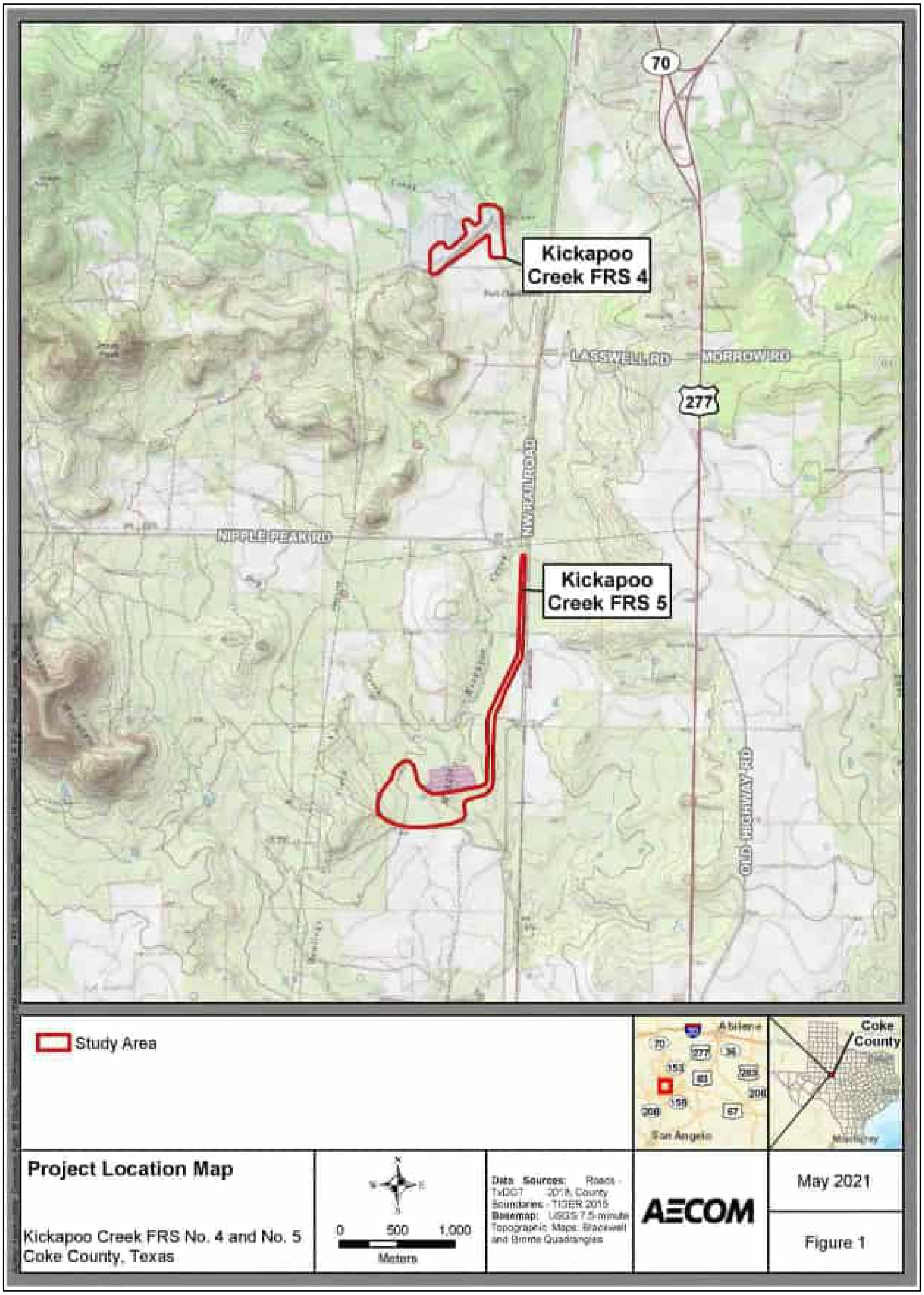

Figure 1. Kickapoo FRS No. 4 and FRS No. 5 Study Areas, Coke County, Texas

Figure 2. Kickapoo FRS No. 4 Study Area

Figure 3. Kickapoo FRS No. 5 Study Area

The SWP will be prepared in accordance with standard engineering principles that comply with NRCS programmatic requirements. In addition, the SWP will be reviewed, concurred, and approved by NRCS. Consequently, the Project falls under the purview of Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended. In accordance with Advisory Council on Historic Preservation regulations pertaining to the protection of historic properties (36 Code of Federal Regulations [CFR] 800), federal agencies are required to assess the effects of their undertakings on historic properties prior to issuing permits or funding. Historic properties are defined as those properties that are included in, or are eligible for inclusion in, the National Register of Historic Places (NRHP). The Project is subject to review by the Texas SHPO, which is the Texas Historical Commission (THC).

The Project will be on lands owned or controlled by the Project sponsors, including the TSSWCB, the Coke County SWCD, and the Kickapoo Water Control and Improvement District #1. These entities are political subdivisions of the State of Texas. As such, the Project falls within the purview of the Antiquities Code of Texas (Texas Natural Resource Code, Title 9, Chapter 191). Regulations pertaining to the code can be found within Title 13, Part 2, Chapter 26 of the Texas Administrative Code (TAC). The code requires the THC to review actions that have the potential to disturb prehistoric and historic sites within the public domain of Texas. The THC issues Antiquities Permits that stipulate the conditions under which survey, discovery, excavation, demolition, restoration, or scientific investigations can occur.

AECOM conducted a cultural resources survey of the Study Areas from April 8 – 13, 2021, under Antiquities Permit Number 30086, requiring approximately 96 person hours to complete. Steve Ahr served as Principal Investigator and Geoarcheologist. Archeological field investigations were carried out by Lucy Harrington, Kyle Johnson, and Shelley Hartsfield. Architectural Historian Beth Reed performed an architectural survey of each Study Area. Helen Potter maintained the GIS data and prepared Project maps.

2 Environmental Setting

2.1 Physiography

Coke County is located within the Edwards Plateau and Rolling Plains/Southwestern Tablelands physiographic regions (Griffith et al. 2007), and within the Caprock Canyons, Badlands, and Breaks and the Semiarid Edwards Plateau (Griffith et al. 2007). Typical vegetation in this area consists of juniper-oak-bluestem savannah, dominant grasses are bluestems, needlegrasses, gramas, and buffalograss. Trees in the region include invasive honey mesquite, junipers and oaks. Fauna in the region include white-tailed deer, Rio Grande wild turkeys, mourning doves, eastern fox squirrels, Virginia opossum and striped skunk (Telfair 1999).

2.2 Topography

The Study Area is located within the United States Geological Survey (USGS) Blackwell [3200-121] and Bronte [3100-434] topographic quadrangles in Coke County, Texas. The Study Area ranges in elevation from 2,043 feet (ft) above mean sea level (amsl) within the upland margins, to approximately 1,964 ft amsl to the southern extent of the dam spillway at FRS No. 4; and approximately 1,925 ft at the northern extent of the Study Area to 1,879 ft amsl at the end of the spillway at FRS No. 5.

2.3 Geology

The major geological unit underlying the Study Area is comprised of the Permian-age San Angelo Formation, which consists of a mixed-clastic combination of sedimentary sandstone and mudstone with incidental quantities of dolostone and gypsum. The thickness of the San Angelo formation is between 90 and 120 ft (Bureau of Economic Geology [BEG] 1974a, b). At FRS No. 4, approximately 72 percent of the Study Area is mapped as outcropped areas of the San Angelo Formation, while 28 percent is mapped as recent Holocene-age alluvium (BEG 1974a). At FRS No. 5, approximately 50 percent of the Study Area is mapped as the San Angelo Formation, while the other 50 percent is mapped as Pleistocene-age fluviatile terrace deposits (BEG 1974b).

2.4 Soils

The FRS No. 4 Study Area encompasses five NRCS soil mapping units (**Table 1; Figure 4**). Within these mapping units are the Cobb, Oben, Miles, Oplin, and Westola series. In the Study Area, these soils occur on upland shoulders, summits, and backslopes on ridges, as well as sloping terrace pediments on dissected plains, limestone ridgetops and erosional uplands, and nearly level floodplains. Parent materials from the Oben, Cobb, and Oplin soils include residuum weathered from sandstone and limestone in the uplands. Parent materials in the Miles soils consists of loamy alluvium within the pediments, while the Westola soils have formed in recent alluvium within level floodplains.

The FRS No. 5 Study Area encompasses seven NRCS soil mapping units (**Table 2; Figure 5**). Within these mapping units are the Bronte, Cobb, Colorado, Oben, Miles, and Sagerton series. In the Study Area, these soils occur on backslopes, shoulders, and summits of upland ridges, level floodplains, terrace pediments on dissected plains, and terrace treads on dissected alluvial plains. Parent materials for the Bronte, Colorado, Miles, and Sagerton soils consists of loamy alluvium. The Cobb and Oben soils formed in residuum weathered from sandstone.

Table 1. Soils within the FRS No. 4 Study Area

Map Unit Symbol	Map Unit Name	Series Description/Typical Pedon	Percent	Landform Setting/Position	Parent Material
CfB	Cobb fine sandy loam, dry, 1 to 3 percent slopes	Moderately deep, well drained, moderately permeable soils / Ap-Bt1-Bt2-Cr	31.9	Nearly level to moderately sloping soils on ridges, shoulders, summit, and backslopes	Residuum derived from sandstone
CnB	Oben and Cobb soils, 1 to 3 percent slopes	Shallow to moderately deep, well drained soils, moderately permeable soils / (Oben) A-Bt1-Bt2-Cr and (Cobb) Ap-Bt1-Bt2-Cr	8.7	Moderately sloping backslopes, shoulder and summits of ridges.	Residuum derived from sandstone.
MmA	Miles fine sandy loam, 0 to 1 percent slopes	Very deep, well drained, moderately permeable soils A-BA-Bt-Btk1-Btk2-Bk-C	1.7	Nearly level to moderately sloping terrace pediments on dissected plains	Loamy alluvial materials
SPW	Spillway	N/A	25.8	N/A	N/A
SS	Oplin-Rock outcrop complex, very steep	Very shallow to shallow, well drained, moderately permeable soils	0.8	Upland soils, convex limestone ridgetops and breaks of erosional uplands.	Residuum from indurated limestone
Ya	Westola very fine sandy loam, dry, 0 to 1 percent slopes, occasionally flooded	Very deep, well drained, moderate to rapidly permeable / Ap-A-C1	31.1	Nearly level flood plains	Calcareous, recent alluvium

Source: NRCS (2021)

Figure 4. Soils within the FRS No. 4 Study Area

Table 2. Soils within the FRS No. 5 Study Area

Map Unit Symbol	Map Unit Name	Series Description/Typical Pedon	Percent	Landform Setting/Position	Parent Material
BrA	Bronte fine sandy loam, 0 to 1 percent slopes	Deep, medium to slowly drained, moderately to slowly permeable / Ap-B/A-Bt1-Bt2-Bk-Ck1-Ck2	6.9	Level plains and wide valleys	Loamy to clayey, old alluvium
CbB	Cobb loamy fine sand, dry, 0 to 3 percent slopes	Moderately deep, well drained permeable soils / Ap-Bt1-Bt2-Cr	17.5	Nearly level to moderately sloping soils on ridges	Residuum derived from sandstone
CfB	Cobb fine sandy loam, dry, 1 to 3 percent slopes	Moderately deep, well drained permeable soils / Ap-Bt1-Bt2-Cr	0.7	Nearly level to moderately sloping soils on ridges	Residuum derived from sandstone
Cm	Colorado loam, 0 to 1 percent slopes, frequently flooded	Very deep, well drained, moderately permeable soils / A-C1-C2	10.3	Level floodplains	Calcareous loamy alluvium
CnB	Oben and Cobb soils, 1 to 3 percent slopes	Shallow to moderately deep, well drained soils, moderately permeable soils / (Oben) A-Bt1-Bt2-Cr and (Cobb) Ap-Bt1-Bt2-Cr	12.7	Moderately sloping backslopes, shoulder and summits of ridges.	Residuum derived from sandstone
MmA	Miles fine sandy loam, 0 to 1 percent slopes	Very deep, well drained, moderately permeable soils / A-BA-Bt-Btk1-Btk2-Bk-C	16.8	Nearly level to moderately sloping terrace pediments on dissected plains	Loamy alluvium
OcA	Sagerton clay loam, 0 to 1 percent slopes	Very deep, well drained, moderate to slowly permeable soils / Ap-Bt1-Bt2-Btk1-Btk2-Btk3	5.4	Treads of terraces on dissected alluvial plains	Calcareous loamy alluvium
SPW	Spillway	N/A	24.4	NA	NA
W	Water	N/A	5.3	NA	NA

Source: NRCS (2021)

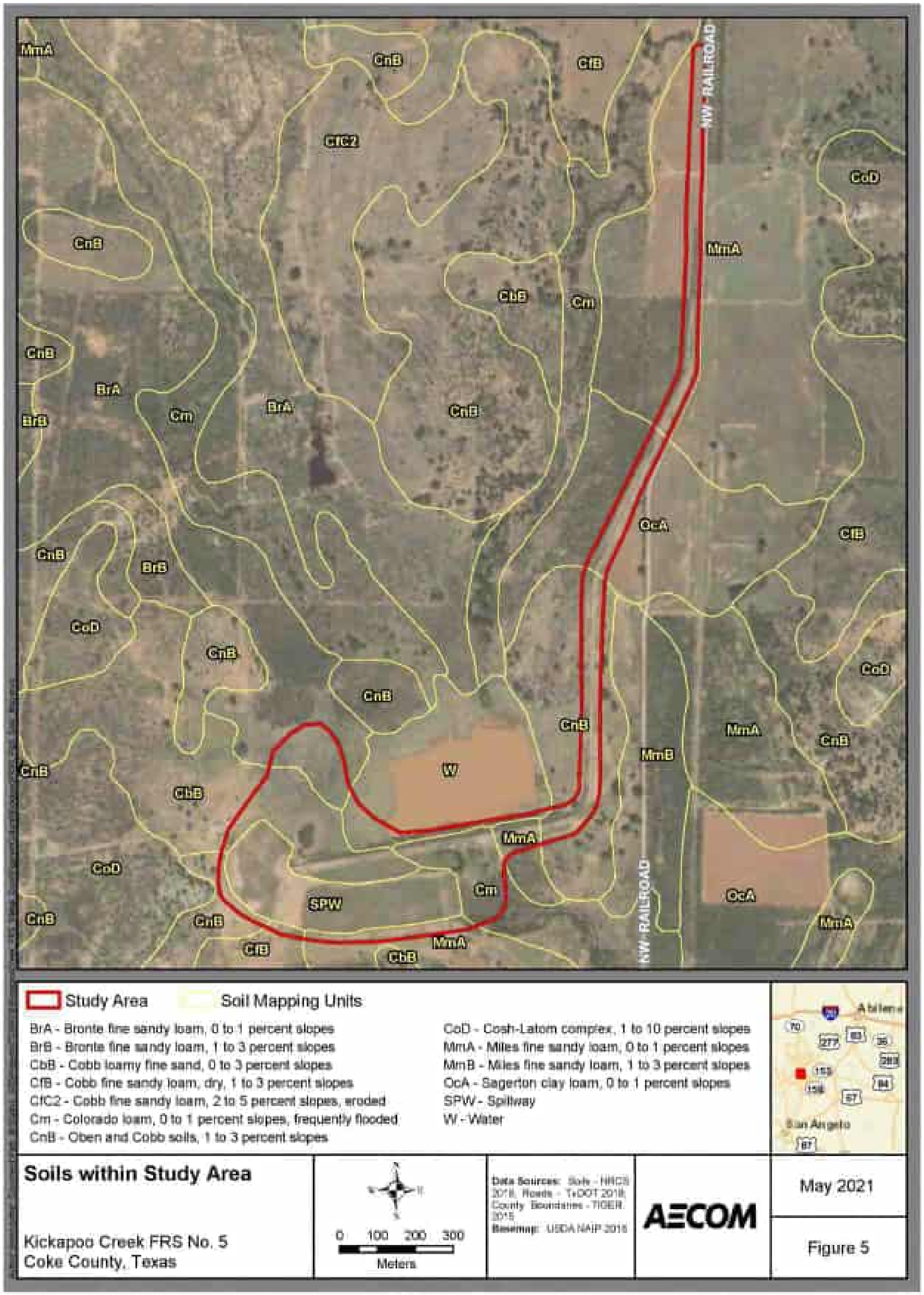

Figure 5. Soils within the FRS No. 5 Study Area

3 Cultural History

The general cultural sequence of Coke County can be divided into four primary chronological and developmental periods — Paleoindian, Archaic, Late Prehistoric, and Historic. These divisions are believed to reflect changes in subsistence and cultural development as evidenced by material remains and settlement patterns. The following discussion of these periods draws on previous summaries by Weir (1976), Prewitt (1981, 1985), Ellis et al. (1994), and Collins (1994). Coke County is located in the West-Central Texas Archaeological region as defined by Perttula (1994).

3.1 Paleoindian Period (11,500 – 8800 Years Before Present [B.P.])

The Paleoindian period is the earliest defined cultural period in North America (representing the earliest known human occupation in North America). Chronologically, it extends from the terminal Pleistocene into the early Holocene. The conventional interpretation of the Paleoindian Period is that it ranges from approximately 11,500 to 8800 B.P. Two main Paleoindian periods have been extensively documented and include Early Paleoindian, represented largely by Clovis points, and Late Paleoindian, represented by Folsom points. Early Paleoindian Clovis cultures were characterized by highly mobile big game hunters consisting of small bands. Notable cases of these occupations within the Central Texas region have been reported at the Gault Site (41BL323) in Bell County, the Buttermilk Creek Site in Williamson County, Kincaid Rockshelter (41UV2) on the southern margin of the Edwards Plateau in Uvalde County, and the Pavo Real Site (41BX42) in Bexar County. The Late Paleoindian Period is represented by Folsom artifacts, which appear to have been more closely aligned to hunting bison and included a much more diverse subsistence base than the preceding period (Collins 1995). Collins (1994) argues the traditional view of big game hunting cultures fails to adequately explain the diversity of the material cultural assemblage, projectile points, and subsistence lifeways. During this Late Pleistocene-Early Holocene transition, the climate is thought to have been much cooler and wetter, though it was becoming increasingly dry and warm. Small, isolated occurrences of Late Paleoindian sites are common in upland settings in Central Texas, while larger, deeply buried, and intact occupations are less well documented. Those sites that weren't eroded away during Late Pleistocene stream erosional events are likely buried deeply in alluvial deposits and still await detection. Those that have been found and fully investigated include the Wilson-Leonard Site (41WM235) in Williamson County and suggest a much wider range of subsistence activities than previously thought (Collins 1998). The Gault site is a good example of a securely dated Clovis site. The Gault site was a multi-component site initially identified as an occupation site of Archaic and Late Prehistoric cultures in the area. Subsequent work recovered evidence of a Clovis occupation, including 6 fragments of engraved stone associated with a Clovis projectile point. The engraved stones constitute the earliest securely dated engraving in North America (Collins 2021). Continuing investigations at the Gault Site and the Buttermilk Creek Site in Central Texas are providing new insights into potential pre-Clovis occupations that date as far back as 15,500 B.P. (Collins and Brown 2000; Waters et al. 2011). These discoveries are challenging long-held notions about the timing of the entrance of humans into North America and Texas.

3.2 Archaic Period (8800 – 1200 B.P.)

The Archaic period in the Central Texas region covers a broad time period from 8800–1200 B.P., and is generally divided in to three phases (early, middle, and late) based on dart point chronologies and technological advancements. Near the end of the Paleoindian period, global climate began to change slowly, becoming gradually warmer and dryer (Brown and Lebo 1991). In response, plant and animal populations also changed and the human populations began to adapt to a wider variety of food resources.

Large game was no longer the primary focus of subsistence. Changes in technology further support this diversification with a suite of new lithic tools and an increased use of grinding stones. In addition, local resources are exploited to a far greater extent than in the Paleoindian period where high quality 'exotic' lithic materials were more commonly used. A key component of Archaic period sites in Central Texas is the use of heated rocks in a variety of forms including hearths, ovens, middens, and other archeological features.

The Early Archaic Period (8800 – 6000 B.P.) is one of increasingly warmer and drier climate conditions than had existed previously, and one in which subsistence strategies were necessarily broadened to include a much more diverse array of plant and animal resources. Early Archaic sites are typically located on terraces along tributaries of larger watercourses. Archeological deposits are frequently deeply buried in floodplain alluvium. The location of Early Archaic sites provides evidence of a shift in subsistence patterns with local populations exploiting aquatic resources such as mussels or fish. Grooved or notched stones appear on Early Archaic sites and are often interpreted as net sinkers or bola stones indicating a change in hunting and gathering techniques (Collins 1994). Seasonal plant resources are also likely to have been exploited when available. Sites from this period tend to be small and contain diverse tool assemblages. Consequently, greater hunter-gatherer mobility and lower population densities are attributed to this period (Prewitt 1981). Increased reliance on floral remains and hot-rock cooking technology and more diverse lithic technology are also indicated, with sites tending to be concentrated along the eastern and southern Edwards Plateau margins (Black 1995; Johnson and Goode 1994). In South Texas, a greater emphasis on gathering and exploitation of riparian environments is observed (Black 1986), while in Central Texas, burned rock middens begin to emerge (Hester 1991; Prewitt 1981). Diagnostic projectile points from this time include Gower, Hoxie, Wells, Bell-Andice, Uvalde, and Martindale types (Hester 1980; Turner and Hester 1985).

The Middle Archaic Period (6000 – 4000 B.P.) is generally recognized as a period of population increase, with a concomitant increase in the number and diversity of archeological site types (Collins 1995; Hall et al. 1986; Turner and Hester 1985). Climate during this time in Central Texas is believed to have been significantly warmer and drier than today because of the mid-Holocene Altithermal. Climate conditions coupled with a reduction in bison populations resulted in greater exploitation of richer environments such as natural springs. During the Middle Archaic period, the trend toward bottomland exploitation increases, with fewer sites found along minor tributaries. The number and sizes of campsites and burned rock middens increased during this period, though there was still a strong reliance on game hunting (Hall et al. 1986; Prewitt 1981). Greater use of cemeteries also occurred across the region during this time (high 1994; Taylor and Highley 1995). Common diagnostic projectile points for this period include Carrollton and Nolan types (Collins 1995; Turner and Hester 1985).

During the Late Archaic Period (4000 – 1200 B.P.), climate is thought to have returned to cooler and moister conditions (Collins 1995). Bison returned in greater numbers than had been present during the Middle Archaic Period, and population densities are thought to have increased substantially (Prewitt 1981). Burned-rock middens are currently believed to have increased in number during the Late Archaic and are represented by abundant fire-cracked rock features, such as hearths and earth ovens. Use of cemeteries continued from the previous period, and defined territories and trade networks emerged (Collins 1995; Hall 1981; Hester 1995; Story 1985). Diagnostic projectile points for this period include Pedernales, Bulverde, and Marcos types, though the relatively low densities of such points in site assemblages may indicate that hunting was of lesser importance than gathering (Prewitt 1981).

The Late Archaic period represents a period of increased population and site density. Subsistence is focused on hunting and gathering within the bottomlands of major creeks and rivers. Deer remains are quite common at Late Archaic sites, and the exploitation of plant foods seems to have increased during this period, based upon an increase in plant-processing tools. Late Archaic sites are typically found on sandy terraces along tributaries, as well as on clay rich soils on floodplains.

3.3 Late Prehistoric Period (1200 – 300 B.P.)

The Late Prehistoric Period in Central Texas is marked by the introduction of small, stemmed projectile points for use with the bow and arrow. Two main periods are recognized in Central and South Texas and include the Austin and Toyah Phases (Collins 1995; Hester 1995). The Austin Phase (1300 – 650 B.P.) is marked by the introduction of the bow and arrow. This period is represented by diagnostic Scallorn arrow points and other side-notched points (Black 1989). Other common artifacts at Austin Phase sites include bifaces, gouges, scrapers, and grinding stones; cemeteries continued to be used as well. Subsistence was broad-based and included hunting deer, exploiting freshwater fish resources, and gathering (Collins 1995; Prewitt 1981; Hester 1995). The Toyah Phase (650 – 300 B.P.) is perhaps the better known of the two Late Prehistoric Periods. It is distinct from the preceding Austin Phase and is marked by the introduction of contracting-stem Perdiz arrow points, bone-tempered pottery, beveled-edge bifacial knives, perforators, and end-scrapers (Black 1986, 1989; Creel 1991; Hester 1980; Johnson 1994; Kelley 1986; Prewitt 1981). The Toyah material culture is arguably geared toward extensive bison exploitation and mobility, and extensive trade relationships likely existed that focused on the exchange of bison hides and other commodities (Creel 1991).

3.4 Historic Period (Post-300 B.P.)

Contact began with the arrival of European and later European-American immigrants in this region with the early Spanish missionaries and French explorations. The earliest historical accounts for the Central Texas region mention numerous displaced cultural groups. The Native American populations moved from Spanish oppression in the southwest or from the mounted Apache encroaching on territory from the northeast. Local groups had been significantly reduced with the spread of European-introduced diseases. The introduction of the horse in Central Texas also increased the range of local populations. The groups in the area were often comprised of multiple social groups forced together by loss as the new migrant populations took land and resources from the Native Americans.

Early Spanish and French documents discuss the Native American population’s reliance on hunting bison, deer, and antelope, as well as the trade of bison products. Native American groups became more transient moving with the local bison populations. The Hasinai Caddo population travelled into Central Texas during the early Historic period to hunt bison and camped with the indigenous populations when bison migrated to the area. The presence of Caddoan ceramics on Toyah sites in Central Texas suggest that this pattern of Caddoan occupation had continued from the late Prehistoric period (Perttula et al. 1995). By 1800, the Shoshonian speaking Comanche had moved into northwest Texas before reaching the Central Texas region. The European American historical accounts document their arrival in the region with hostility. By the mid- to late-nineteenth century, the Native American population in Central Texas had waned.

Coke County is located in the west Central Texas region, approximately 30 miles north of San Angelo. Coke County is approximately 910-square miles in area, sharing county boundaries with Runnels County, Tom Green County, Sterling County, Mitchell County, and Nolan County. The terrain is generally flat but includes prairie, hills, and the Colorado River valley (Anonymous 2021). Robert Lee is the county seat and largest town.

During the eighteenth and nineteenth centuries, Kickapoo, Kiowa, Comanche, Tonkawa and Lipan Native American tribes traveled the Edwards Plateau and Colorado River valley. Within the eastern part of Coke County, rock ledges gave shelter to members of these tribes (Texas Historic Sites Atlas [THSA] 2021a). Coke County was named after Richard Coke (1829-1897), the Virginia born lawyer who moved to Waco, Texas in 1850, later became the Texas governor and United States senator (Payne 2021). By 1859, Coke was appointed to a commission that ultimately decided to remove the Comanche Tribe settled on the Brazos Indian Reservation from the State of Texas. Coke was part of the 1861 Secession Convention in Austin voting in favor of secession and Coke also served as Captain in the Fifteenth Texas Infantry during the Civil War (Payne 2021).

From 1851 to 1861, the United States Army established Fort Chadbourne in present-day northeast Coke County. The fort was occupied by federal troops and established for the purpose of providing protection to frontier settlers from Native Americans in the area. The fort was abandoned by the U.S. Army during the Civil War and a company of First Regiment Texas Mounted Rifles occupied the post. Patrols of Confederate and state troops used the fort to guard the frontier until the end of the war (Davis 2021; THSA 2021b, 2021c).

Fort Chadbourne was also an important station on the Butterfield Overland Mail stage route. The Butterfield (also known as the Southern) Overland Mail route was a semi-weekly mail and passenger stagecoach service, which linked St. Louis and San Francisco. John Butterfield won a mail contract established by an act of Congress effective in 1857, which authorized twice weekly mail distribution and requiring each trip to be completed within 25 days. Each trip took 25 days one-way, with seven of those days required to cross Texas. A one-way fare for the 2,700-mile trip was $200. The stage service ended in 1861 upon the beginning of the Civil War. (Richardson 2021; THSA 2021d, 2021e).

Initial European-American settlement in Coke County was established during the 1870s by open-range ranchers. Early ranchers to the area included John J. Austin in 1875, and Pate Francher in 1877. Additional settlers were brought to the region in 1882 after the construction of the Texas and Pacific Railway to San Angelo. As ranching increased in the area during the 1880s, hostilities frequently developed between cattlemen who favored open range ranching and those who fenced their herds. Open range advocates were usually non-landowners who relied on the availability of grass and water for their herds. A drought in 1883 exacerbated the situation and anti-fence groups developed. A ‘fence-cutting’ war occurred as fences were cut and pastures were burned (Lomas 2003). After significant property damage occurred, the Texas legislature passed laws in 1884 making fence-cutting a felony (Gard 2021; THSA 2021f).

In 1889, the Texas legislature established Coke County using land taken from Tom Green County, with the community of Hayrick as the first county seat. In 1891, residents voted to change the name of the community to Robert Lee, named after Robert E. Lee who had served at Fort Chadbourne. The smaller communities of Brontë; and Tennyson, were also established during this period (Hunt and Leffler 2021).

By 1890, there were 163 farms and ranches in Coke County, and the population reached 2,059. Ranching dominated the local economy, with 13,806 cattle counted in Coke County. By 1900, 480 farms and ranches totaling approximately 605,842 acres had been established in the county. Although ranching dominated the economy the cultivation of cotton increased after 1900. From 1900 to 1910, the total acreage of cotton planted in Coke County increased from approximately 7,000 acres to more than 29,600 acres. In 1910, approximately 969 farms and ranches had been established in the county, and the population reached 6,412.

During the 1920s, a boll weevil infestation resulted in decreased cotton production, and by 1925, as cotton production continued to drop, the number of farms declined to 636. By 1929, only 5,321 acres of cotton were planted in the county. However, cattle ranching remained important to the economy and farmers increased cultivation of other crops such as corn, wheat, and sorghum. As a result, between 1925 and 1929, the number of farms and ranches in Coke County increased from 636 to 838. During the early twentieth century, fruit trees were planted, and by 1920 about 18,000 fruit trees, including almost 14,000 peach trees, were growing in Coke County (Hunt and Leffler 2021).

By 1930, the population of Coke County was 5,253. As a result of the Great Depression of the 1930s, cropland harvested in Coke County dropped more than 10 percent between 1930 and 1940. The number of farms in the area fell again to 756 and many residents left the area during this period. By 1940, the population of the Coke County was 4,593 (Hunt and Leffler 2021).

The first important oil well was discovered in Coke County in 1946 when Sun Oil drilled Well Number 1 in the Allen Jameson field. Although drilling had occurred in the county during the early twentieth century, the discovery of the Jameson well began a county-wide oil boom. In 1948, Humble Oil Company (now Exxon) opened the Bronte field in the eastern part of the county. Additional wells were drilled through the early 1950s and included the North Bronte Multipay field, the McCutchen field, and the Wendkirk field. In 1948, Coke County produced almost 1,082,500 barrels of petroleum and by 1958, more than 12,795,000 barrels were produced in the county. Through the twentieth century, Coke County has been one of the top oil-producing counties in Texas. By the end of the twentieth century and into the twenty-first century, oil production has provided the majority of the income for Coke County and greatly exceeded the county’s income from agriculture (Hunt and Leffler 2021; THSA 2021g). Agriculture remains an important source of economic income for Coke County. Most of Coke County's agricultural income comes from cattle, sheep, goats, and horses with the remainder from cotton, sorghum, small grains, hay, fruits, and peanuts. As of 2014, the population of Coke County was 3,254 (Hunt and Leffler 2021).

4 Methods

4.1 Antiquities Permit

A Texas Antiquities Permit application and research design was submitted to the THC prior to fieldwork. The THC approved the application and issued Antiquities Permit No. 30086 on March 26, 2021. Steve Ahr served as Principal Investigator.

4.2 Background Review

Prior to fieldwork, AECOM conducted an archeological background review of the Texas Archeological Sites Atlas (TASA) to identify previously recorded archeological sites, cemeteries, and previous surveys within 1,000 meters (m) of the Study Area.

An AECOM architectural historian conducted a historic resources background review of the Texas Historic Sites Atlas (THSA) and the Texas Department of Transportation's (TxDOT's) Historic District and Properties GIS layer to identify properties listed in, or eligible for listing in, the NRHP, National Historic Landmarks (NHLs), State Antiquities Landmarks (SALs), Recorded Texas Historic Landmarks (RTHLs), and Official Texas Historical Markers (OTHMs) within 1,300 ft of the Study Area. The background reviews also utilized historic aerial photographs and topographic maps.

4.3 Archeological Survey

AECOM conducted an intensive archeological survey of the Study Area in conformance with the Council of Texas Archeologists' (CTA) *Intensive Terrestrial Survey Guidelines*. The objectives of the survey were to identify and record archeological and historic resources within the Study Area, evaluate their eligibility for inclusion in the NRHP and for designation as SALs, and determine whether additional investigations were warranted. All work was supervised by AECOM cultural resources staff meeting the United States Secretary of the Interior's *Professional Qualification Standards for Archeology and Historic Preservation* (Title 36 CFR Part 61), and Texas' professional qualification requirements for Principal Investigator (13 TAC 26.4).

A 50-m shovel testing grid was established over the Study Area. Each north-south 50-m grid line was subject to pedestrian walkover to inspect exposed ground surfaces for archeological materials, with shovel tests excavated at each undisturbed grid point. However, in some areas the orientation of the Study Area necessitated alternate transect directions. The intervening areas between each grid transect line was also subject to parallel pedestrian walkover. Overall, this resulted in an effective transect interval of 25 m over the entire Study Area. Shovel tests were 30 cm in diameter and were dug in 20-cm levels. In depositional areas, shovel tests were dug either to the bottom of the Holocene deposits, or to 80 cm below surface. In upland areas, shovel tests were dug to subsoil or bedrock. Excavated soils were screened through ¼-inch mesh unless high clay or water content required that they be troweled through. All shovels tests were backfilled upon completion. Shovel testing was precluded in upland or erosional settings with exposed bedrock; on slopes greater than 20 percent; and areas with significant ground disturbance. At least one shovel test was excavated and photo-documented for each excluded area, regardless of surface visibility, to assess the potential for buried deposits where artifacts may not be visible on the surface and/or to demonstrate the nature and extent of significant ground disturbance. For each shovel test, the location, depth, soil description, and the presence/absence of cultural materials were recorded. The Study Area was assessed to determine whether deeply buried and intact cultural materials could be impacted by the Project. The assessment investigated the soil-geomorphic setting and depositional environments, the age and lithology of the soil parent materials, the types of active pedogenic site formation processes, and the anticipated depth of impacts from the Project.

4.4 Site Recording and Assessment

A site was defined by the presence of at least five or more artifacts. Isolated farm/ranch equipment was not considered as sites. Cultural materials greater than 50 years of age were minimally designated as isolated finds. All artifact scatters were delineated as sites through shovel testing and field observations. Positive shovel tests were excavated in a cruciform pattern at intervals no greater than 15 m until two negative shovel tests were found in each direction, or until topographic limits (e.g., landform boundaries, streams) were reached. A site boundary was established at the location of the first negative shovel test past the last positive shovel test. Each site was photographed from a minimum of two angles. All cultural features and natural features of interest were also photographed, along with representative overviews of the Study Area. Site boundaries and the locations of all subsurface excavations, cultural features, photographs, individual artifacts, or artifact clusters, and other relevant natural or landscape features (e.g., roads, buildings) were recorded with a handheld GPS.

No artifacts were collected during the survey. For all sites identified during the survey, the quantities of artifacts or estimates of materials in surface scatters were recorded and the locations of artifact concentrations were plotted on site maps. Artifacts from shovel tests or other sub-surface investigations were photographed. In addition, all non-collected diagnostic artifacts and a representative sample of non-diagnostic materials from the surface were documented in the field. TexSite forms for all new sites were prepared and submitted to the Texas Archeological Research Laboratory (TARL) for assignment of a permanent trinomial designation.

All cultural resources sites were assessed for their eligibility for listing in the NRHP according to the National Register criteria for evaluation (36 CFR Part 60.4 [a-d]), which states that "[t]he quality of significance in American history, architecture, archeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association and:

a) that are associated with events that have made a significant contribution to the broad patterns of our history; or
b) that are associated with the lives of persons significant in our past; or
c) that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
d) that have yielded, or may be likely to yield, information important in prehistory or history.

All cultural resource sites were also assessed for SAL eligibility. Under 13 TAC 26.9 and 13 TAC 26.10, an archeological site under the ownership or control of the State of Texas may merit official designation as a SAL if one of the following criteria applies:

1. The site has the potential to contribute to a better understanding of the prehistory and/or history of Texas by the addition of new and important information;
2. The site's archeological deposits and the artifacts within the site are preserved and intact, thereby supporting the research potential or preservation interests of the site;
3. The site possesses unique or rare attributes concerning Texas prehistory and/or history; or
4. The study of the site offers the opportunity to test theories and methods of preservation, thereby contributing to new scientific knowledge.

In addition, SALs may also be located, owned, and/or controlled by a private individual or entity (see TAC Title 13, Part 2, Chapter 26, Subchapter B, Rule §26.9).

4.5 Curation

The survey employed a non-collection strategy. Pursuant to 13 TAC 26.17, correspondence, field records, and photographs generated during the investigation were prepared for permanent curation at TARL.

4.6 Historic Resources Methods

Historic resources refer to any buildings, structures, objects, sites, and potential historic districts that are, or will be, 45 years of age or older at the time of the anticipated Project letting date for construction, which currently is estimated to be 2021. Therefore, buildings, structures, objects, sites, or potential historic districts dating to 1976 or earlier were evaluated as historic resources.

A historic resources reconnaissance survey of FRS No. 4 and FRS No. 5 was conducted on April 8 – 9, 2021 by AECOM Architectural Historian, Beth Reed. All historic-age resources within 150 ft of the Study Area were identified, documented with digital photography, and evaluated for NRHP eligibility.

5 Results

5.1 Background Review Results

The site file search revealed no previous archeological surveys have taken place within 1,000 m of either Study Area. However, the site file search did reveal the presence of two previously recorded prehistoric archeological sites within 1,000 m of the FRS No. 4 Study Area, and two sites within 1,000 m of the FRS No. 5 Study Area (**Table 3; Figures 6** and **7**). Two of the sites (41CK134 and 41CK180) contain no information about the site type or cultural period. Archeological site 41CK160 is described as a prehistoric camp/workshop. The site was analyzed in 1982 based on records from 1929. The TASA entry indicates some uncertainty regarding the location of the site and does not list the artifacts or features potentially associated with the site. Archeological site 41CK296 is a historic site from the depot ruins of the Fort Chadbourne Depot Atchison Topeka and Santa Fe Railroad. The foundation was recorded by a THC Regional Steward in 2017. None of these previously recorded sites are located inside either Study Area.

Based on the historic resources background review, no properties listed in, or eligible for listing in, the NRHP or designated NHLs, SALs, RTHLs, or OTHMs are recorded within 1,300 ft of the Study Area. Finally, no recorded cemeteries are located within the Study Area or within the wider 1,000 m background review buffer.

Table 3. Previously Recorded Archeological Sites within 1,000 m of the Study Areas

Site Number	Cultural Period	Site Type	Designation Status	Relationship to Study Area
41CK134	No data	No data	Undetermined	[redacted]
41CK296	Historic	Historic depot ruins of the Fort Chadbourne Depot KCM&O Railroad; a 20 x 80 ft concrete slab remains where a depot structure was once situated	Undetermined	[redacted]
41CK160	Prehistoric	Camp or workshop with ceramic sherd	Undetermined	[redacted]
41CK180	No data	No data	Undetermined	[redacted]

Source: TASA (2021)

[redacted]

Figure 6. Results of Site File Search at FRS No. 4

[redacted]

Figure 7. Results of Site File Search at FRS No. 5

5.2 FRS No. 4 Survey Results

The FRS No. 4 Study Area was surveyed April 9 – 11, 2021 and required approximately 52 person hours to complete. Most of the FRS No. 4 Study Area is used primarily as the existing facility and an agricultural field to the southeast. Existing facilities include the earthen dam, auxiliary spillway, the drainage outlet and impact basin, and contoured lands bordering the water (**Figures 8** through **15**). Prior impacts exist from construction and continued use of the dam complex as well as erosional processes to the impacted surrounding area.

During the survey within the FRS No. 4 Study Area, two newly recorded prehistoric archeological sites (41CK333 and 41CK334) and one prehistoric isolated find (IF-1) were identified and recorded (**Figure 16**). In addition, FRS No. 4 was recorded as Historic Resource 001. A total of 75 shovel tests was excavated within the Study Area, including 53 survey shovel tests, 4 judgmental shovel tests, and 18 site delineation shovel tests. Shovel tests ranged from 5 to 100 cm in depth, with an average depth of 33 cm before encountering subsoil or bedrock (**Appendix A**). Overall ground surface visibility was around 30 percent, with increased visibility in disturbed/eroded areas. Excavated soils consisted of reddish brown to yellowish red sandy loam over reddish brown to yellowish red sandy clay subsoil. Approximately 29 percent of the shovel tests within the Study Area revealed gravelly and cobbly soils, mostly adjacent to the existing dam footing, auxiliary spillway, and two-track road, while all the shovel tests exhibiting bedrock at shallow depths occurred within the auxiliary spillway. Numerous cobbles and gravels were also scattered across the surface.

Each cultural resource identified within the FRS No. 4 Study Area is discussed below.

Figure 8. Overview of FRS No. 4 from outflow side, facing south

Figure 9. Overview of agricultural field and FRS No. 4 at the southern extent of the Study Area, facing south

Figure 10. Overview of the Study Area from east of the spillway towards FRS No. 4, facing west

Figure 11. Overview of the Study Area from east of the auxiliary spillway, facing east

Figure 12. View of the west end of FRS No. 4, facing west

Figure 13. Intake structure for FRS No. 4, facing northeast

Figure 14. FRS No. 4 plunge basin and outlet pipe, facing southeast

Figure 15. Erosion at the north part of the Study Area, facing south

[redacted]

Figure 16. Location of Shovel Tests and Newly Recorded Cultural Resources at FRS No. 4

41CK333

Site 41CK333 was recorded during the current survey and consists of a large prehistoric lithic surface scatter/procurement site measuring approximately 465 m north-south by 125 m east-west, at an elevation of 2,000 ft amsl. 41CK333 is an approximate 15-acre site located within the south-central portion of the Blackwell, Tex. [3022-121] USGS 7.5-minute topographic quadrangle map, on a low terrace adjacent to Middle Kickapoo Creek to the west, encompassing the northeastern terminus of the historic earthen FRS No. 4. The site is somewhat clear with short grasses interspersed with small trees along the outer boundaries, and a northwest-to-northeast two-track gravel road bisecting the northern portion of the site. Soils at the site are shallow and mapped as Spillway (SPW); Oben and Cobb soils (CnB), 1 to 3 percent slopes to the west; Westola (Ya) very fine sandy loam, dry, 0 to 1 percent slopes, occasionally flooded to the southwest; and Miles fine sandy loam, 0 to 1 percent slopes, along the eastern boundary. The site is underlain by San Angelo Formation (Psa) in the northern seven acres, with the remaining eight acres underlain by Holocene alluvium (BEG 1987; NRCS 2021).

A dense lithic scatter was identified beginning at the northern extent of the Study Area at the two-track road, continuing south within the entire spillway boundary (**Figure 17**). Additional artifacts were identified on the eroding face of a bedrock escarpment east of the two-track road (**Figure 18** through **Figure 22**). The site continues to the southern extent of the Study Area, exhibiting dense clusters of lithic debitage interspersed with formal and informal tools on the surface. Most of the archeological materials are primarily distributed along the tree line bordering the spillway within the Study Area, indicating redeposition of artifacts due to processes associated with the construction and use of the dam and spillway. It appears site 41CK333 continues to the east, outside of the Study Area. However, due to Study Area constraints, the newly recorded archeological site was not delineated outside of the Study Area.

[redacted]

Figure 17. 41CK333 Site Map

Figure 18. Overview of the northern extent of site 41CK333, facing west

Figure 19. View towards the intersection of the gravel road and the dam at site 41CK333, facing south

Figure 20. View of the eroding face of a bedrock escarpment east of the two-track road within site 41CK333, facing east

Figure 21. View towards the tree line along the eastern boundary of the spillway within site 41CK333, facing east

Figure 22. View along the eastern boundary of the spillway within site 41CK333, facing south

The shallow depth of the potential artifact-bearing soils was confirmed by the excavation of 34 shovel tests within the site, including 8 judgmentally placed shovel tests which averaged 26 cm deep before encountering clay hardpan or bedrock (**Appendix A**). One of the 34 shovel tests, ST-34, yielded a single primary flake (**Figure 23**). A complete projectile point and point base were located within the southern extent of the site-a Darl-like complete point, possibly attributed to the Transitional Archaic (ca. AD 200) (**Figure 24**), and a Moran-like arrow point base, potentially dating to the Late Prehistoric (ca. AD 700-1200) (**Figure 25**) (Turner et. al 2011). All additional cultural materials were discovered in a surficial setting. A summary of artifacts recorded at this site is presented in **Table 4**. A representative sample of artifacts is illustrated in **Figure 26** through **Figure 32**. No features were located within the Study Area.

Table 4. Artifacts Identified at Site 41CK333

Artifacts	Quantity
Primary Flakes	3
Secondary Flakes	35
Tertiary Flakes	440
Modified/Utilized Flakes	2
Cultural Shatter	2
Cores/Tested Cobbles	50
Unifaces	4
Bifaces	10
Projectile Points	2
Total	**548**

Figure 23. Primary flake recovered from ST-34 (0-11 centimeters below surface [cmbs]) at site 41CK333

Figure 24. Darl-like projectile point located on the surface near the southeastern boundary of site 41CK333

Figure 25. Moran-like arrow point base located on the surface near the southeastern boundary of site 41CK333

Figure 26. Secondary flakes located on the surface near the southern boundary of site 41CK333

Figure 27. Representative sample of tertiary flakes located on the surface near the southern boundary of site 41CK333

Figure 28. Representative sample of tertiary flakes located on the surface near the northeastern boundary of site 41CK333

Figure 29. Modified flake located on the surface near the southern boundary of site 41CK333

Figure 30. Biface located on the surface near the northern boundary of site 41CK333

Figure 31. Biface located on the surface near the northeastern boundary of site 41CK333

Figure 32. Biface located on the surface near the northeastern boundary of site 41CK333

The artifacts identified during the current survey indicate site 41CK333 likely represents lithic procurement activities in an area where numerous outcropping chert gravels were readily available. Based on field observations, the site has been severely disturbed from the construction and use of the earthen dam, spillway, and two-track road. Natural erosion and weathering further impacted the site. Most of the site components were found to be resting on eroded or shallow soil surfaces. Given the severely disturbed setting of the site, there is very little potential for deeply buried intact cultural materials being present within the Study Area. Given the severe disturbances and the surficial setting of deposits, the site is not likely to yield information important to prehistory. Therefore, the portion of site 41CK333 within the Study Area is recommended as ineligible for NRHP listing and SAL designation. No further investigations are recommended within the current boundary of this site.

41CK334

Site 41CK334 was recorded during the current survey and consists of a diffuse prehistoric subsurface lithic scatter measuring approximately 70 m northeast-southwest by 35 m northwest-southeast, at an elevation of 2,000 ft amsl (**Figure 33**). No artifacts were discovered on the surface. This site may be an extension of site 41CK333 approximately 300 m to the east due to the entire Study Area being severely disturbed from the construction and use of the earthen dam and spillway. 41CK334 is an approximate 0.5-acre site located within the south-central portion of the Blackwell, Tex. [3022-121] USGS 7.5-minute topographic quadrangle map.

The site was discovered on a low terrace adjacent to Middle Kickapoo Creek to the east and an unnamed tributary of Middle Kickapoo Creek to the west, along the base of the earthen dam near the southwestern terminus. The site is within a plowed agricultural field, with 100 percent ground surface visibility at the time of survey, near the southern portion of the Study Area (**Figure 34** and **Figure 35**). Sparse vegetation and small trees line the base of the dam. Soils at the site are mapped as Cobb fine sandy loam (CfB), dry, 1 to 3 percent slopes. The site is underlain by San Angelo Formation (BEG 1987; NRCS 2021).

[redacted]

Figure 33. 41CK334 Site Map

Figure 34. Overview of ST-13 of site 41CK334, facing north

Figure 35. Overview of ST-13 of site 41CK334, facing south

The disturbances of the potential artifact-bearing soils were confirmed by the excavation of eight delineation shovel tests radiating off the initial positive shovel test, ST-13, to determine the site boundary. Two tertiary flakes, two secondary flakes, and one modified flake were recovered from ST-13. Including ST-13, three of the eight shovel tests, all 80 cm in depth within the plowed field, contained cultural materials. A single secondary flake was recovered from ST-13+30 NE and a single tertiary flake was located within ST-13+30 SW. All artifacts were recovered within the upper 60 cmbs (**Table 5; Appendix A**). The artifacts are shown in **Figure 36** through **Figure 39**. No features were located at the site.

Table 5. Artifacts Identified at Site 41CK334

Artifacts	Quantity
Secondary Flakes	3
Tertiary Flakes	3
Modified/Utilized Flakes	1
Total	**7**

Figure 36. Tertiary flake recovered from ST-13 (0-20 cmbs) at site 41CK334

Figure 37. Modified flake, two secondary flakes, and one tertiary flake from ST-13 (20-40 cmbs) at site 41CK334

Figure 38. Secondary flake recovered from ST-13+30 NE (0-10 cmbs) at site 41CK334

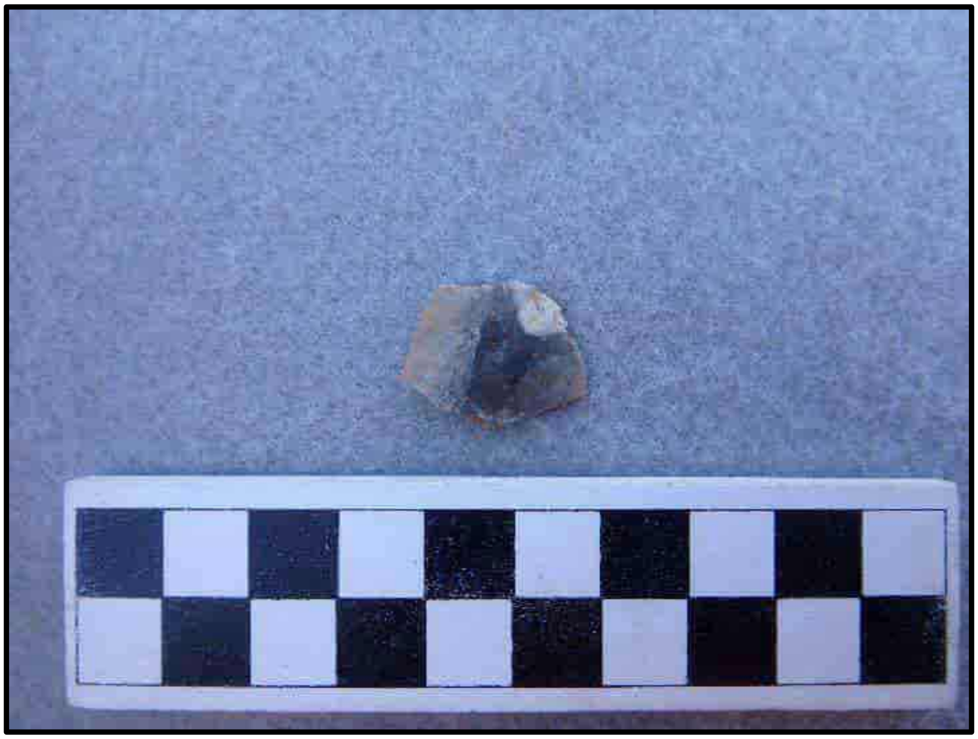

Figure 39. Tertiary flake recovered from ST-13+30 SW (50-60 cmbs) at site 41CK334

The artifacts identified during the current survey indicate site 41CK334 potentially represents a disturbed extension of site 41CK333, situated approximately 300 m east. It is likely that site 41CK334 continues outside of the Study Area. However, due to Study Area constraints, the newly recorded archeological site was not delineated outside of the Study Area. The site is in an area where numerous outcropping chert gravels were readily available. Based on field observations, the site has been impacted by the initial construction and continued use of the dam, spillway, and agricultural field. The site components were found to be within the plow zone of the agricultural field to a depth of 60 cmbs. Given the geomorphic setting of this site, there is little potential for deeply buried intact cultural materials to be present within the Study Area. Given the absence of temporally diagnostic artifacts and features, the setting of the deposits, and the sparse distribution, the site is not likely to yield information important to prehistory. Therefore, the portion of site 41CK334 within the Study Area is recommended ineligible for NRHP listing and SAL designation. No further investigations are recommended within the current boundary of this site.

IF-1

IF-1 was located within the FRS No. 4 Study Area at ST-5 (see **Figure 16**). Two tertiary flakes were recovered from 0-20 cmbs. Eight delineation shovel tests were excavated at 15 m and 30 m intervals to the north, south, east, and west. No additional cultural materials were discovered within these shovel tests and no features or surface finds were identified. IF-1 is Not Eligible for listing in the NRHP and does not merit designation as a SAL.

Historic Resource 001

Historic Resource 001 is the FRS No. 4 earthen dam structure (see **Figure 16**; **Figure 40**). FRS No. 4 is identifiable as TX03515 in the National Inventory of Dams (NRCS 2016). FRS No. 4 is a single purpose FRS that was built by NRCS in 1962 as a Significant Hazard dam. The dam is currently owned, operated, and maintained by the Coke County Kickapoo Water Control and Improvement District No. 1, Coke Soil Conservation District, and City of Bronte.

FRS No. 4 is a homogeneous earthen embankment with an impervious core of compacted earthen fill (**Figure 41**). The dam is approximately 2,200 ft long and has a maximum height of 35 ft. The dam crest is 14 ft wide. A 12-ft wide berm was constructed along the front slope and a 19-ft wide berm was constructed along the back slope (NRCS 2016). FRS No. 4 has a total storage capacity of 2,289 acre-ft (NRCS 2016). The principal spillway is a standard NRCS concrete riser that functions as both a principal spillway inlet and low-level inlet (**Figure 42**). The principal spillway conduit consists of a 220-ft long 30-inch diameter pre-stressed concrete lined steel cylinder pipe that empties into a plunge basin at the toe of the dam and is returned to the natural drainageway way via an outlet channel with a 12-ft bottom width and 3:1 side slopes. The auxiliary spillway consists of a channel with a bottom width of approximately 230 ft with 3:1 side slopes (NRCS 2016).

Deed research shows the land on which Resource 001 is located is part of an original grant to J.S. Baldwin (GLO 2021a) (**Figure 43**). The resources are situated in section 396, Block 1A. Baldwin was granted 323.50 acres on December 4, 1925. Research shows the 323-acre land parcel on which Resources 001 is located is currently privately owned and intersects Coke County Appraisal District (CCAD) land parcel 3864 (**Figure 44**) (CCAD 2021a).

Since FRS No. 4 was constructed in 1962, it meets the age requirement for NRHP eligibility consideration and was therefore evaluated for NRHP eligibility based on criteria presented in 36 CFR Part 63 [a–d]. Resource 001 does not appear to have been altered, and the surrounding landscape has remained undeveloped. Therefore, the resource has retained integrity of location, design, materials, workmanship, setting, feeling, and association. Although the resource retains integrity, its association with flood control development or agriculture in the Kickapoo Creek Watershed is not sufficient for NRHP-listing as there are other examples of these types of resources in Coke County, with similar historical context. The resource is also not associated with a pattern of development in Coke County. Resource 001 fails to illustrate any known association with significant historical events or a significant pattern of development in Coke County, and does not qualify for NRHP eligibility under Criterion A. The resource is not associated with significant persons in history and lacks engineering design merit to qualify for NRHP eligibility under Criteria B or C. Finally, the resource is not likely to yield information important to history or prehistory, and does not qualify for NRHP eligibility under Criterion D. Therefore, Resource 001 is recommended as Not Eligible for listing in the NRHP. Furthermore, Resource 001 does not merit SAL designation.

Figure 40. Overview of FRS No. 4 (Resource 001), facing southwest

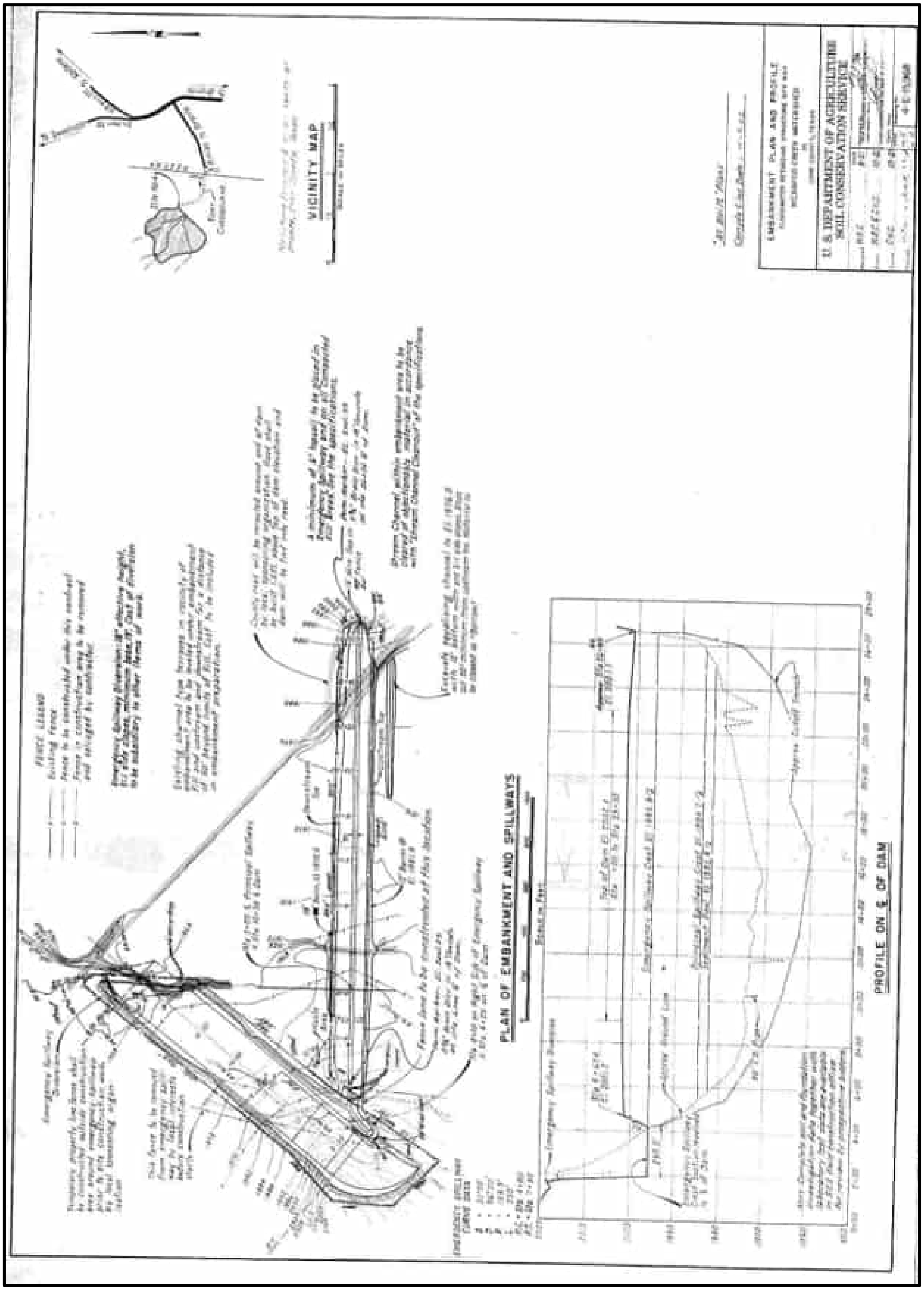

Figure 41. As-built plan of dam complex at Kickapoo Creek Watershed FRS No. 4 (Soil Conservation Service [SCS] 1962)

Figure 42. View of concrete intake structure, facing south

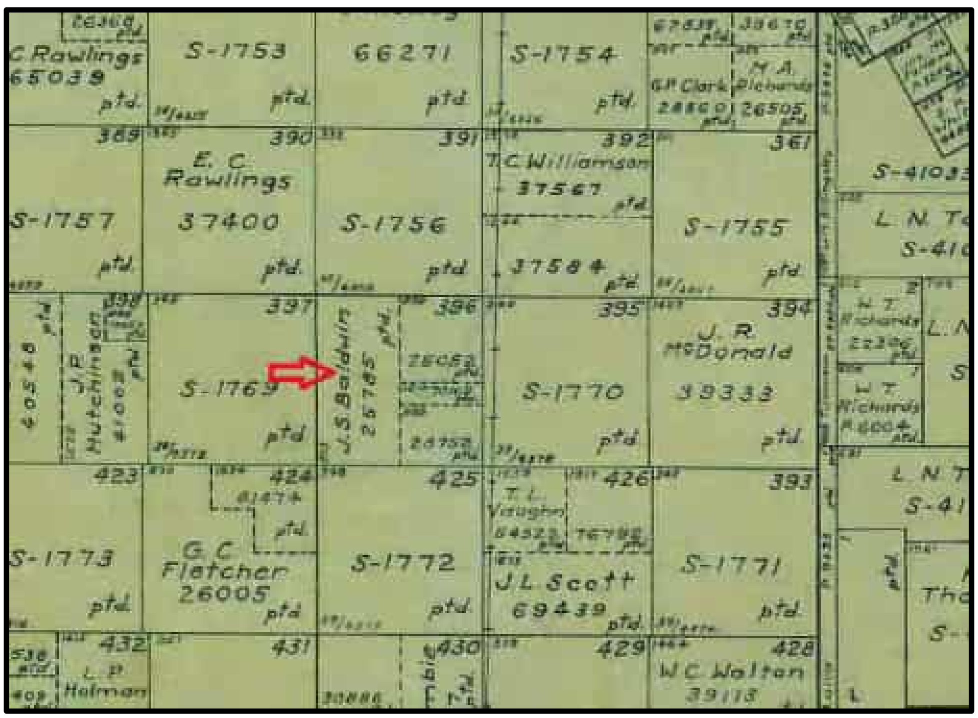

Figure 43. 1945 map showing Section 396 of Abstract 819 (GLO 2021b)

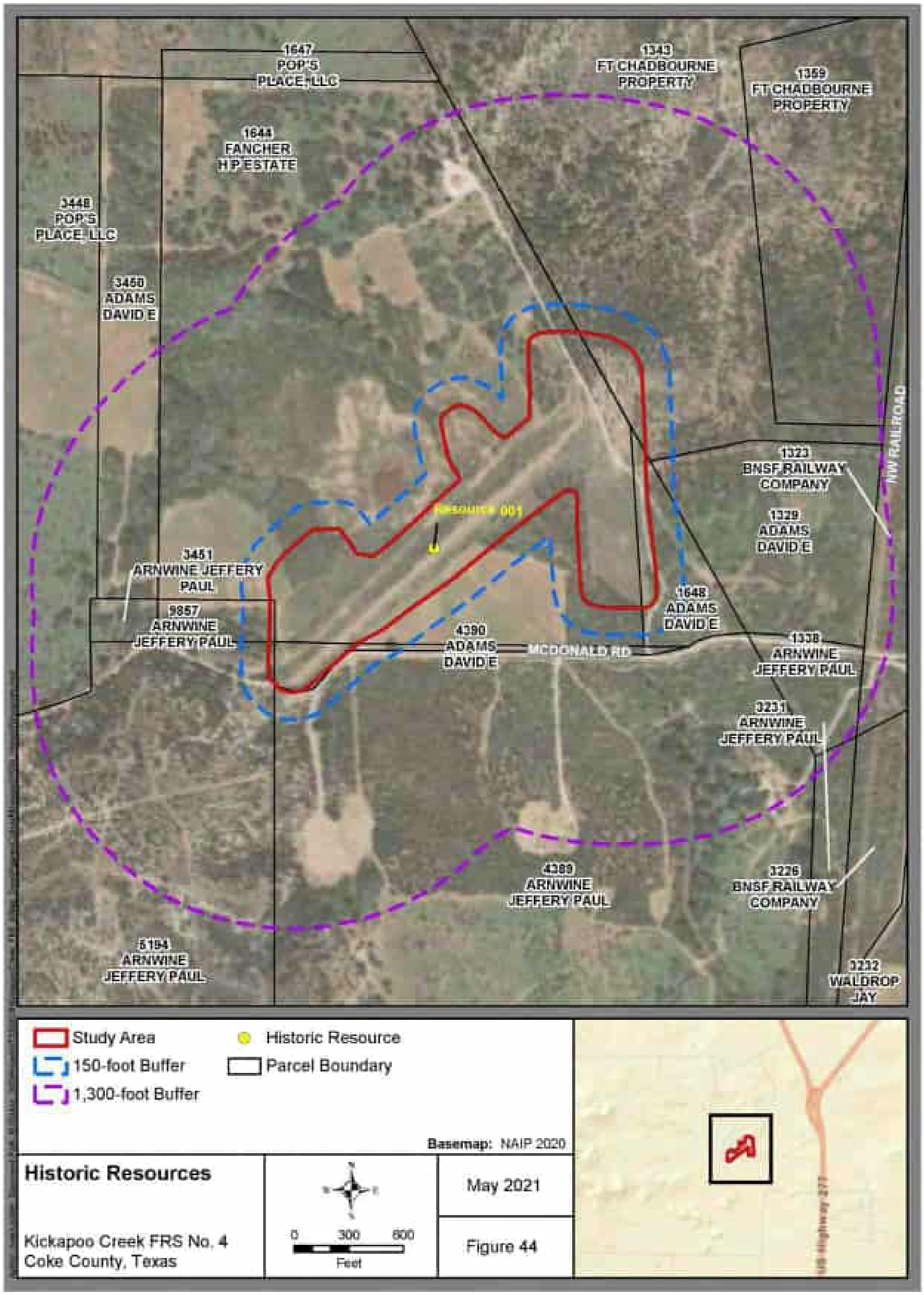

Figure 44. Parcel Boundaries for Historic Resource 001 at FRS No. 4

5.3 FRS No. 5 Survey Results

The FRS No. 5 Study Area was surveyed April 8, and 12-13, 2021 and required approximately 44 person hours to complete. The FRS No. 5 Study Area is currently used as the existing facility and artificially constructed berms south of the dam and adjacent to an access road to the north (**Figure 45** through **Figure 47**). Existing facilities include the earthen dam, auxiliary spillway, the drainage outlet, impact basin, and contoured lands bordering the spillway and reservoir (**Figures 48** through **Figure 51**). Prior impacts exist from construction and continued use of the dam complex as well as erosional processes to the impacted surrounding area (**Figure 52**).

During the survey within the FRS No. 5 Study Area, one newly recorded prehistoric archeological site (41CK335), three prehistoric isolated finds (IFs 2, 3, and 4), and two historic-age resources (Resources 002 and 003) were identified and recorded (**Figure 53**). A total of 84 shovel tests was excavated within the Study Area, including 64 survey shovel tests, 19 site delineation shovel tests, and one judgmentally placed shovel test. Shovel tests ranged from 9 to 65 cm in depth, with an average depth of 27 cm before encountering subsoil or bedrock (**Appendix A**). Overall ground surface visibility was around 30 percent, with increased visibility in disturbed/eroded areas. Excavated soils consisted of reddish brown to yellowish red sandy loam over reddish brown to yellowish red sandy clay subsoil. Approximately 27 percent of the shovel tests within the Study Area exhibited soils mixed with gravels and cobbles, most of which were adjacent to the existing dam footing and artificial berms. Numerous lag deposits of cobbles and gravels were also scattered across the surface.

Each cultural resource identified at FRS No. 5 is discussed below.

Figure 45. Overview of FRS No. 5 west of the impact basin, facing south

Figure 46. Overview of FRS No. 5 from east of Middle Kickapoo Creek, facing north

Figure 47. Overview of the Study Area from the southwest boundary of the spillway towards FRS No. 5, facing east

Figure 48. View towards the outflow of FRS No. 5 at Middle Kickapoo Creek, facing south

Figure 49. Overview of FRS No. 5, facing east

Figure 50. Inlet drain and reservoir from northern side of FRS No. 5, facing northeast

Figure 51. View of plunge basin and outlet pipe from southern side of FRS No. 5, facing south

Figure 52. View of erosion occurring at the southwest extent of the Study Area, facing south

[redacted]

Figure 53. Location of Shovel Tests and Newly Recorded Cultural Resources at FRS No. 5

41CK335

Site 41CK335 was recorded during the current survey and consists of a large prehistoric lithic surface scatter/procurement site measuring approximately 1,000 m east-west by 220 m north-south at the widest extent in the west portion of the site, at an elevation of 1,900 ft amsl. 41CK335 is an approximate 37-acre site located within the north-central portion of the Bronte, Tex. [3100-434] USGS 7.5-minute topographic quadrangle map, on a low terrace bisected by Middle Kickapoo Creek. The site area contains short grasses interspersed with small trees along the banks of Middle Kickapoo Creek in the southeast portion of the site. Soils at the site are mapped as Cobb loamy fine sand, dry (CbB), 0 to 3 percent slopes; Oben and Cobb soils (CnB), 1 to 3 percent slopes; and Cobb fine sandy loam, dry (CfB), 1 to 3 percent slopes along the western boundary surrounding the spillway (SPW). CbB soils also encompass the western extent of the earthen dam. Miles fine sandy loam (MmA), 0 to 1 percent slopes, and CnB soils make up the easternmost portion of the site within the Study Area. The site is underlain by San Angelo Formation to the west and east, with the central approximate ten acres mapped as Holocene alluvium (BEG 1987; NRCS 2021).

Site 41CK335 was identified as a dense lithic scatter extending from the western edge of the Study Area, along the edge of the excavated auxiliary spillway boundary, continuing east along the dam and earthen berm to the south. Artifacts were continuous within these site limits, though concentrations of lithic debitage were also mapped in various places within this boundary (**Figure 54**). Additional artifacts were identified along the eroded edge of the auxiliary spillway (**Figure 55** through **Figure 59**). The surface scatter contained dense clusters of lithic debitage interspersed with formal and informal tools. Most of the archeological materials are primarily distributed along this edge and on the dam and associated berms within the Study Area. These artifacts were clearly redeposited during construction of the dam and auxiliary spillway, and likely originated from where the spillway was excavated.

[redacted]

Figure 55. Overview of the western extent of site 41CK335, facing northwest

Figure 56. View towards the earthen berm south of the dam within site 41CK335, facing southeast

Figure 57. Overview of site 41CK335 from ST-33 towards Middle Kickapoo Creek, facing west

Figure 58. Overview of site 41CK335 from ST-50 at northern extent, facing south

Figure 59. View of lithic scatter eroding from the spillway slope east of ST-35, facing west

The shallow depth of the potential artifact-bearing soils was confirmed by the excavation of 29 shovel tests within the site, which averaged 27 cm in depth before encountering clay hardpan or bedrock. Out of the 29 shovel tests, none were positive for cultural materials (**Appendix A**). The hundreds of lithic artifacts were observed within a clearly disturbed and mixed surficial setting, including chert debitage, biface thinning flakes, unifaces, bifaces, scrapers, and a bifacial knife. None of the artifacts recorded were temporally diagnostic. A representative sample of artifacts is illustrated in **Figure 60** through **Figure 65**. No features were located within the Study Area.

Figure 60. Secondary and tertiary flakes located on the surface near ST-24+15N at site 41CK335

Figure 61. Representative sample of tertiary flakes located on the surface near ST-38N25 at site 41CK335

Figure 62. Biface thinning flakes located on the surface of FRS No. 5 at site 41CK335

Figure 63. Biface fragment and scraper located on the surface southeast of ST-38 at site 41CK335

Figure 64. Biface on surface 15 m east of ST-35 at site 41CK335

Figure 65. Bifacial knife eroding from the slope near ST-35E30 at site 41CK335

The artifacts identified during the current survey indicate site 41CK335 likely represents lithic procurement activities in an area where numerous outcropping chert gravels were readily available. It is likely that site 41CK335 continues outside of the Study Area. However, due to Study Area constraints, the newly recorded archeological site was not delineated outside of the Study Area. Based on field observations, the site has been severely disturbed from the construction and use of the earthen dam, earthen berms, and auxiliary spillway. Natural erosion and weathering further impacted the site. All site components were found to be resting on eroded or shallow soil surfaces. Given the severely disturbed setting of the site, there is very little potential for deeply buried intact cultural materials being present within the Study Area. Given the severe disturbances and the surficial setting of deposits, the site is not likely to yield information important to prehistory. Therefore, the portion of site 41CK335 within the Study Area is recommended ineligible for NRHP listing and SAL designation. No further investigations are recommended within the current boundary of this site.

IF-2

IF-2 consists of the surface find of a chert graver and tertiary flake located approximate 20 m south of ST-63 (see **Figure 53**). Five delineation shovel tests were excavated at 15 m and 30 m intervals to the north and south, and 15 m to the west. Due to the narrow Study Area, no shovel tests were conducted to the east or at 30 m west. No additional cultural materials were discovered within these shovel tests and no features or additional surface finds were identified.

IF-3

IF-3 consists of a single tertiary flake discovered on the surface approximately 17 m south of ST-58. This area is at the north end of the artificial berm and is adjacent to the two-track road paralleling the Study Area (see **Figure 53**). No delineation shovel tests were conducted due to the disturbed and built-up surroundings within this portion of the Study Area. No features or additional surface finds were identified.

IF-4

IF-4 consists of a single tertiary flake recovered from ST-56 (0-14 cmbs), on the western base of the artificial berm at the north end of the Study Area (see **Figure 53**). Four delineation shovel tests were excavated at 15 m and 30 m intervals to the north and south. No shovel tests were placed to the west or east due to disturbance related to the berm. No additional cultural materials were discovered within these shovel tests and no features or additional surface finds were identified.

Due to the isolated occurrences of these cultural materials and the lack of integrity context, IFs do not meet NRHP eligibility requirements, nor do they merit designation as SALs. No further investigations are recommended for these IFs.

Historic Resource 002

Resource 002 is the FRS No. 5 earthen dam structure (**Figure 66** through **Figure 68**). FRS No. 5 is identifiable as TX03524 in the National Inventory of Dams (NRCS 2015). FRS No. 5 is a single purpose FRS that was built by NRCS in 1963 as a Significant Hazard dam to provide flood damage reduction (NRCS 2015). FRS No. 5 embankment is a zoned, compacted earth fill dam. A 12-foot-wide core trench with 1:1 side slopes was constructed at the centerline of the dam. The dam is approximately 32 ft tall and 8,096 ft long. The top width of the structure is approximately 16 ft. FRS No. 5 has a maximum flood detention pool storage capacity of 2,199 acre-ft (NRCS 2015). The principal spillway is a standard concrete drop inlet (2.5 ft wide by 8.33 ft long by 18 ft deep). The inlet structure includes an 8-inch diameter gate valve. The outlet conduit consists of 220 ft of 30-inch pre-stressed, concrete lined, steel cylinder pipe with 5 anti-seep collars. The auxiliary spillway consists of a 400-ft wide channel with a protective vegetative cover (NRCS 2015).

Figure 66. Overview of FRS No. 5 (Resource 002), facing east

Figure 67. View of FRS No. 5 (Resource 002), facing west from NW Railroad Road

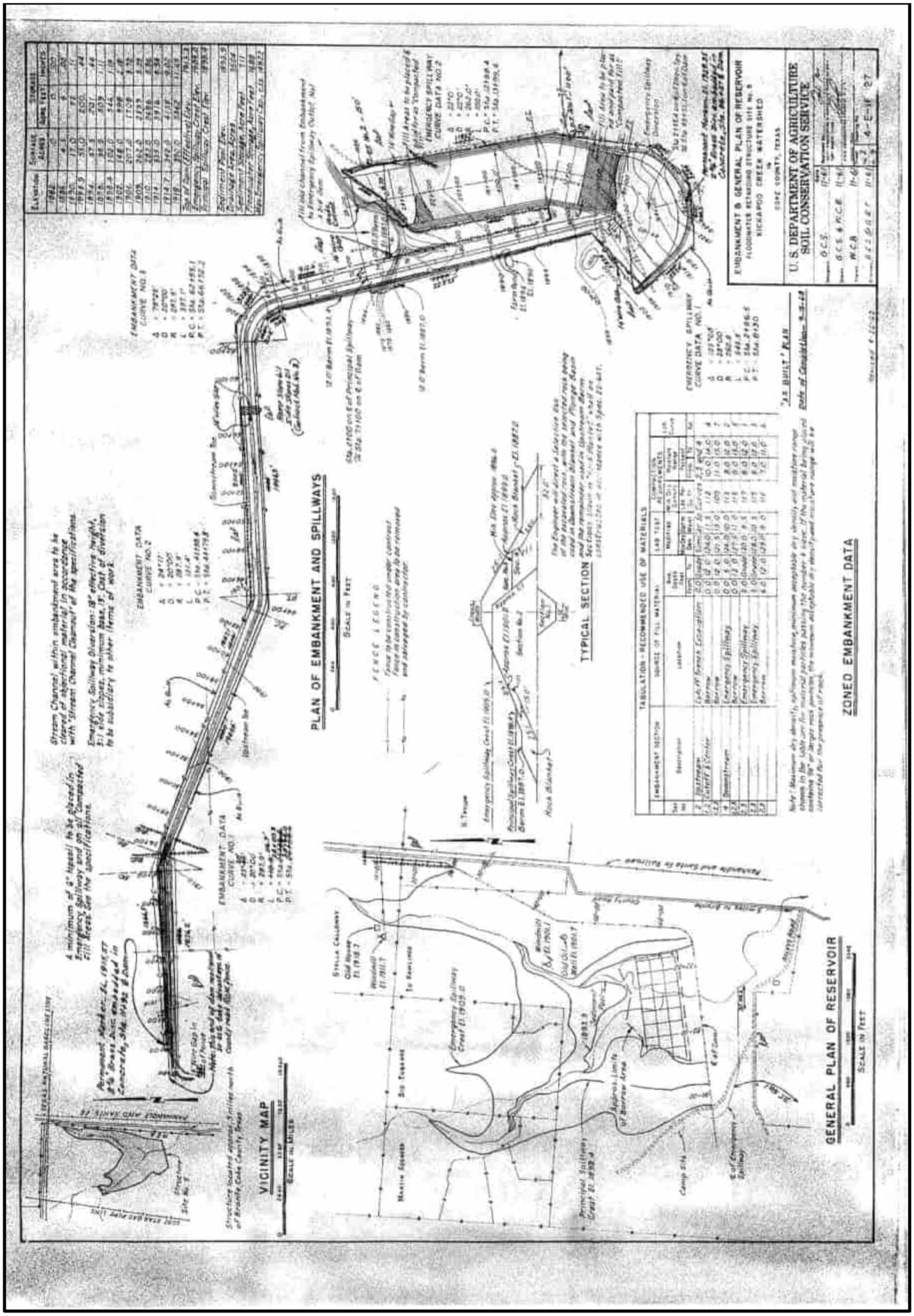

Figure 68. As-built plan of dam complex at Kickapoo Creek Watershed FRS No. 5 (SCS 1963)

Historic Resource 003

Resource 003 consists of two separate but related components, including a livestock shelter (Resource 003a) and an adjacent livestock corral structure (Resource 003b). The livestock shelter (Resource 003a) is situated immediately west of the auxiliary spillway (see **Figure 53**). The shelter consists of an enclosed building with a rectangular plan and an open canopy section extending south (**Figure 69**). The building has a shallow-pitched, end-gabled roof with metal cladding. The exterior walls are clad with ribbed metal siding. The south elevation exhibits a pair of large metal doors and the west elevation exhibits one large bay opening with a metal overhead door. The north and east elevations exhibit no window or door openings. The gabled roof extends south to create an open canopy structure supported by metal pipe.

Figure 69. View of livestock shelter (Resource 003a), facing northeast

Resource 003b is a livestock corral structure **(Figure 70)**. The corral is situated to the south and east of the livestock shelter. The corral structure is rectangular in plan. Multiple holding pens are constructed of welded pipes and contain various fencing materials including smooth wire, barbed wire and metal panel fencing.

Resources 003a and 003b were not visible in a review of aerial photography from 1966 but were visible in a 1996 aerial photograph. Although a definite date of construction could not be determined, based on their design, materials and workmanship, the date of construction for Resources 003a and 003b is estimated to be ca. 1975. Based on this information, these resources meet the age requirement for NRHP eligibility consideration and were evaluated for NRHP eligibility based on criteria presented in 36 CFR Part 63 [a–d].

Figure 70. View of corral (Resource 003b), facing north

Deed research reveals that Resources 002 and 003 are on a land parcel that is part of an original grant to the Houston and Texas Central Railway Company (GLO 2021c) (**Figure 71**). The railroad was granted 640 acres in return for the completion of a section of 93 and132/176 miles of main track and 2 and 35/66 miles of sidings from Brenham to Austin City. The company was entitled to the 640-acre parcel of land upon ‘any of the unreserved, vacant, and unappropriated Public Domain of the State of Texas” (GLO 2021c). Research shows the 407.91-acre land parcel on which Resources 001a-c are located is currently privately owned and intersects CCAD land parcel 9852 (**Figure 72**) (CCAD 2021b).

Resources 002 and 003 do not appear to have been altered, and the surrounding landscape has remained undeveloped. Therefore, the resources have retained integrity of location, design, materials, workmanship, setting, feeling, and association. Although the resources retain integrity, their association with flood control development or agriculture in the Kickapoo Creek Watershed is not sufficient for NRHP-listing as there are other examples of these types of resources in Coke County, with similar historical context. The resources are also not associated with a pattern of development in Coke County. Resources 002 and 003 fail to illustrate any known association with significant historical events or a significant pattern of development in Coke County, and do not qualify for NRHP eligibility under Criterion A. The resources are also not associated with significant persons in history and lack engineering design merit to qualify for NRHP eligibility under Criteria B or C. Finally, the resources are not likely to yield information important to history or prehistory, and do not qualify for NRHP eligibility under Criterion D. Therefore, Resources 002 and 003 are recommended Not Eligible for listing in the NRHP. Furthermore, Resources 002 and 003 do not merit SAL designation.

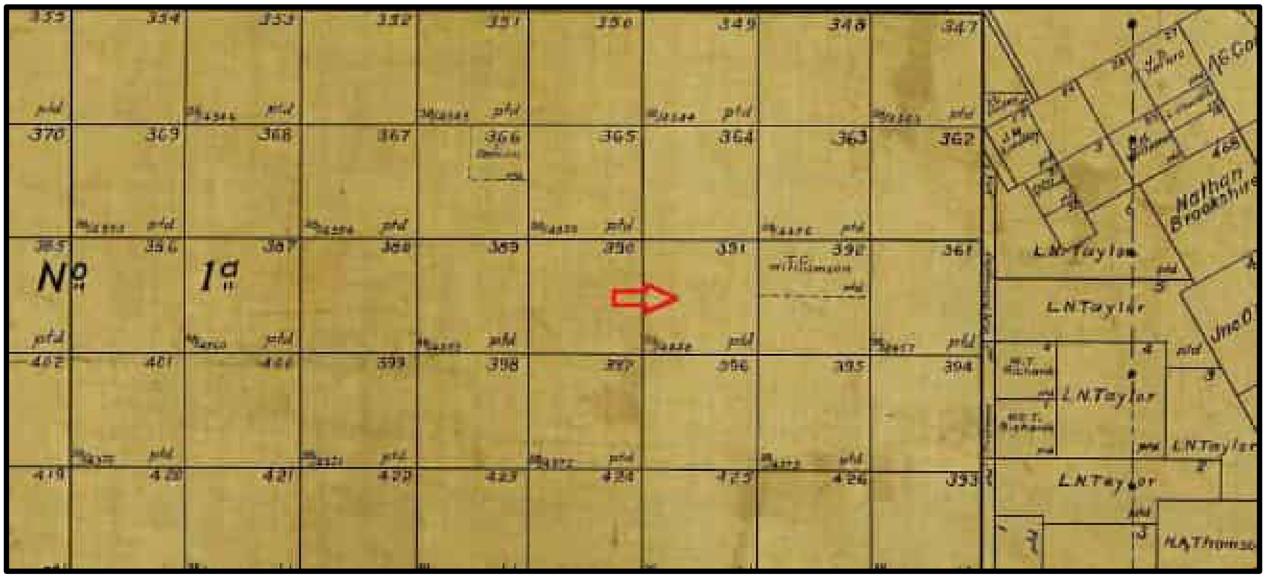

Figure 71. Part of a 1904 map showing the Houston and Texas Central Railway Company land grant, Abstract 332, Section 391 on which Historic Resources 002 and 003 are situated. (GLO 2021d)

[redacted]

Figure 72. Parcel Boundaries for Historic Resources at FRS No. 5

[redacted]

Figure 72 continued

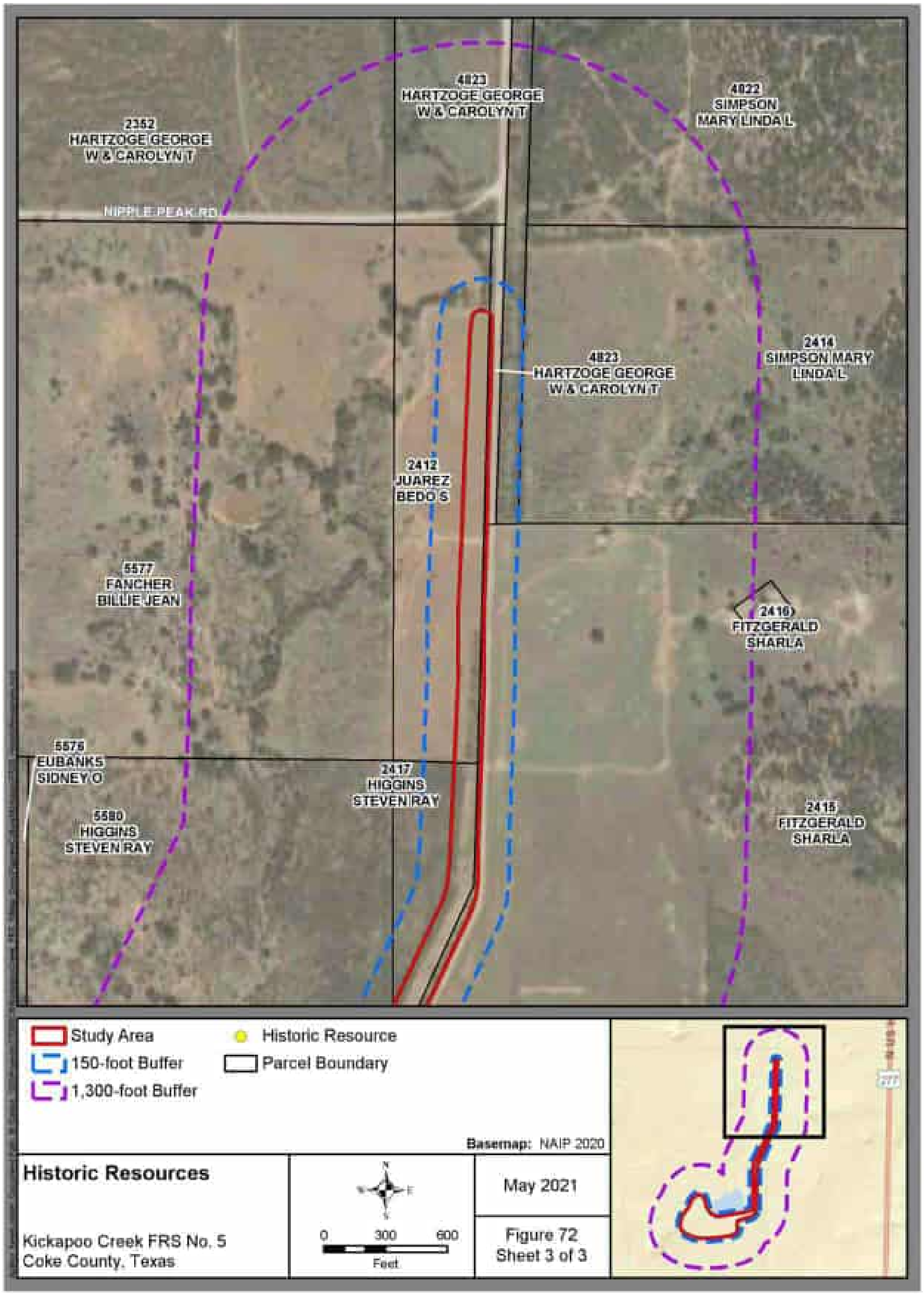

Figure 72 continued

5.4 Geomorphological Assessment

A geomorphological assessment was conducted by AECOM Geoarcheologist Steve Ahr to evaluate the potential for the Project to impact deeply buried archeological deposits. The assessment considered the soil-geomorphic setting and depositional environments, the age and lithology of the soil parent materials, the types of active pedogenic site formation processes, and the types of impacts anticipated from the Project. As previously described, the Permian-age San Angelo Formation underlies the Study Areas and consists of mixed-clastic sedimentary sandstone and mudstone, with incidental quantities of dolostone and gypsum. Geologic mapping shows Pleistocene fluviatile terrace deposits and Holocene alluvium inset to the older San Angelo Formation.

FRS No. 4

Approximately 72 percent of the FRS No. 4 Study Area is mapped as the San Angelo Formation, which correlates with the distribution of the Cobb, Oben, Miles, and Oplin upland soil series. The Oplin-Rock outcrop soils are classified as Lithic Calciustols containing very shallow, flaggy clay loam soils that formed in residuum over limestone bedrock. These soils comprise less than one percent of the Study Area. The Cobb, Oben, and Miles soils formed in weakly cemented sandstone and are taxonomically classified as Typic Haplustalfs and Paleustalfs. These soils exhibit strong texture contrasts, with reddish brown fine sandy loams over a series of well-developed yellowish red and dark reddish-brown sandy clay loam Bt (argillic) horizons (NRCS 2021). These horizons in turn overlie weakly cemented reddish sandstone Cr horizons. The presence of well-developed argillic subsurface horizons meets the central requirements of Alfisol classification, wherein weathering and translocation of phyllosilicate clays from upper soil horizons contributes to the Bt horizons in the lower profile (Soil Survey Staff 2010). Depending on local soil forming factors such as mean annual precipitation and parent materials, the formation of argillic horizons is largely time-dependent and can require tens of thousands of years to form (Hallmark and Franzmeier 1999).

Artifacts are often found buried within the sandy loams in the upper part of the soil profile but tend to be absent from the argillic horizon due to the extensive time requirements for argillic horizon. Furthermore, the compact Bt horizons tend to act as a restrictive layer to further downward artifact movement. Because of this, archeological materials are often identified within a “stone line” that forms at the contact between the bottom of the sandy zone and the top of the argillic horizon. Since these upland soils formed via the pedogenic model of sandy mantle genesis, as opposed to geomorphic processes (Ahr et al. 2012), there are rarely in-situ archeological deposits ever found within it because of extensive bioturbation and high soil turnover rates. Within the FRS No. 4 Study Area, 51 shovel tests were excavated within these sandy upland soils. These shovel tests revealed that the sandy loam A and Ap horizons averaged 26 cm thick over the compacted and well-developed sandy clay loam Bt horizon. A total of 10 lithic flakes were recovered from these sandy mantle soils, but in a disturbed, mixed context.

Holocene alluvium comprises 28 percent of the FRS No. 4 Study Area and corresponds to the areal distribution of the Westola soils (Typic Ustifluvents). These soils that formed in nearly level floodplains contain reddish brown (5YR 4/4) and dark reddish brown (5YR 3/4) fine sandy loam over several reddish-brown loam and fine sandy loam C horizons. The C horizons tend to be massive, but can also contain distinct strata of loamy fine sand and fine sand that is between 3 and 13 millimeters (mm) thick, and common distinct strata of yellowish red (5YR 4/6) and dark reddish brown loam and fine sandy loam 1 to 2 mm thick (NRCS 2021). Based on the limited degree of pedogenic development and the retention of primary depositional bedding structures, these soils are presumably of recent historic age.

Sixteen shovel tests were dug within the alluvial deposits represented by the Westola soil. These shovel tests averaged 40 cm before encountering a sandy clay Bt horizon. Three shovel tests (ST-18, ST-21, and ST-23) reached as deep as 100 cmbs, revealing deep soils behind the dam. The presence of laminae recorded within at least one of these shovel tests suggests the thick soils were possibly caused in part by historic sedimentation due to the impoundment of water. Overall, the depth of the sandy clay Bt horizon across the Westola alluvial soils was encountered at nearly twice the depth as in the upland portion of the Study Area, but still within shovel test range.

The relatively thin floodplain deposits in the Study Area can be attributed to at least two factors. First, the floodplain morphology is consistent with infrequent but intense (e.g., flash floods) flooding events over broad areas that characterize this region. Often such hydrologic events are erosional, particularly in arid settings, and can also result in widely distributed and dissected sheetwash deposits. As shown in the elevation profile in **Figure 73** the original floodplain surface likely rose approximately 2 m above the valley floor, as evidenced by various preserved floodplain remnants. However, most of the floodplain in the Study Area appears to have been eroded by as much as 1 to 1.8 m below the original floodplain surface. This was probably due to high energy erosive flash floods, which is why the current flood control dam was constructed. Second, floodplain erosion in the Study Area was likely exacerbated in later years by construction of the dam and spillway, as well as agricultural impacts below the dam.

Based on the foregoing geomorphological observations, the FRS No. 4 Study Area exhibits low potential to contain deeply buried and intact archeological deposits. Furthermore, no deep impacts are currently anticipated at this time. No backhoe trenching is recommended.

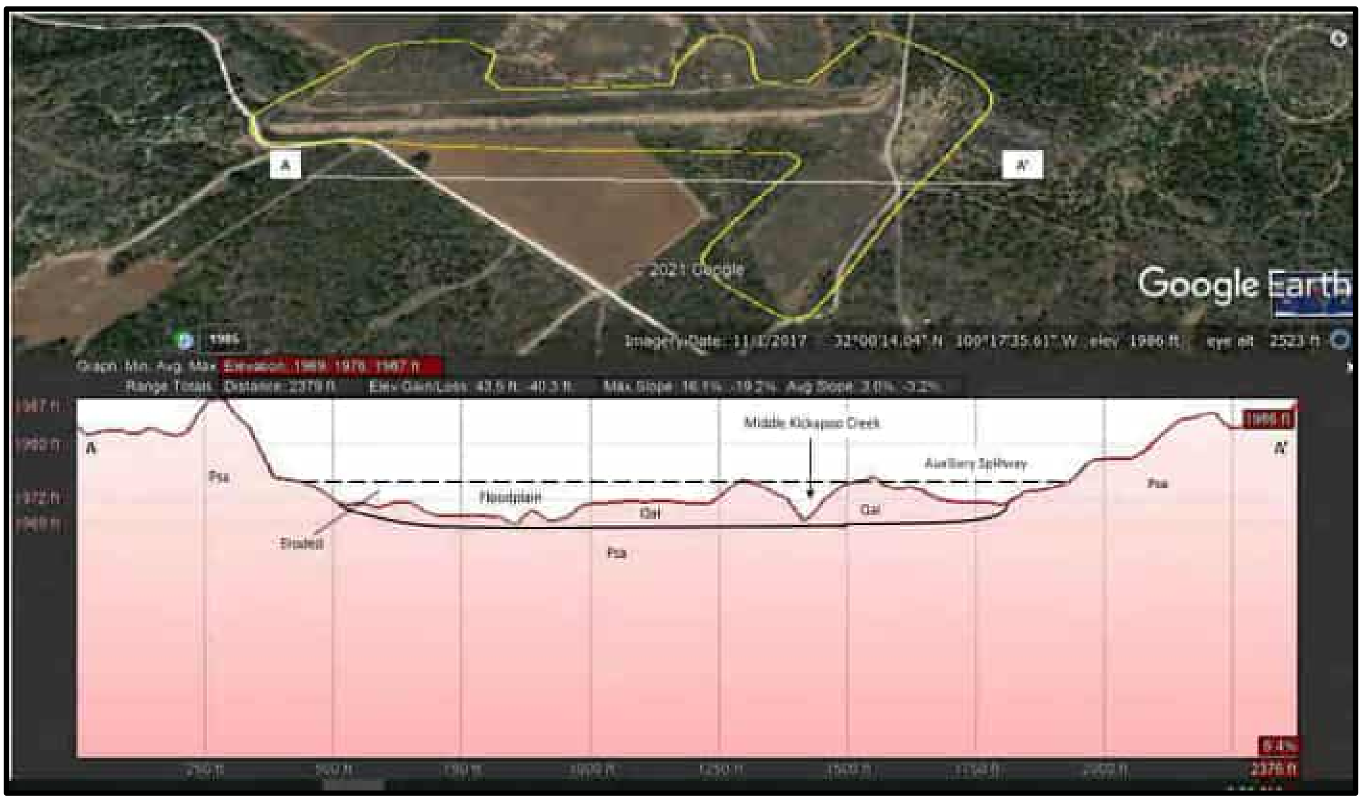

Figure 73. Stratigraphic cross section of FRS No. 4 Study Area

FRS No. 5

Approximately 50 percent of the FRS No. 5 Study Area is mapped as the San Angelo Formation, while the remainder is mapped as Pleistocene-age fluviatile terrace deposits. The uplands correlate with the distribution of the Cobb and Oben soils, which formed in weakly cemented sandstone and are taxonomically classified as Typic Haplustalfs. As described above for FRS No. 4, these soils exhibit strong texture contrasts, with a fine sandy loam A horizon overlying compacted and well-developed sandy clay Bt horizons. Artifacts are often found buried within the sandy loams in the upper part of the soil profile but tend to be absent from the argillic horizon due to the extensive time requirements for argillic horizon, and because it is a fairly restrictive layer to vertical artifact movement. There are rarely in-situ archeological deposits ever found within the sandy mantle zone because of extensive bioturbation and high soil turnover rates.

Within the FRS No. 5 Study Area, 72 shovel tests were excavated within these sandy upland soils. These shovel tests revealed an average depth of 22 cm of sand and sandy loam A and Ap horizons, occasionally mixed with pebbles and small gravels, before encountered a culturally sterile, compacted, and well-developed sandy clay loam Bt horizon. Only one modified flake and one tertiary flake were recovered from these mixed sandy mantle soils, which was located between 24 and 30 cmbs.

Pleistocene-age fluviatile terrace deposits are mapped within the remaining 50 percent of the FRS No. 5 Study Area and corresponds to the distribution of the Bronte (Aridic Haplustalfs), Colorado (Typic Ustifluvents), Miles (Typic Paleustalfs), and Sagerton (Typic Argiustolls) soils. Bronte, Miles, and Sagerton soils formed within loamy ancient terrace alluvium situated on both sides of Middle Kickapoo Creek. The soils consist of reddish brown, brown, and dark brown fine sandy loam, silt loam, and clay loam overlying brown and dark reddish-brown sandy clay Bt horizons. These soils are pedogenically and morphologically similar to the Cobb and Oben soils on the uplands. Given the shallow depths of potential artifact bearing soils, no potential exists for deeply buried archeological materials.

The Official series description for the Colorado soils, which are located within the floodplain in the central part of the Study Area immediately below the dam, indicates they contain a light reddish brown, weakly developed silt loam A horizon 13 cm thick, over stratified to massive clay loam C horizon deposits to a depth of 152 cmbs. Based on the limited degree of pedogenic development and retention of primary depositional bedding, these soils would possibly be of recent historic age. A total of 12 shovel tests were dug within the Colorado soils adjacent to Middle Kickapoo Creek, which averaged 24 cm before encountering a sandy clay Bt horizon that was observed in most other areas of the Project. Given such a shallow depth of loamy floodplain soils, it is suggested that the recent alluvial deposits likely represent a thin overbank veneer which is resting unconformably upon a partially truncated/eroded Qt terrace surface (**Figure 73**). As such, any cultural materials would likely be within the range of standard shovel tests.

Based on the foregoing geomorphological observations, the FRS No. 5 Study Area exhibits low potential to contain deeply buried and intact archeological deposits. Furthermore, no deep impacts are currently anticipated at this time. No backhoe trenching is recommended.

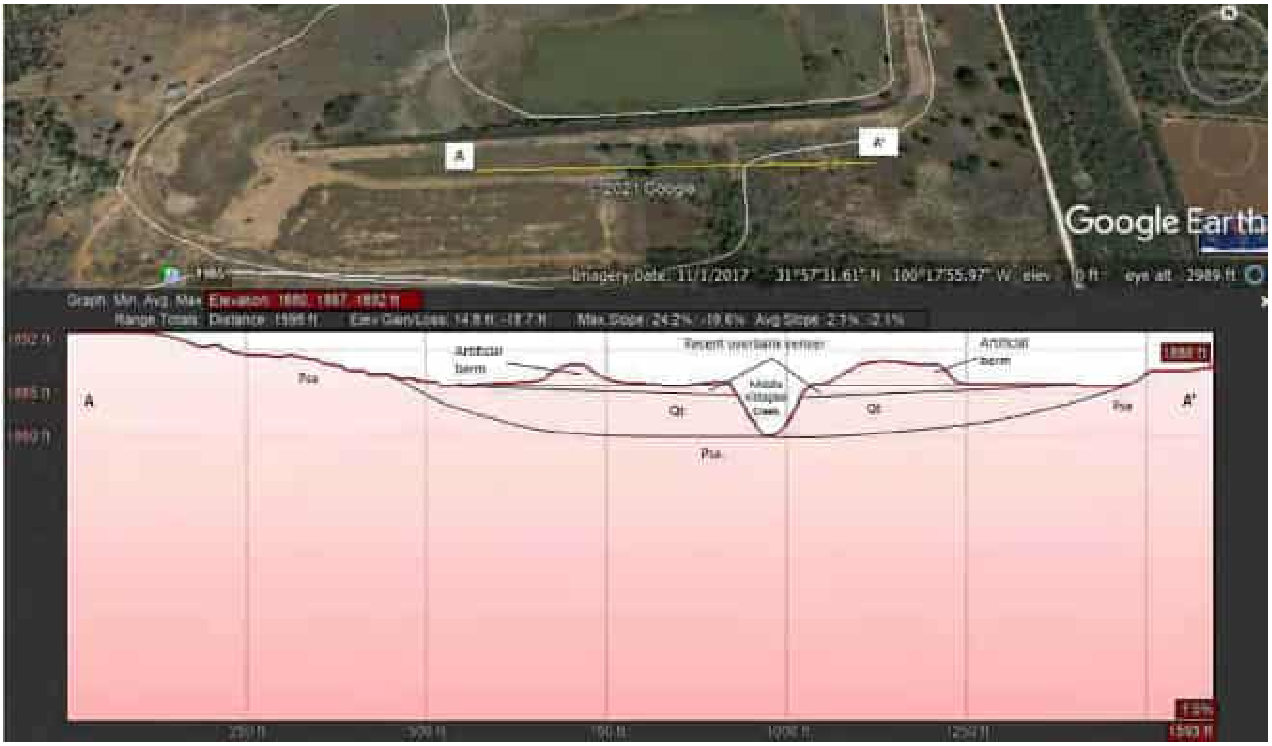

Figure 74. Stratigraphic cross section of FRS No. 5 Study Area

6 Summary and Recommendations

AECOM conducted a cultural resources survey of the 39-acre FRS No. 4 and the 94-acre FRS No. 5. Study Areas from April 8 – 13, 2021, under Antiquities Permit Number 30086, requiring approximately 96 person hours to complete. The survey consisted of a pedestrian visual inspection supplemented with the excavation of 159 shovel tests. Three prehistoric archeological sites (41CK333, 41CK334, and 41CK335), three historic resources (Resource 001, Resource 002, and Resource 003), and four prehistoric IFs (IF-1, IF-2, IF-3, and IF-4) were identified during the survey.

Archeological site 41CK333 consists of a 15-acre prehistoric lithic surface scatter/procurement site at FRS No. 4. Site 41CK334 consists of a 0.25-acre diffuse prehistoric subsurface lithic scatter located within a plowed agricultural field along the southern boundary of the Study Area at FRS No. 4. Site 41CK335 was identified as a 37-acre dense surface lithic scatter from the western extent of the Study Area along the excavated spillway boundary, continuing east along the western portion of FRS No. 5 and earthen berm to the south. Numerous clusters of lithic debitage were also identified along the eastern extent of the dam and north-to-south berm to the east.

Each of these archeological sites has been impacted from the construction and continued use of the dam facilities, erosion and natural weathering, and the site components were found to be resting on the disturbed and eroded surfaces or within very shallow or severely disturbed soils. Given the severe disturbances of the site settings and based on field results, these sites do not exhibit integrity and are therefore not likely to yield information important to prehistory. AECOM recommends that the portions of these sites within the Study Area are Not Eligible for listing in the NRHP and do not merit designation as SALs. No further investigations are recommended for these sites within the Study Area.

Historic Resource 001 (FRS No. 4) and Historic Resource 002 (FRS No. 5) are single purpose dams that were constructed in 1962 and 1963, respectively, as Significant Hazard dams in the Kickapoo Creek watershed. Although the resources retain integrity, their association with flood control development or agriculture in the Kickapoo Creek watershed is not sufficient for NRHP-listing as there are other examples of these types of resources in Coke County, with similar historical context. A livestock shelter and associated corral (Resource 003), were also identified. Following review by an architectural historian, Historic Resources 001, 002, and 003 do not meet the NRHP criteria of eligibility and are therefore recommended as Not Eligible for listing in the NRHP or for designation as a SAL.

Four prehistoric isolated finds (IF-1 through IF-4) were also identified. IF-1 was located within the FRS No. 4 Study Area in ST-5. Two tertiary flakes were recovered from 0-20 cmbs. IF-2 was located approximately 20 m south of ST-63 within the Study Area of FRS No. 5 and consists of the surface find of a chert graver and tertiary flake. IF-3, a single tertiary flake, was identified approximately 17 m south of ST-58, on the surface near the northern extent of the dam berm and adjacent to the two-track road paralleling the Study Area. IF-4 consists of a single tertiary flake recovered from ST-56 (0-14 cmbs) on the western base of the artificial berm along the northern extension of the Study Area. Each of these isolated finds is recommended as Not Eligible for the NRHP or for SAL designation, and no further work is recommended.

Based on the geomorphological assessment, it was determined that each Study Area exhibits low potential to contain deeply buried and intact archeological deposits. No deep impacts are currently anticipated at this time. No backhoe trenching is recommended.

Based on the results of the survey, AECOM recommends future rehabilitation efforts within the Study Area at FRS No. 4 and FRS No. 5 should have No Effect on properties included in, or eligible for inclusion in, the NRHP, or that merit designation as SALs, and construction can proceed without further investigations. If the dimensions of the Project area change, additional archeological and historical investigations may be warranted.

In the event that previously undiscovered sites are found during construction, appropriate actions should be taken in accordance with the Prototype Programmatic Agreement between the USDA, Texas NRCS State Office, and the THC, as well as the National Programmatic Agreement among NRCS, the National Conference of SHPOs, and the Advisory Council on Historic Preservation, and NRCS General Manual 420, Part 401 guidance.

If any prehistoric or historic human remains or unmarked burials are encountered at any point during construction, the area of the remains should be avoided until a qualified person, as defined by §711.0105(a) under the Texas Health and Safety Code, can determine the status of the remains. Any area determined to contain the intentional burial of the remains is considered a cemetery under current Texas law. Cemeteries are protected under provisions of the Texas Health and Safety Code in Chapters 711-715 (Title 13, § 2, Chapter 22 of the TAC, and in Section 28.03(f) of the Penal Code. All cemeteries are protected and cannot be disturbed. The Texas Penal Code provides that intentional damage or destruction inflicted on a human burial site is a state jail felony. If a cemetery is identified in the Project APE, all work in the area of the discovery must cease and the THC must be notified by contacting the Archeology Division at (512) 463-6096. Following consultation with the THC, a treatment or avoidance plan would be developed and implemented.

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APPENDIX A: SHOVEL TEST DATA

Kickapoo FRS 4

Shovel Test	Depth (cm)	Matrix Description	Date	Site No.	Cultural Materials
1	50	0-20 cm: 5YR 5/4 sand 30-40 cm: 5YR 5/4 sandy loam 40-50 cm: 5YR 4/4 sandy clay loam	4/9/2021	-	None
2	34	0-29 cm: 5YR 4/6 sandy loam 19-34 cm: 5YR 5/4 sandy clay	4/9/2021	-	None
3	29	0-24 cm: 5YR 4/6 sandy loam 24-29 cm: 5YR 5/4 sandy clay	4/9/2021	-	None
4	32	0-22 cm: 5YR 5/4 sandy loam; 10% gravel/cobbles 22-32 cm: 5YR 4/4 sandy clay loam; 5% gravel/cobbles	4/9/2021	-	None
5	30	0-25 cm: 5YR 5/4 sandy loam 25-30 cm: 5YR 4/4 sandy clay loam	4/9/2021	IF-1	2 tertiary flakes 0-20 cmbs
5+15W	22	0-13 cm: 5YR 5/4 sandy loam 13-22 cm: 5YR 4/4 sandy clay loam	4/11/2021	-	None
5+30W	30	0-14 cm: 5YR 5/4 sandy loam 14-30 cm: 5YR 4/4 sandy clay loam	4/11/2021	-	None
5+15N	27	0-17 cm: 5YR 5/3 sandy loam 17-27 cm: 5YR 4/6 sandy clay loam	4/11/2021	-	None
5+30N	35	0-25 cm: 5YR 5/4 sandy loam 25-35 cm: 5YR 4/4 sandy clay loam	4/11/2021	-	None
5+15S	20	0-17 cm: 5YR 4/6 sandy loam 17-20 cm: 5YR 4/4 sandy clay	4/11/2021	-	None
5+30S	35	0-25 cm: 5YR 4/6 sandy loam 25-35 cm: 5YR 4/4 sandy clay	4/11/2021	-	None
5+15E	25	0-21 cm: 5YR 4/6 sandy loam 21-25 cm: 5YR 4/4 sandy clay	4/11/2021	-	None
5+30E	30	0-16 cm: 5YR 4/4 sandy clay loam 16-30 cm: 5YR 4/4 sandy clay	4/11/2021	-	None
6	42	0-31 cm: 5YR 4/6 sandy loam 31-42 cm: 5YR 5/4 sandy clay	4/9/2021	-	None
7	18	0-15 cm: 5YR 4/6 sandy loam 15-18 cm: 5YR 5/4 sandy clay	4/9/2021	-	None
8	40	0-32 cm: 5YR 5/4 sandy loam 32-40 cm: 5YR 4/4 sandy clay loam	4/10/2021	-	None
9	20	0-20 cm: 5YR 4/4 sandy clay loam	4/9/2021	-	None
10	20	0-17 cm: 5YR 4/6 sandy loam 17-20 cm: 5YR 5/4 sandy clay	4/9/2021	-	None

Shovel Test	Depth (cm)	Matrix Description	Date	Site No.	Cultural Materials
11	32	0-22 cm: 5YR 5/4 sandy loam 22-32 cm: 5YR 4/4 sandy clay loam	4/10/2021	-	None
12	25	0-20 cm: 5YR 5/4 sandy loam 20-25 cm: 5YR 4/4 sandy clay loam	4/9/2021	-	None
13	80	0-20 cm: 5YR 5/4 sandy loam; 10% gravel 20-80 cm: 5YR 4/4 sandy loam; 10% gravel	4/10/2021	41CK334	1 tertiary flake 0-20 cmbs; 1 modified flake, 2 secondary flakes, 1 tertiary flake 20-40 cmbs
13+30NE	80	0-23 cm: 5YR 5/4 sandy loam; 1% gravel 23-48 cm: 5YR 4/4 sandy loam; 5% gravel 48-80 cm: 5YR 5/4 loamy sand; 10% gravel	4/10/2021	41CK334	1 secondary flake 0-10 cmbs
13+45NE	60	0-22 cm: 5YR 5/4 sandy loam; 1% gravel 22-60 cm: 5YR 4/4 sandy clay loam; 1% gravel	4/10/2021	-	None
13+30SW	80	0-37 cm: 5YR 4/6 sandy loam 37-80 5YR 4/4 sandy loam	4/11/2021	41CK334	1 tertiary flake 50-60 cmbs
13+45SW	80	0-28 cm: 5YR 4/6 sandy loam 28-80 cm: 5YR 4/4 sandy loam	4/11/2021	-	None
13+60SW	20	0-18 cm: 5YR 4/4 sandy loam 18-20 cm: 5YR 4/3 sandy clay	4/11/2021	-	None
14	28	0-24 cm: 5YR 4/4 sandy clay 24-28 cm: 5YR 5/4 sandy clay	4/9/2021	-	None
15	32	0-13 cm: 5YR 5/4 sandy loam 13-27 cm: 5YR 5/3 sandy loam 27-32 cm: 5YR 3/3 sandy clay loam	4/10/2021	-	None
16	28	0-25 cm: 5YR 4/6 sandy loam 25-28 cm: 5YR 4/4 sandy clay	4/9/2021	-	None
17	35	0-14 cm: 5YR 5/4 sandy loam; 1% gravel 14-25 cm: 5YR 5/4 sandy loam; 1% gravel 25-35 cm: 5YR 4/4 sandy clay loam; 1% gravel	4/10/2021	-	None
18	100	0-27 cm: 5YR 5/4 sandy loam; 1% gravel 27-32 cm: 5YR 5/6 sand; 1% gravel 32-55 cm: 5YR 4/4 sandy loam; 1% gravel 55-100 cm: 5YR 2.5/2 sandy loam; 2% gravel	4/9/2021	-	None

Shovel Test	Depth (cm)	Matrix Description	Date	Site No.	Cultural Materials
19	30	0-23 cm: 5YR 5/4 sandy loam; 1% gravel 23-30 cm: 5YR 4/4 sandy loam; 1% gravel/calcium carbonate	4/9/2021	-	None
20	42	0-38 cm: 5YR 4/6 sandy loam 38-42 cm: 5YR 5/4 sandy clay	4/9/2021	-	None
21	100	0-31 cm: 5YR 4/3 sandy clay 31-100 cm: 5YR 4/4 sandy loam	4/9/2021	-	None
22	30	0-18 cm: 5YR 5/4 sandy loam 18-23 cm: 5YR 5/4 sandy loam 23-30 cm: 5YR 4/4 sandy clay loam	4/10/2021	-	None
23	100	0-28 cm: 5YR 5/4 sandy loam 28-43 cm: 5YR 5/4 sandy loam; 1% calcium carbonate 43-100 cm: 5YR 5/4 sand w/ 5YR 4/4; lamellae bands	4/9/2021	-	None
24	18	0-15 cm: 5YR 4/6 sandy loam 15-18 cm: 5YR 4/4 sandy clay	4/10/2021	-	None
25	20	0-20 cm: 5YR 5/6 sandy clay loam	4/9/2021	-	None
26	8	0-8 cm: 5YR 4/6 sandy loam; 20% gravel	4/10/2021	-	None
27	20	0-14 cm: 5YR 5/4 sandy loam 14-20 cm: 5YR 4/4 sandy clay loam	4/9/2021	41CK333	None
28	21	0-16 cm: 5YR 5/4 sandy loam 16-21 cm: 5YR 4/4 sandy clay loam; 5% gravel	4/9/2021	41CK333	None
29	16	0-14 cm: 5YR 5/6 sandy loam 14-16 cm: 5YR 5/4 sand	4/9/2021	41CK333	None
30	10	0-8 cm: 5YR 4/6 sandy loam 8-10 cm: 5YR 4/4 sandy clay	4/10/2021	-	None
31	28	0-25 cm: 5YR 4/6 sandy loam 25-28 cm: 5YR 4/4 sandy clay	4/10/2021	-	None
32	15	0-15 cm: 5YR 4/3 sandy loam 15 cm: bedrock	4/10/2021	41CK333	None
32+15W	40	0-32 cm: 5YR 5/4 sandy loam; 2% gravel 32-40 cm: 5YR 4/4 sandy loam; 2% gravel	4/11/2021	41CK333	None
32+25W	13	0-13 cm: 5YR 5/4 loamy sand; 50% gravel/cobbles 13 cm: bedrock	4/11/2021	41CK333	None
32+15S	11	0-11 cm: 5YR 5/4 loamy sand	4/11/2021	41CK333	None
32+30S	6	0-6 cm: 5YR 4/6 sandy loam	4/11/2021	41CK333	None

Shovel Test	Depth (cm)	Matrix Description	Date	Site No.	Cultural Materials
32+15N	34	0-34 cm: 5YR 5/6 sandy loam	4/11/2021	41CK333	None
33	10	0-10 cm: 5YR 5/6 sand; 2% gravel	4/9/2021	41CK333	None
34	11	0-11 cm: 5YR 4/4 sandy loam; 30% gravel/cobbles 11 cm: bedrock	4/10/2021	41CK333	1 primary flake 0-11 cmbs
35	12	0-12 cm: 5YR 4/6 sandy loam; 20% gravel	4/10/2021	41CK333	None
36	33	0-30 cm: 5YR 4/6 sandy loam 30-33 cm: 5YR 5/4 sandy clay	4/10/2021	41CK333	None
37	100	0-32 cm: 5YR 4/6 sandy loam 32-48 cm: 5YR 5/4 sandy loam 48-100 cm: 5YR 4/4 sand	4/10/2021	41CK333	None
38	30	0-27 cm: 5YR 4/6 sandy loam 27-30 cm: 5YR 4/4 sandy clay loam	4/10/2021	41CK333	None
39	28	0-18 cm: 5YR 5/4 sandy loam; 5% gravel 18-28 cm: 5YR 4/4 sandy loam 10% gravel	4/10/2021	41CK333	None
40	12	0-12 cm: 5YR 4/5 sandy loam; 30% gravel 12 cm: bedrock	4/10/2021	41CK333	None
41	10	0-10 cm: 5YR 5/4 sand; 60% gravel/cobbles	4/10/2021	41CK333	None
42	12	0-12 cm: 5YR 5/4 sandy loam; 20% gravel 12 cm: bedrock	4/10/2021	41CK333	None
43	20	0-20 cm: 5YR 5/3 sandy loam; 50% gravel/cobbles	4/10/2021	41CK333	None
44	24	0-24 cm: 5YR 4/4 sandy loam; 20% gravel/cobbles 24 cm: bedrock	4/10/2021	41CK333	None
45	34	0-20 cm: 5YR 5/3 sandy loam; 15% sandstone 20-34 cm: 5YR 4/6 sandy loam; 30% sandstone	4/10/2021	41CK333	None
46	5	0-5 cm: 5YR 4/6 sand; 25% cobbles 5 cm: bedrock	4/10/2021	41CK333	None
47	6	0-6 cm: 5YR 5/4 sandy loam	4/10/2021	41CK333	None
48	15	0-15 cm: 5YR 5/6 sandy loam	4/10/2021	41CK333	None
49	25	0-18 cm: 5YR 5/4 sandy loam; 15% gravel 18-25 cm: 5YR 4/4 sandy loam; 40% gravel	4/10/2021	41CK333	None

Shovel Test	Depth (cm)	Matrix Description	Date	Site No.	Cultural Materials
50	43	0-29 cm: 5YR 4/6 sandy loam 29-40 cm: 5YR 4/4 sandy loam 40-43 cm: 5YR 5/4 sandy clay	4/10/2021	41CK333	None
51	15	0-13 cm: 5YR 4/6 sandy loam 13-15 cm: 5YR 4/4 sandy clay	4/10/2021	41CK333	None
52	55	0-33 cm: 5YR 5/6 sandy loam 33-55 cm: 5YR 5/4 sand	4/10/2021	41CK333	None
53	45	0-29 cm: 5YR 5/6 sandy loam 29-45 cm: 5YR 5/4 sand	4/10/2021	41CK333	None
J-01	36	0-26 cm: 5YR 5/4 sandy loam 26-36 cm: 5YR 4/4 sandy clay loam	4/11/2021	41CK333	None
J-02	28	0-18 cm: 5YR 5/4 sandy loam 18-28 cm: 5YR 4/4 sandy clay loam; 3% gravel	4/11/2021	41CK333	None
J-03	65	0-32 cm: 5YR 5/4 sandy loam 32-55 cm: 5YR 5/4 loamy sand 55-65 cm: 5YR 4/4 sandy clay loam	4/11/2021	41CK333	None
J-04	40	0-20 cm: 5YR 5/4 sandy loam 20-40 cm: 5YR 4/6 sandy loam; 10% calcium carbonate	4/11/2021	41CK333	None

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Shovel Test	Depth (cm)	Matrix Description	Date	Site No.	Cultural Materials
1	30	0-20 cm: 5YR 4/6 sandy loam 20-30 cm: 5YR 4/4 sandy clay loam	4/8/2021	-	None
2	35	0-20 cm: 5YR 5/4 sandy loam 20-32 cm: 5YR 4/4 sandy loam 32-35 cm: 5YR 4/3 sandy clay loam	4/8/2021	-	None
3	24	0-21 cm: 5YR 4/6 sandy loam 21-24 cm: 5YR 5/4 sandy clay	4/8/2021	-	None
4	15	0-12 cm: 5YR 4/6 sandy loam 12-15 cm: 5YR 5/4 sandy clay	4/8/2021	-	None
5	20	0-16 cm: 5YR 4/6 sandy loam 16-20 cm: 5UR 5/4 sandy clay	4/8/2021	-	None
6	35	0-35 cm: 5YR 5/4 sandy loam 35+ cm: 5YR 4/3 sandy clay loam	4/8/2021	-	None
7	25	0-20 cm: 5YR 5/4 sandy loam 20-25 cm: 5YR 4/3 sandy clay loam	4/8/2021	-	None
8	20	0-15 cm: 5YR 5/4 sandy loam 15-20 cm: 5YR 4/3 sandy clay loam	4/8/2021	-	None
9	25	0-20 cm: 5YR 5/4 sandy loam; 20% wood 20-25 cm: 5YR 4/4 sandy clay loam	4/8/2021	-	None
10	24	0-20 cm: 5YR 4/6 sandy loam 20-24 cm: 5YR 5/4 sandy clay	4/8/2021	-	None
11	16	0-12 cm: 5YR 4/6 sandy loam 12-16 cm: 5YR 5/4 sandy clay	4/8/2021	-	None
12	20	0-16 cm: 5YR 4/6 sandy loam 16-20 cm: 5YR 5/4 sandy clay	4/8/2021	-	None
13	24	0-19 cm: 5YR 4/6 sandy loam 19-24 cm: 5YR5/4 sandy clay	4/8/2021	-	None
14	25	0-23 cm: 5YR 5/4 sandy loam 23-25 cm: 5YR 4/4 sandy clay loam	4/8/2021	-	None
15	39	0-29 cm: 5YR 5/4 sandy loam 29-39 cm: 5YR 4/4 sandy loam	4/8/2021	-	None
16	23	0-19 cm: 5YR 5/4 sandy loam 19-23 cm: 5YR 4/4 sandy clay loam	4/8/2021	-	None
17	45	0-22 cm: 5YR 5/3 sandy loam 22-45 cm: 5YR 5/4 sandy clay loam; 1% gravel	4/8/2021	-	None
18	16	0-14 cm: 5YR 4/6 sandy loam 14-16 cm: 5YR 5/4 sandy clay	4/8/2021	-	None
19	14	0-10 cm: 5YR 4/6 sandy loam 10-14 cm: 5YR 5/4 sandy clay	4/8/2021	-	None

Shovel Test	Depth (cm)	Matrix Description	Date	Site No.	Cultural Materials
20	22	0-18 cm: 5YR 4/6 sandy loam 18-22 cm: 5YR 5/4 sandy clay	4/8/2021	-	None
21	60	0-31 cm: 5YR 4/6 sandy loam 31-60 5YR 4/6 sand	4/8/2021	-	None
22	45	0-31 cm: 5YR 5/4 sandy loam 31-45 cm: 5YR 4/4 sandy loam; 10% gravel	4/8/2021	-	None
23	22	0-19 cm: 5YR 4/6 sandy loam 19-22 cm: 5YR 5/4 sandy clay	4/8/2021	-	None
24	15	0-13 cm: 5YR 4/6 sandy loam 13-15 cm: 5YR 5/4 sandy clay	4/8/2021	41CK335	None
24+15N	53	0-15 cm: 5YR 5/6 sandy loam 15-53 5YR 4/4 sandy loam 53+cm: 5YR 4/4 sandy clay	4/12/2021	41CK335	None
24+25E	35	0-25 cm: 5YR 4/6 sandy loam; 3% gravel 25-35 cm: 5YR 4/4 sandy clay	4/12/2021	41CK335	None
25	40	0-22 cm: 5YR 4/6 sandy loam 22-40 cm: 5YR 4/4 coarse sand	4/8/2021	41CK335	None
26	20	0-20 cm: 5YR 4/4 clay loam	4/8/2021	41CK335	None
27	20	0-20 cm: 5YR4/4 sandy clay mottled with 5YR 2/2 sandy clay and 5YR 5/6 sandy clay	4/8/2021	41CK335	None
28	10	0-10 cm: 5YR 4/4 clay	4/8/2021	41CK335	None
29	20	0-20 cm: 5YR 4/4 sandy clay loam	4/8/2021	41CK335	None
30	15	0-15 cm: 5YR 5/4 sandy loam; 20% sandstone	4/8/2021	41CK335	None
31	30	0-27 cm: 5YR5/4 sandy loam; 440% sandstone 27-30 cm: 5YR 4/4 sandy clay loam; 10% sandstone	4/8/2021	41CK335	None
32	65	0-40 cm: 5YR 5/4 sandy loam 40-65 cm: 5YR 5/6 sand	4/8/2021	41CK335	None
33	23	0-18 cm: 5YR 5/4 sandy loam 18-23 cm: 5 YR 4/4 sandy clay loam	4/8/2021	41CK335	1 flake 2 m E
33+15N	20	0-8 cm: 5YR 5/4 sandy loam; 2% cobbles 8-15 cm: 5YR 4/4 sandy clay loam; 10% cobbles 15-20 cm: 5YR 4/3 sandy clay loam; 10% cobbles	4/12/2021	41CK335	None

Shovel Test	Depth (cm)	Matrix Description	Date	Site No.	Cultural Materials
33+30N	18	0-13 cm: 5YR 5/4 sandy loam; 1% gravel 13-18 cm: 5YR 4/4 sandy clay loam; 1% gravel	4/12/2021	41CK335	None
33+15W	30	0-19 cm: 5YR 5/4 sandy loam; 1% gravel 19-30 cm: 5YR 4/4 sandy clay loam; 1% gravel	4/12/2021	41CK335	None
33+30W	27	0-18 cm: 5YR 5/4 sandy loam 18-27 cm: 5YR 4/4 sandy clay loam	4/12/2021	41CK335	None
33+15S	25	0-25 cm: 5YR 4/6 sandy loam; 50% gravel	4/12/2021	-	None
33+30S	40	0-40 cm: 5YR 4/4 sandy clay	4/12/2021	-	None
34	35	0-30 cm: 5YR 5/4 sando loam 30-35 cm: 5YR 4/6 sandy clay loam	4/8/2021	-	None
35	30	0-20 cm: 5YR 5/6 sandy loam 20-30 cm: 5YR 4/6 sandy loam; 30% gravel/cobbles	4/8/2021	41CK335	Unifacially modified flake 0.5 m W
35+30E	50	0-20 cm: 5YR 4/4 sandy loam; 2% gravel 20-40 cm: 5YR 5/6 sandy loam; 2% gravel 40-50 cm: 10YR 5/6 clay	4/12/2021	41CK335	None
36	13	0-11 cm: 5YR 4/6 sandy loam 11-13 cm: 5YR 5/4 sandy clay	4/8/2021	-	None
37	34	0-29 cm: 5YR 4/4 sandy loam 29-34 cm: 5YR 5/4 sandy clay	4/8/2021	-	None
38	18	0-18 cm: 5YR 4/6 sandy loam	4/8/2021	41CK335	None
38+25N	50	0-10 cm: 5YR 4/4 sandy loam; 2% gravel 10-40 cm: 5YR 5/6 sandy loam; 2% gravel 40-50 cm: 10YR 5/6 clay	4/12/2021	41CK335	None
38+20E	20	0-20 cm: 5YR 4/6 sandy loam; 10% gravel 20 cm: bedrock	4/12/2021	41CK335	None
39	19	0-19 cm: 5YR 5/6 sandy loam; 40% gravel/cobbles 19 cm: bedrock	4/8/2021	-	None
40	49	0-15 cm: 5YR 5/4sandy loam 15-39 cm: 5YR 5/4 sand 39-49 cm: 5YR 4/5 sandy clay	4/8/2021	-	None
41	22	0-18 cm: 5YR 4/6 sandy loam 18-22 cm: 5YR 5/4 sandy clay	4/8/2021	-	None

Shovel Test	Depth (cm)	Matrix Description	Date	Site No.	Cultural Materials
42	12	0-8 cm: 5YR 4/6 sandy loam 8-12 cm: 5YR 5/4 sandy clay	4/8/2021	-	None
43	26	0-18 cm: 5YR 5/4 sandy loam; 1% gravel 18-26 cm: 5YR 4/4 sandy clay loam; 1% gravel	4/12/2021	41CK335	None
44	19	0-14 cm: 5YR 5/4 sandy loam; 10% gravel 14-19 cm: 5YR 4/4 sandy clay loam; 30% gravel	4/12/2021	41CK335	None
45	9	0-8 cm: 5YR 5/4 sandy loam 8-9 cm: 5YR 4/4 sandy clay loam	4/12/2021	41CK335	None
46	15	0-10 cm: 5YR 5/4 sandy loam; 2% gravel 10-15 cm: 5YR 4/4 sandy clay loam; 2% gravel	4/12/2021	41CK335	None
47	20	0-16 cm: 5YR 5/4 sandy loam; 20% gravel 16-20 cm: 5YR 4/4 sandy clay loam; 20% gravel	4/12/2021	41CK335	None
48	30	0-28 cm: 5YR 5/4 sandy loam; 3% gravel 28-30 cm: 5YR 4/4 sandy clay loam	4/12/2021	41CK335	None
49	30	0-23 cm: 5YR 5/4 sandy loam 23-30 cm: 5YR 4/4 sandy clay loam	4/12/2021	41CK335	None
50	25	0-15 cm: 5YR 5/4 sandy loam 15-25 cm: 5YR 4/4 sandy clay loam	4/12/2021	41CK335	None
51	11	0-11 cm: 5YR 5/4 sandy loam	4/12/2021	-	None
52	25	0-15 cm: 5YR 5/4 sandy loam 15-25 cm: 5YR 4/4 sandy clay loam	4/12/2021	-	None
53	10	0-10 cm: 5YR 5/4 sandy loam	4/12/2021	-	None
54	22	0-13 cm: 5YR 5/4 sandy loam 13-22 cm: 5YR 4/4 sandy clay loam; rock and calcium carbonate	4/12/2021	-	None
55	16	0-9 cm: 5YR 5/4 sandy loam; 1% gravel 9-16 cm: 5YR 4/4 sandy loam; 1% gravel	4/12/2021	-	None
56	24	0-14 cm: 5YR 5/4 sandy loam 14-24 cm: 5YR 4/4 sandy clay loam	4/12/2021	IF-4	1 tertiary flake (0-14 cmbs)
56+15S	30	0-21 cm: 5YR 5/6 sandy loam; 1% gravel 21-30 cm: 5YR 4/4 sandy clay loam; 1% gravel	4/13/2021	-	None

Shovel Test	Depth (cm)	Matrix Description	Date	Site No.	Cultural Materials
56+30S	29	0-19 cm: 5YR 5/4 sandy loam; 1% gravel 19-29 cm: 5YR 4/4 sandy clay loam; 1% gravel	4/13/2021	-	None
56+15N	37	0-37 cm: 5YR 4/6 sandy clay loam	4/13/2021	-	None
56+30N	30	0-17 cm: 5YR 5/6 sandy loam; 1% gravel 17-30 cm: 5YR 4/4 sandy clay loam; 1% gravel	4/13/2021	-	None
57	27	0-25 cm: 5YR 5/4 sandy loam 25-27 cm: 5YR 4/4 sandy clay loam	4/12/2021	-	None
58	27	0-22 cm: 5YR 5/4 sandy loam 22-27 cm: 5YR 4/4 sandy clay loam	4/12/2021	-	None
59	25	0-19 cm: 5YR 5/4 sandy loam 19-25 5YR 4/4 sandy clay loam	4/12/2021	-	None
60	60	0-25 cm: 5YR 4/6 sandy loam 25-60 cm: 5YR 4/4 sandy clay	4/13/2021	-	None
61	40	0-30 cm: 5YR 4/6 sandy loam 30-40 cm: 5YR 4/4 sandy clay	4/13/2021	-	None
62	29	0-19 cm: 5YR 5/4 sandy loam; 5% gravel 19-29 cm: 5YR 4/4 sandy clay loam; 5% gravel	4/13/2021	-	None
63	15	0-9 cm: 5YR 5/4 sandy loam 9-15 cm: 5YR 4/4 sandy clay loam	4/13/2021	-	None
64	20	0-14 cm: 5YR 5/4 sandy loam 14-20 cm: 5YR 4/4 sandy clay loam	4/13/2021	-	None
IF-2 +15S	23	0-14 cm: 5YR 5/4 sando loam 14-23 cm: 5YR 4/4 sandy clay loam	4/13/2021	-	None
IF-2 +30S	24	0-24 cm: 5YR 4/6 sandy loam 24+ cm: 5YR 4/4 sandy clay	4/13/2021	-	None
IF-2 +30N	28	0-18 cm: 5YR 5/4 sandy loam 18-28 cm: 5YR 4/4 sandy clay loam	4/13/2021	-	None
IF-2 +15W	20	0-12 cm: 5YR 5/4 sandy loam 12-20 cm: 5YR 4/4 sandy clay loam	4/13/2021	-	None
J-01	45	0-31 cm: 5YR 5/4 sandy loam 31-45 cm: 5YR 4/4 sandy loam; 10% gravel; lens of 10YR 3/1 12 cmbs	4/8/2021	-	None

E-7 Kickapoo Creek FRS No. 4 – Preliminary Geologic Investigation and Soil Mechanics Report

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If you would like to request this document, please contact Mark Northcut, Natural Resources Planning Manager, USDA/NRCS, 101 South Main, Temple, Texas 76501 (254-742-9824).

E-8 Kickapoo Creek FRS No. 4 – Technical Memorandum, Preliminary Geotechnical Recommendations for SITES Parameters

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E-9 Kickapoo Creek FRS No. 5 – Preliminary Geologic Investigation Report and Soil Mechanics Report

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