APPENDIX D

Stream Condition Assessment Report

Stream Condition Assessment Report for the Dow Harris Reservoir Expansion Project in Brazoria County, Texas

USACE File No. SWG-2016-01027

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PREPARED FOR

Dow Chemical Company

PREPARED BY

SWCA Environmental Consultants

STREAM CONDITION ASSESSMENT REPORT FOR THE DOW HARRIS RESERVOIR EXPANSION PROJECT IN BRAZORIA COUNTY, TEXAS

Prepared for

Dow Chemical Company
Texas Innovation Center
332 SH 332 E
Lake Jackson, Texas 77566

Prepared by

SWCA Environmental Consultants
10245 W. Little York Road, Suite 600
Houston, Texas 77040
(281) 617-3217
www.swca.com

SWCA Project No. 52827

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1 INTRODUCTION

At the request of Dow Chemical Company, SWCA Environmental Consultants (SWCA) conducted Level I and Level II Stream Condition Assessments per the guidelines of the U.S. Army Corps of Engineers (USACE) Galveston District for the proposed Dow Harris Reservoir Expansion Project (Project), an approximately 2,529-acre tract in Brazoria County, Texas. The tract is 2,300 feet northwest of Otey, Texas, and is 4.28 miles south of the intersection of Farm-to-Market Road (FM) 521 and FM 34 (Figure 1, Appendix A). The site is located inside the U.S. Geological Survey (USGS) 7.5-minute quadrangles for Otey, Texas. The approximate center of the project is located at latitude 29.268˚ north and longitude 95.550˚ west (Figure 1, Appendix A). The tract extends between the Brazos River and Oyster Creek. Please refer to the figures in Appendix A for the location and setting of the survey area.

To facilitate the increasing water demands of their Texas Operations facilities in Freeport, Texas, Dow Chemical Company plans to expand their existing reservoir impoundment complex that currently lies immediately south of the project area. The project area is adjacent to both the Brazos River and Oyster Creek and would be used for surface water diversion. Additional reservoir facilities, including intake and pump stations, inlets, outlets, and spillways would be constructed for the proposed Project.

SWCA collected data for a Level I Stream Condition Assessment on 31 ephemeral channels while data for the Level II Stream Condition Assessment was collected on the three intermittent channels, (i.e., SA001, SA003, and SX014) within the project area on September 17, 20, 23, 24, and 25, 2019.

2 METHODS

As described by USACE guidelines, the fundamental unit for evaluating a stream's condition is the stream assessment transect (USACE 2013, 2014). To simplify the process of establishing transects, a fixed transect length of 350 feet was placed within set intervals along the assessed reaches. Table 1 provides the number of transects evaluated per channel under the Level I Stream Condition Assessment, while Table 2 provides the number of transects evaluated per channel under the Level II Stream Condition Assessment. Please refer to the Vicinity Map (Figure 1, Appendix A) and Stream Assessment Maps (Figures 2, 3, and 4, Appendix A) for a depiction of the project area and the channels being assessed under the Level I Stream Condition and Level II Stream Condition Assessments (Figures 3 and 4, Appendix A, respectively).

Each transect was evaluated under the Level I Stream Condition Assessment and scored based on the following criteria (USACE 2013):

- Channel Condition (CV) – describes the stream channel's evolutionary process and stability.
- Riparian Buffer (BV) – qualifies the vegetation community's ability to prevent the nutrients from entering the channel system.
- Aquatic Use (UV) – examines surface water health and quality.
- Channel Alteration (AV) – assesses direct impacts to the channel from anthropogenic sources that may disrupt the channel's natural conditions.

The Level II Stream Assessment splits the UV criteria into two parameters which are used to indicate long-term water quality and are only assessed within perennial pools, perennial streams, and wadeable rivers (USACE 2014). These parameters include the following:

- Rapid In-Stream Macroinvertebrate Observation (MV) – evaluates the tolerances of benthic macroinvertebrate species as a surrogate for water quality.

- Regionalized Index of Biotic Integrity for Fish (FV) – quantifies the fish community's biological integrity.

The Level I Stream Assessment assigns a score for each criterion at each transect ranging from Severe (1) to Optimal (5) based on direct visual observation. The Level I Stream Assessment Data Forms are provided in Appendix B. A summary of the results is provided in Table 1 following the Results discussion.

The Level II Stream Assessment assigns a score for each criterion at each transect as well; however, these ranges vary, as listed below.

- The CV ranges from Extreme (1) to Very Low (6)
- The BV ranges from Severe (1) to Optimal (5)
- The AV ranges from Severe (1) to Negligible (5)
- The MV ranges from Severe (1) to Optimal (5)
- The FV ranges from Severe (1) to Exceptional (5)

The Level II Stream Assessment Data Forms are provided in Appendix C. A summary of the results is provided in Table 2 following the results discussion.

3 RESULTS

3.1 Level I Stream Condition Assessment

3.1.1 Channel Condition (CV)

The Level I Stream Condition Assessment determines the CV score by analyzing the evolutionary process of the cross section and to make a correlation to the current state of stream stability, whether it be degrading, aggrading, healing, or stable. The CV scores ranged from Severe (1.00) to Optimal (5.00) throughout all the transects for the assessed channels. As most of the channels are ephemeral agricultural ditches manipulated into depressional areas within upland areas, evidence of artificial widening is present.

3.1.2 Riparian Buffer (BV)

The Level I Stream Condition Assessment BV score considers the qualitative evaluation of the land cover types surrounding the assessed transects at 100 feet from the ordinary high watermark along the transects' left and right banks. This criteria reflects the channel's effectiveness of removing nutrients by influencing retention through plant sequestration or removal through microbial denitrification. The Level I Stream Condition Assessment emphasizes the benefit of wetland areas with unmaintained native woody vegetation within the riparian buffer areas. The BV scores ranged from Severe (1.00) to Low (4.38) throughout all the transects for the assessed channels. The majority of the riparian buffers consist of a mixed land use between herbaceous land maintained by grazing and conventional row crops. However, areas dominated by woody vegetation also parallel some assessed channels (i.e., SB003).

3.1.3 Aquatic Use (UV)

Under the Level I Stream Condition Assessment, the UV score is based off of the Texas Surface Water Quality Standards (TSWQS) as defined by the Texas Commission on Environmental Quality (TCEQ) (TCEQ 2018). However, for channels which are not classified in the TSWQS, the UV score is presumed based on the stream flow type, which is the case for each channel assessed within the project area. The UV scores resulted as Severe (1.00) throughout all the transects for the Level I assessed channels as they were all identified as ephemeral channels.

3.1.4 Channel Alteration (AV)

The AV criteria is considerably similar in both the Level I and Level II Stream Condition Assessments, with the only difference being the split between the resulting score to the percentage of impact along the transects as well as the resulting score labels. The AV scores ranged from Severe (1.00) to Optimal (5.00) throughout all the transects for the assessed channels. The majority of the channels assessed exhibit evidence of past alteration through channelization and impacts by culverts and hoof shear, while some also exhibit stream stability and recovery from these impacts. The variation in AV scores primarily results in the percentage of the channel with these impacts, where the higher the percentage of impacted area, the lower the AV score.

3.2 Level II Stream Condition Assessment

3.2.1 Channel Condition (CV)

According to the *Galveston District Interim Level 2- Stream Conditional Assessment Procedur*e (USACE 2014):

> "…[CV] is assessed based on the *A Practical Method of Computing Streambank Erosion Rate* (Rosgen 2001), which involves collecting field data on streambank characteristics to calculate a bank erosion hazard index (BEHI). The BEHI procedure consists of five metrics: 1) bank height ratio; 2) root depth ratio 3) root density, in percent; 4) bank angle, in degrees; and 5) surface protection, in percent. Each of these five metrics are used to compute an erosion risk index, and then the individual erosion risk indices are summed to provide a total erosion risk index for use in identifying the [CV]."

After calculating these metrics, SA003 exhibited a CV of Moderate (4.00). However, the transects within SA001 ranged from High (3.00) to Low (5.00) and SX014 ranged from High (3.00) to Moderate (4.00) as the majority of the transects showed some evidence of alteration but exhibited notable recovery within the banks.

3.2.2 Riparian Buffer (BV)

Under the Level II Stream Condition Assessment, BV is determined similarly to the Level I Stream Condition Assessment criteria except that the Level II assessment considers all native plant species in the community, rather than just the native woody vegetation species within the community. The BV scores ranged from Severe (1.00) to Low-Suboptimal (4.38) across all the transects surveyed. All three assessed channels resulted in an average BV score of Severe to Poor, where SA001 averaged 2.86, SA003 averaged 2.00, and SX014 averaged 1.00. The majority of the riparian buffers consisted of areas dominated by herbaceous plant communities maintained by grazing or conventional row crops; however, the presence of native woody community species varies throughout the project area. Forested wetland areas occur more often along the southwestern portions of the project area, affecting the southern transects of SA001.

3.2.3 Channel Alteration (AV)

The AV criteria is, again, considerably similar in both the Level I and Level II Stream Condition Assessments, with the only difference being the split between the resulting score to the percentage of impact along the transects as well as the resulting score labels. All of the transects assessed varied from scores of Severe (1.00) to Low-Minor (4.00). SA001's transects ranged from Severe (1.00) to Low-Minor (4.00) and averaged at a score of High-Moderate (3.36). SA003's and SX014's transects both ranged from Severe (1.00) to Low-Moderate (2.00) and averaged at a score of Severe (1.67 and 1.87, respectively).

3.2.4 Rapid In-Stream Macroinvertebrate Observation (MV)

The MV assessment evaluates the biological integrity of a channel by rapidly sampling and identifying benthic macroinvertebrate species. The macroinvertebrate population of a channel demonstrates the complexity and extent of the food web as well as documenting the presence of water pollution within the channel, while also being relatively easy to collect via kicknet or snag sampling procedures (USACE 2014). The MV sampling assessment is calculated using the Hilsenhoff Biotic Index (HBI); specifically, by relating the relative abundance of taxa to an assigned pollution tolerance level. The equation to this calculation is:

$$HBI = \sum (t_i \times x_i) \div N$$

where,

t_i = tolerance value for an individual taxon
x_i = number of individuals in that taxon for all samples
N = total number of individuals in all samples

The resulting HBI value determines the MV score for that transect (USACE 2014). The MV scores ranged from Severe (1.00) to Optimal (5.00) throughout all the transects for the assessed waterbodies. The average MV score for SA001 resulted as Poor (2.71), while SA003 and SX014 resulted as Severe (1.17 and 1.07, respectively). Tables D-1–D-3 in Appendix D summarize the macroinvertebrate species count, tolerance values, HBI values, and resulting MV score. Note that certain transects present no collected data as no water was present within the transect. For stream transects lacking water, a score of Severe (1.00) was assumed.

3.2.5 Regionalized Index of Biotic Integrity for Fish (FV)

The FV assessment evaluates the biotic integrity of the fish community present within the channel by calculating the relative abundances of fishes collected via seines, electrofishing, and/or simultaneously collected during the kicknet or snag sampling procedures performed for the MV sampling. Sampling method techniques are described within the *Galveston District Interim Level 2- Stream Conditional Assessment Procedure* (USACE 2014). The results of the In-Stream Fish Observations are available in Tables E-1–E-3 in Appendix E.

After the sampled fish are identified, their aquatic life score is calculated following metrics based on the Level III ecoregion in which they were sampled. The project area is encompassed within the Western Gulf Coastal Plains Level III Ecoregion (Ecoregion 34) (Griffith et al. 2004). Ecoregion 34 provides 11 scoring metrics to assess the channel's fish community, as indicated in Tables F-1–F-3 within Appendix F. The first metric, "Total number of fish species" requires the project area's watershed basin size in square kilometers to determine its scoring criteria (Appendix F). To derive watersheds, SWCA used the "Watershed" tool found in the ArcGIS Ready-To-Use online toolbox within the hydrology toolset (ESRI

2019). After each transect watershed and species composition is determined, as exhibited within Figure 5 of Appendix A, the MV score is defined (USACE 2014).

The MV scores ranged from Severe (1.00) to Intermediate (3.00) within SA001, while SA003 and SX014 ranged from Severe (1.00) to Limited (2.00). The average FV score for SA001, SA003, and SX014 all resulted as Severe (1.96, 1.17, and 1.07, respectively). As with the benthic macroinvertebrates scores, certain transects present no collected data as no water was present within the transect from which to sample. For stream transects lacking water, a score of Severe (1.00) was assumed.

3.3 Condition Index (CI) and Reach Condition Index (RCI)

The four criteria of the Level I Stream Assessment were used to calculate the Condition Index (CI) for each transect, using the following equation:

$$CI = (CV + BV + UV + AV) \div 4$$

The five criteria of the Level II Stream Assessment were used to calculate the Condition Index (CI) for each transect, using the following equation:

$$CI = (CV + BV + AV + MV + FV) \div 5$$

After the CI was calculated for each transect, the overall Reach Condition Index (RCI) was calculated for the existing and proposed conditions using the following equation:

$$RCI = \left(\sum\nolimits_{n=1}^{Y} CIn\right) \div Y$$

Table 1. Summary of Level I Stream Assessment Data for Channels

Channel ID	Transect	CV	BV	UV	AV	CI	RCI
SB002	1	1.00	2.00	1.00	1.00	1.25	1.250
	2	1.00	2.00	1.00	1.00	1.25	
SB003	1	5.00	3.88	1.00	4.00	3.47	3.240
	2	5.00	3.38	1.00	4.00	3.35	
	3	5.00	4.38	1.00	4.00	3.60	
	4	5.00	3.88	1.00	4.00	3.47	
	5	2.00	4.25	1.00	2.00	2.31	
SB004	1	1.00	2.00	1.00	1.00	1.25	1.250
	2	1.00	2.00	1.00	1.00	1.25	
	3	1.00	2.00	1.00	1.00	1.25	
	4	1.00	2.00	1.00	1.00	1.25	
	5	1.00	2.00	1.00	1.00	1.25	
	6	1.00	2.00	1.00	1.00	1.25	
SB005	1	1.00	2.00	1.00	1.00	1.25	1.270
	2	1.00	2.13	1.00	1.00	1.28	

Channel ID	Transect	CV	BV	UV	AV	CI	RCI
	3	1.00	2.13	1.00	1.00	1.28	
SB006	1	1.00	2.00	1.00	1.00	1.18	2.215
	2	1.00	1.70	1.00	1.00	1.25	
SB007	1	1.00	2.50	1.00	1.00	1.38	1.380
SB013	1	3.00	1.50	1.00	3.00	2.00	2.130
SB014	1	1.00	1.00	1.00	1.00	1.00	1.071
	2	1.00	1.00	1.00	1.00	1.00	
	3	1.00	1.00	1.00	1.00	1.00	
	4	1.00	1.00	1.00	1.00	1.00	
	5	2.00	1.00	1.00	1.00	1.25	
	6	2.00	1.00	1.00	1.00	1.25	
	7	1.00	1.00	1.00	1.00	1.00	
SC005	1	3.00	1.00	1.00	5.00	2.50	2.500
SC016	1	4.00	3.50	1.00	5.00	3.38	3.380
SD016	1	1.00	2.00	1.00	1.00	2.25	1.250
SD017	1	1.00	2.00	1.00	1.00	1.25	1.250
SX003	1	1.00	2.00	1.00	1.00	1.25	1.256
	2	1.00	2.00	1.00	1.00	1.25	
	3	1.00	2.38	1.00	1.00	1.25	
	4	1.00	2.19	1.00	1.00	1.30	
	5	1.00	2.19	1.00	1.00	1.30	
	6	1.00	2.00	1.00	1.00	1.23	
	7	1.00	1.96	1.00	1.00	1.24	
	8	1.00	1.93	1.00	1.00	1.23	
SX004	1	1.00	2.13	1.00	1.00	1.28	1.287
	2	1.00	2.30	1.00	1.00	1.33	
	3	1.00	2.13	1.00	1.00	1.28	
	4	1.00	2.06	1.00	1.00	1.27	
	5	1.00	2.13	1.00	1.00	1.28	
	6	1.00	2.13	1.00	1.00	1.28	
SX005	1	1.00	2.00	1.00	1.00	1.25	1.250
	2	1.00	2.00	1.00	1.00	1.25	
	3	1.00	2.00	1.00	1.00	1.25	
	4	1.00	2.00	1.00	1.00	1.25	
	5	1.00	2.00	1.00	1.00	1.25	
SX006	1	1.00	2.00	1.00	1.00	1.25	1.250

Channel ID	Transect	CV	BV	UV	AV	CI	RCI
	2	1.00	2.00	1.00	1.00	1.25	
SX007	1	1.00	1.13	1.00	1.00	1.03	1.036
	2	1.00	1.15	1.00	1.00	1.04	
	3	1.00	1.20	1.00	1.00	1.05	
	4	1.00	1.15	1.00	1.00	1.04	
	5	1.00	1.08	1.00	1.00	1.02	
SX008	1	1.00	1.00	1.00	1.00	1.00	1.000
	2	1.00	1.00	1.00	1.00	1.00	
	3	1.00	1.00	1.00	1.00	1.00	
SX009	1	1.00	1.00	1.00	1.00	1.00	1.000
	2	1.00	1.00	1.00	1.00	1.00	
	3	1.00	1.00	1.00	1.00	1.00	
SX010	1	1.00	1.10	1.00	1.00	1.03	1.033
	2	1.00	1.10	1.00	1.00	1.03	
	3	1.00	1.10	1.00	1.00	1.03	
	4	1.00	1.15	1.00	1.00	1.04	
SX011	1	1.00	1.35	1.00	1.00	1.09	1.090
SX012	1	1.00	1.00	1.00	1.00	1.00	1.000
	2	1.00	1.00	1.00	1.00	1.00	
	3	1.00	1.00	1.00	1.00	1.00	
	4	1.00	1.00	1.00	1.00	1.00	
	5	1.00	1.00	1.00	1.00	1.00	
	6	1.00	1.00	1.00	1.00	1.00	
	7	1.00	1.00	1.00	1.00	1.00	
SX013	1	1.00	1.00	1.00	1.00	1.00	1.000
	2	1.00	1.00	1.00	1.00	1.00	
	3	1.00	1.00	1.00	1.00	1.00	
	4	1.00	1.00	1.00	1.00	1.00	
	5	1.00	1.00	1.00	1.00	1.00	
	6	1.00	1.00	1.00	1.00	1.00	
	7	1.00	1.00	1.00	1.00	1.00	
	8	1.00	1.00	1.00	1.00	1.00	
SX015	1	1.00	1.18	1.00	1.00	1.05	1.010
	2	1.00	1.00	1.00	1.00	1.00	
	3	1.00	1.00	1.00	1.00	1.00	
	4	1.00	1.00	1.00	1.00	1.00	
	5	1.00	1.00	1.00	1.00	1.00	
SX016	1	1.00	1.00	1.00	1.00	1.00	1.000

Channel ID	Transect	CV	BV	UV	AV	CI	RCI
SX017	1	1.00	1.00	1.00	1.00	1.00	1.000
	2	1.00	1.00	1.00	1.00	1.00	
	3	1.00	1.00	1.00	1.00	1.00	
	4	1.00	1.00	1.00	1.00	1.00	
SX018	1	1.00	1.00	1.00	1.00	1.00	1.000
	2	1.00	1.00	1.00	1.00	1.00	
	3	1.00	1.00	1.00	1.00	1.00	
	4	1.00	1.00	1.00	1.00	1.00	
SX019	1	1.00	1.25	1.00	1.00	1.00	1.060
	2	1.00	1.25	1.00	1.00	1.00	
	3	1.00	1.25	1.00	1.00	1.00	
	4	1.00	1.25	1.00	1.00	1.00	
SX020	1	1.00	1.20	1.00	1.00	1.05	1.050
SX021	1	2.50	1.00	1.00	1.00	1.38	1.380
SX022	1	1.00	1.00	1.00	1.00	1.00	1.109
	2	1.00	1.00	1.00	1.00	1.00	
	3	1.00	1.00	1.00	1.00	1.00	
	4	1.00	1.00	2.00	1.00	1.25	
	5	1.00	1.25	2.00	1.00	1.31	
	6	1.00	1.25	2.00	1.00	1.31	
	7	1.00	1.00	1.00	1.00	1.00	
	8	1.00	1.00	1.00	1.00	1.00	

CV = Channel Condition

BV = Riparian Buffer

UV = Aquatic Use

AV = Channel Alteration

CI = Condition Index

RCI = Reach Condition Index

Table 2. Summary of Level II Stream Assessment Data for Channels

Channel ID	Transect	CV	BV	AV	MV	FV	CI	RCI
SA001	1	4.00	2.10	4.00	1.00	1.00	2.42	2.96
	2	4.00	3.55	4.00	4.00	2.00	3.51	
	3	4.00	3.55	4.00	4.00	2.00	3.51	
	4	4.00	3.66	4.00	5.00	2.00	3.73	
	5	4.00	3.63	4.00	4.00	2.00	3.53	
	6	4.00	3.75	4.00	2.00	2.00	3.15	
	7	4.00	4.38	4.00	3.00	2.00	3.48	
	8	4.00	4.00	4.00	2.00	2.00	3.20	
	9	4.00	2.50	3.00	2.00	2.00	2.70	
	10	5.00	2.88	3.00	2.00	2.00	2.98	
	11	4.00	2.55	4.00	3.00	3.00	3.31	
	12	4.00	2.55	4.00	3.00	3.00	3.31	
	13	4.00	2.43	4.00	2.00	3.00	3.09	
	14	4.00	2.30	4.00	3.00	2.00	3.06	
	15	4.00	2.40	4.00	3.00	2.00	3.08	
	16	4.00	2.35	3.00	2.00	1.00	2.47	
	17	4.00	2.70	3.00	2.00	2.00	2.74	
	18	4.00	2.85	3.00	3.00	3.00	3.17	
	19	4.00	2.68	4.00	3.00	3.00	3.34	
	20	4.00	2.53	3.00	3.00	3.00	3.11	
	21	4.00	2.05	3.00	3.00	1.00	2.61	
	22	3.00	2.25	3.00	3.00	1.00	2.45	
	23	3.00	2.80	3.00	3.00	1.00	2.56	
	24	3.00	2.60	3.00	3.00	3.00	2.92	
	25	4.00	2.55	2.00	2.00	2.00	2.51	
	26	4.00	2.90	2.00	1.00	1.00	2.18	
	27	4.00	2.60	3.00	1.00	1.00	2.32	
	28	4.00	3.00	1.00	4.00	1.00	2.60	
SA003	1	4.00	2.00	1.00	2.00	2.00	2.20	2.00
	2	4.00	2.00	2.00	1.00	1.00	2.00	
	3	4.00	2.00	2.00	1.00	1.00	2.00	
	4	4.00	2.00	2.00	1.00	1.00	2.00	
	5	4.00	2.00	2.00	1.00	1.00	2.00	
	6	4.00	2.00	1.00	2.00	2.00	2.20	
	7	4.00	2.00	2.00	1.00	1.00	2.00	
	8	4.00	2.00	2.00	1.00	1.00	2.00	
	9	4.00	2.00	2.00	1.00	1.00	2.00	
	10	4.00	2.00	1.00	1.00	1.00	1.80	
	11	4.00	2.00	2.00	1.00	1.00	2.00	
	12	4.00	2.00	1.00	1.00	1.00	1.80	
SX014	1	4.00	1.00	2.00	1.00	1.00	1.80	1.76
	2	4.00	1.00	2.00	1.00	1.00	1.80	
	3	4.00	1.00	2.00	1.00	1.00	1.80	
	4	4.00	1.00	1.00	1.00	1.00	1.60	
	5	4.00	1.00	2.00	1.00	1.00	1.80	
	6	4.00	1.00	2.00	1.00	1.00	1.80	
	7	4.00	1.00	2.00	1.00	1.00	1.80	
	8	4.00	1.00	2.00	1.00	1.00	1.80	

Channel ID	Transect	CV	BV	AV	MV	FV	CI	RCI
	9	3.00	1.00	2.00	1.00	1.00	1.60	
	10	3.00	1.00	2.00	1.00	1.00	1.60	
	11	3.00	1.00	2.00	1.00	1.00	1.60	
	12	4.00	1.00	1.00	2.00	2.00	2.00	
	13	4.00	1.00	2.00	1.00	1.00	1.80	
	14	4.00	1.00	2.00	1.00	1.00	1.80	
	15	4.00	1.00	2.00	1.00	1.00	1.80	

CV = Channel Condition

BV = Riparian Buffer

AV = Channel Alteration

MV = Rapid In-Stream Macroinvertebrate Observation

FV = Regionalized Index of Biotic Integrity for Fish

CI = Condition Index

RCI = Reach Condition Index

4 CONCLUSION

SWCA performed a Level I Stream Condition Assessment on 31 ephemeral channels while data for the Level II Stream Condition Assessment was collected on the three intermittent channels, (i.e., SA001, SA003, and SX014) within the proposed Dow Harris Reservoir Expansion Project, on September 17, 20, 23, 24, and 25, 2019. The Level I Stream Condition Assessment RCI calculations revealed SC016 to have the highest overall RCI with a score of 3.380. SX008, SX009, SX012, SX013, SX016, SX017, and SX018, were found to have the lowest overall RCI scores at 1.000. Overall, RCI scores averaged around a score of Severe (1.387). The Level II Stream Condition Assessment RCI calculations revealed SA001 to have the highest overall RCI with a score of 2.96, and SX014 was found to have the lowest overall RCI score at 1.76. Overall, RCI scores averaged around a score of 2.23.

5 LITERATURE CITED

Environmental Systems Research Institute (ESRI). 2019. *Watersheds*. Accessed on November 2019. Available at: https://pro.arcgis.com/en/pro-app/tool-reference/ready-to-use/watershed.htm.

Griffith, G.E., Bryce, S.A., Omernik, J.M., Comstock, J.A., Rogers, A.C., Harrison, B., Hatch, S.L., and Bezanson, D. 2004. *Ecoregions of Texas* (color poster with map, descriptive text, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:2,500,000).

Rosgen, David. 2001. *A Practical Method of Computing Streambank Erosion Rate*. Wildland Hydrology Inc., Pagosa Springs, Colorado, p 1-10.

Texas Commission on Environmental Quality (TCEQ). 2018. 2018 Texas Surface Water Quality Standards. Accessed on November 2019. Available at: https://www.tceq.texas.gov/waterquality/standards/2018-surface-water-quality-standards.

U.S. Army Corps of Engineers (USACE). 2013. *Galveston District Stream Condition Assessment.*

________. 2014. *Galveston District Interim Level 2- Stream Conditional Assessment Procedure.*

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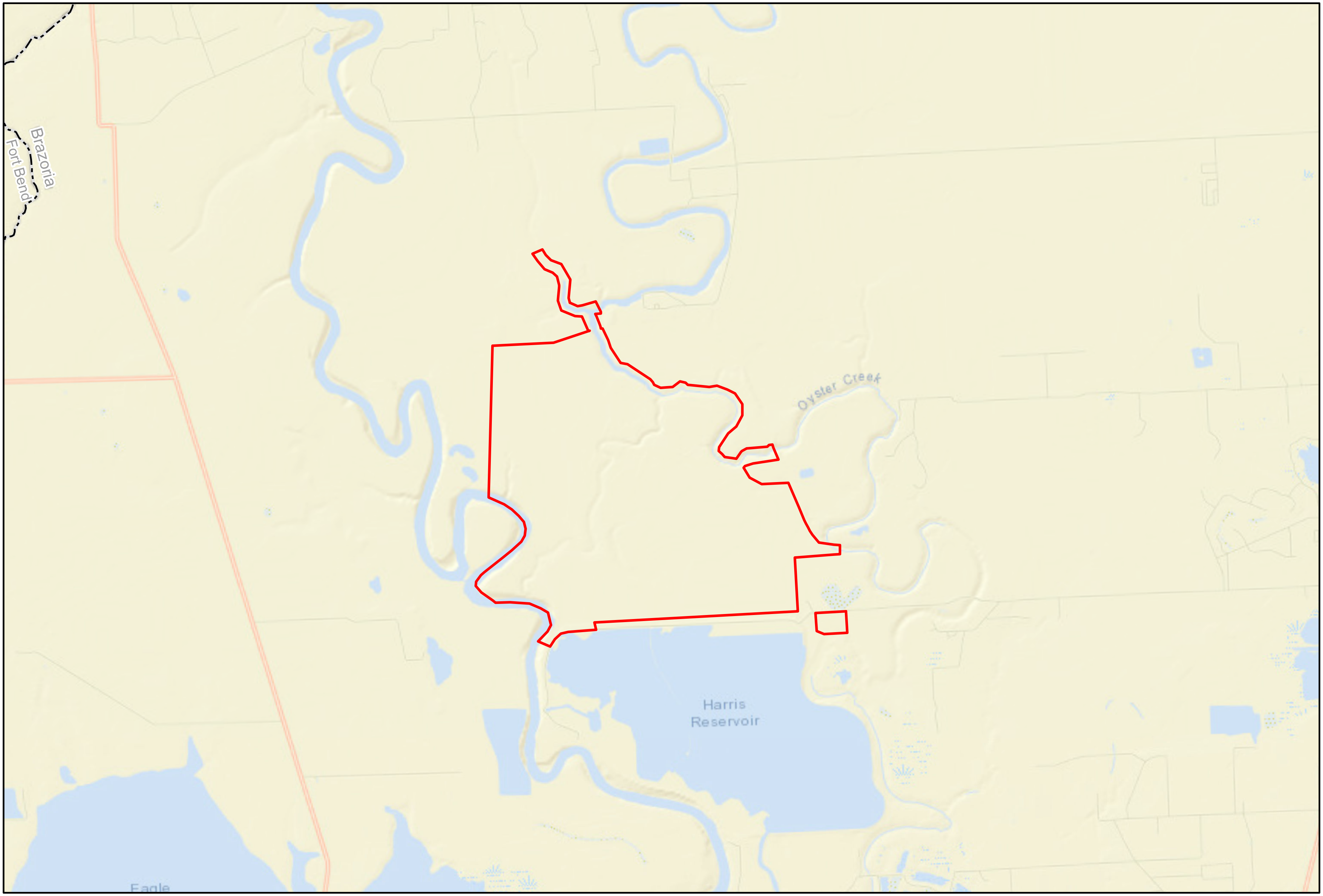
APPENDIX A

Maps



SWCA ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

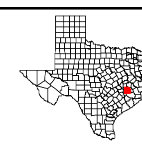
VICINITY MAP

BRAZORIA COUNTY, TEXAS

FIGURE 1

Project Boundary

County Boundary



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Project Number: 52872
Date: 10/31/2019
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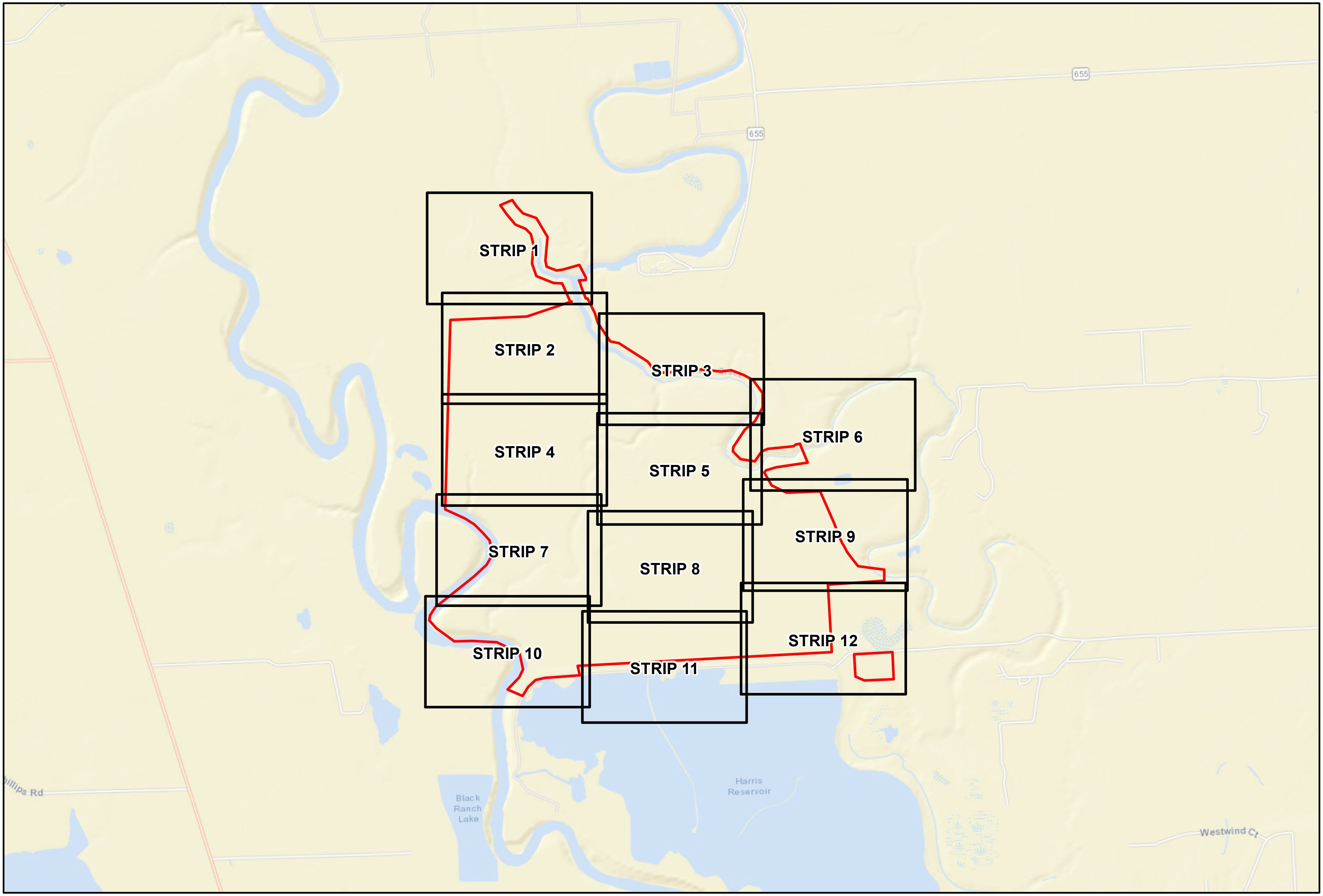
0 1,000 2,000 3,000 4,000 Feet

0 300 600 900 1,200 Meters



SWCA ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

INDEX MAP

BRAZORIA COUNTY, TEXAS

FIGURE 2

Created By: K. Shields
Project Number: 52872
Date: 11/4/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

SWCA® ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

LEVEL I STREAM ASSESSMENT MAP

BRAZORIA COUNTY, TEXAS

SHEET 1 OF 12 FIGURE 3

Project Boundary	Ephemeral Waterbody
Stream Transect	Intermittent Waterbody
Stream Assessment Survey	Perennial Waterbody
Emergent Wetland	
Forested Wetland	
Scrub-Scrub Wetland	

1:6,000

Created By: K. Shields
Project Number: 52872.10
Date: 11/12/2019
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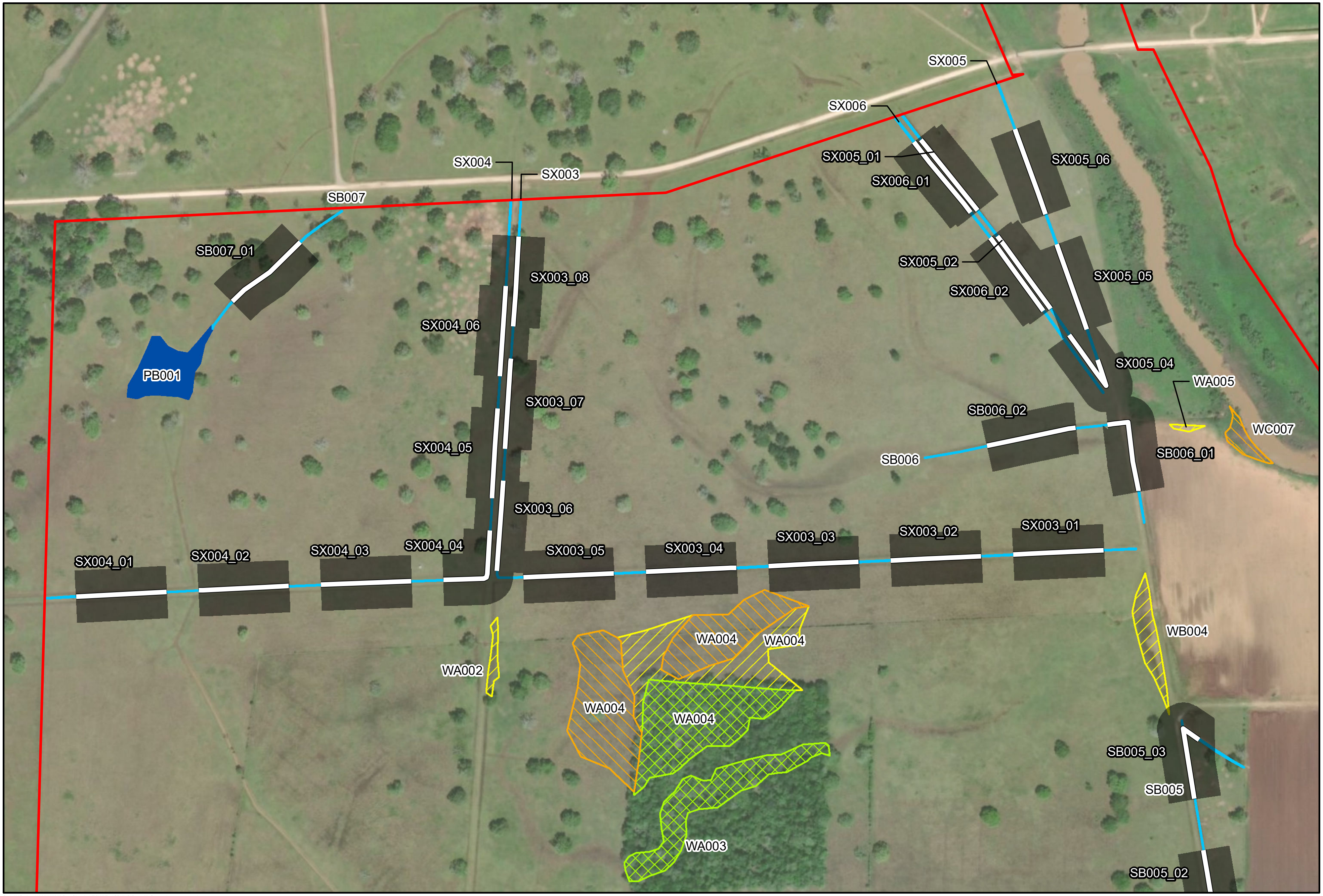
0 30 60 90 120 150 Meters



DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

LEVEL I STREAM ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 2 OF 12

FIGURE 3

SWCA ENVIRONMENTAL CONSULTANTS

Project Boundary
Stream Transect
Stream Assessment Survey
Ephemeral Waterbody
Intermittent Waterbody
Perennial Waterbody
Emergent Wetland
Forested Wetland
Scrub-Scrub Wetland

1:6,000

Created By: K. Shields
Project Number: 52872.10
Date: 11/12/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

LEVEL I STREAM ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 3 OF 12

FIGURE 3

SWCA ENVIRONMENTAL CONSULTANTS

- Project Boundary
- Stream Transect
- Stream Assessment Survey
- Ephemeral Waterbody
- Intermittent Waterbody
- Perennial Waterbody
- Emergent Wetland
- Forested Wetland
- Scrub-Scrub Wetland

1:6,000

Created By: K. Shields
Project Number: 52872.10
Date: 11/12/2019
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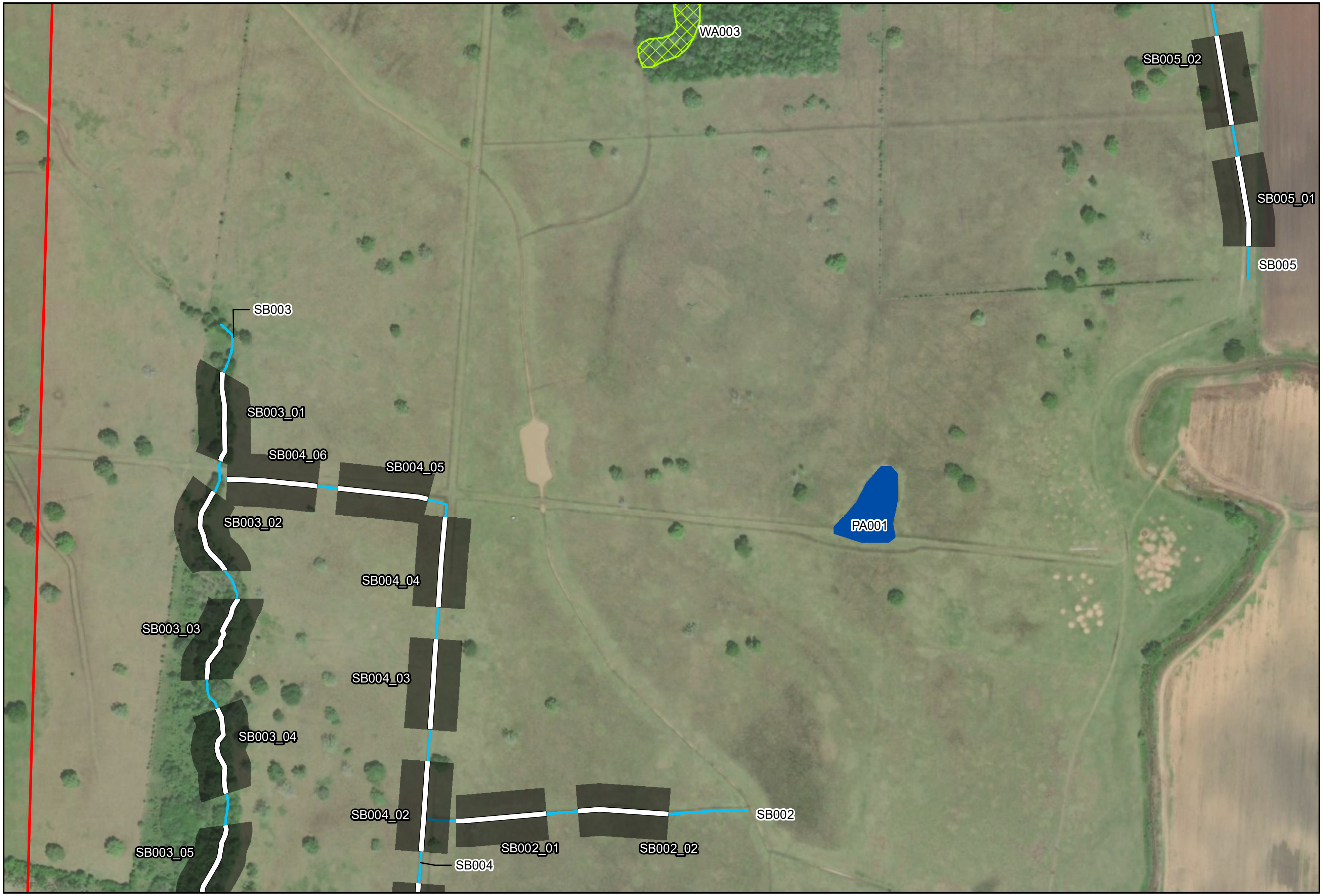


SWCA ENVIRONMENTAL CONSULTANTS

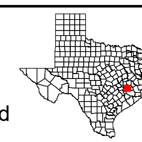
DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

LEVEL I STREAM ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 4 OF 12

FIGURE 3

Project Boundary
Stream Transect
Stream Assessment Survey
Ephemeral Waterbody
Intermittent Waterbody
Perennial Waterbody
Emergent Wetland
Forested Wetland
Scrub-Scrub Wetland



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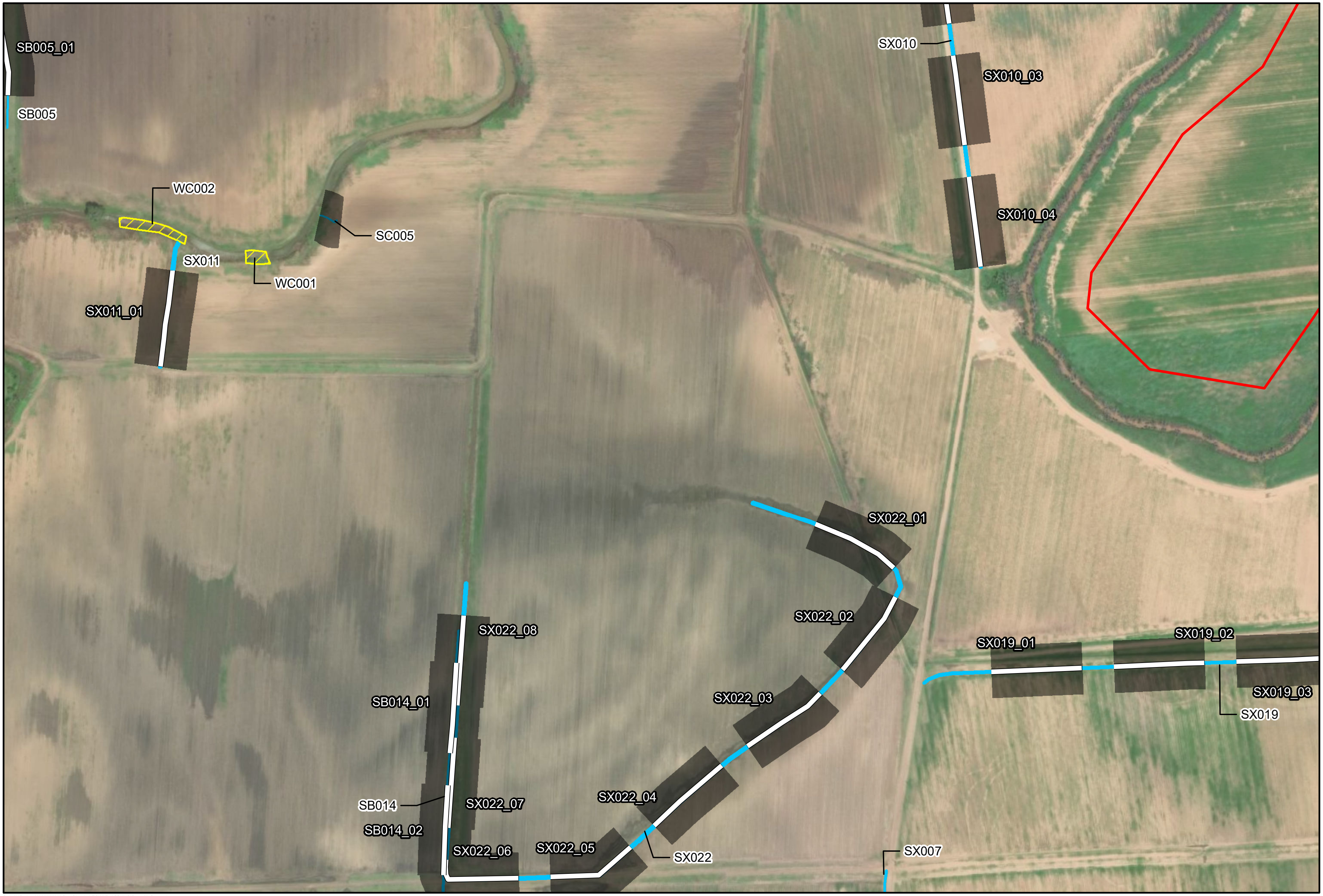


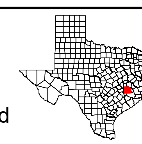
SWCA® ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

LEVEL I STREAM ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 5 OF 12 FIGURE 3

Project Boundary
Stream Transect
Stream Assessment Survey
Ephemeral Waterbody
Intermittent Waterbody
Perennial Waterbody
Emergent Wetland
Forested Wetland
Scrub-Scrub Wetland



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0 30 60 90 120 150 Meters

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DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

LEVEL I STREAM ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 6 OF 12 FIGURE 3

Project Boundary
Stream Transect
Stream Assessment Survey
Ephemeral Waterbody
Intermittent Waterbody
Perennial Waterbody
Emergent Wetland
Forested Wetland
Scrub-Scrub Wetland

1:6,000

Created By: K. Shields
Project Number: 52872.10
Date: 11/12/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

0 100 200 300 400 500 Feet
0 30 60 90 120 150 Meters

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DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

LEVEL I STREAM ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

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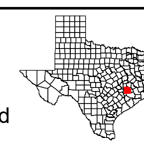
FIGURE 3

- Project Boundary
- Stream Transect
- Stream Assessment Survey
- Ephemeral Waterbody
- Intermittent Waterbody
- Perennial Waterbody
- Emergent Wetland
- Forested Wetland
- Scrub-Scrub Wetland



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Created By: K. Shields
Project Number: 52872.10
Date: 11/12/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

0 100 200 300 400 500 Feet

0 30 60 90 120 150 Meters

DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

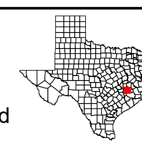
LEVEL I STREAM ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 8 OF 12

FIGURE 3

SWCA ENVIRONMENTAL CONSULTANTS

- Project Boundary
- Stream Transect
- Stream Assessment Survey
- Ephemeral Waterbody
- Intermittent Waterbody
- Perennial Waterbody
- Emergent Wetland
- Forested Wetland
- Scrub-Scrub Wetland



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Project Number: 52872.10
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NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

0 100 200 300 400 500 Feet

0 30 60 90 120 150 Meters

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DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

LEVEL I STREAM ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 9 OF 12

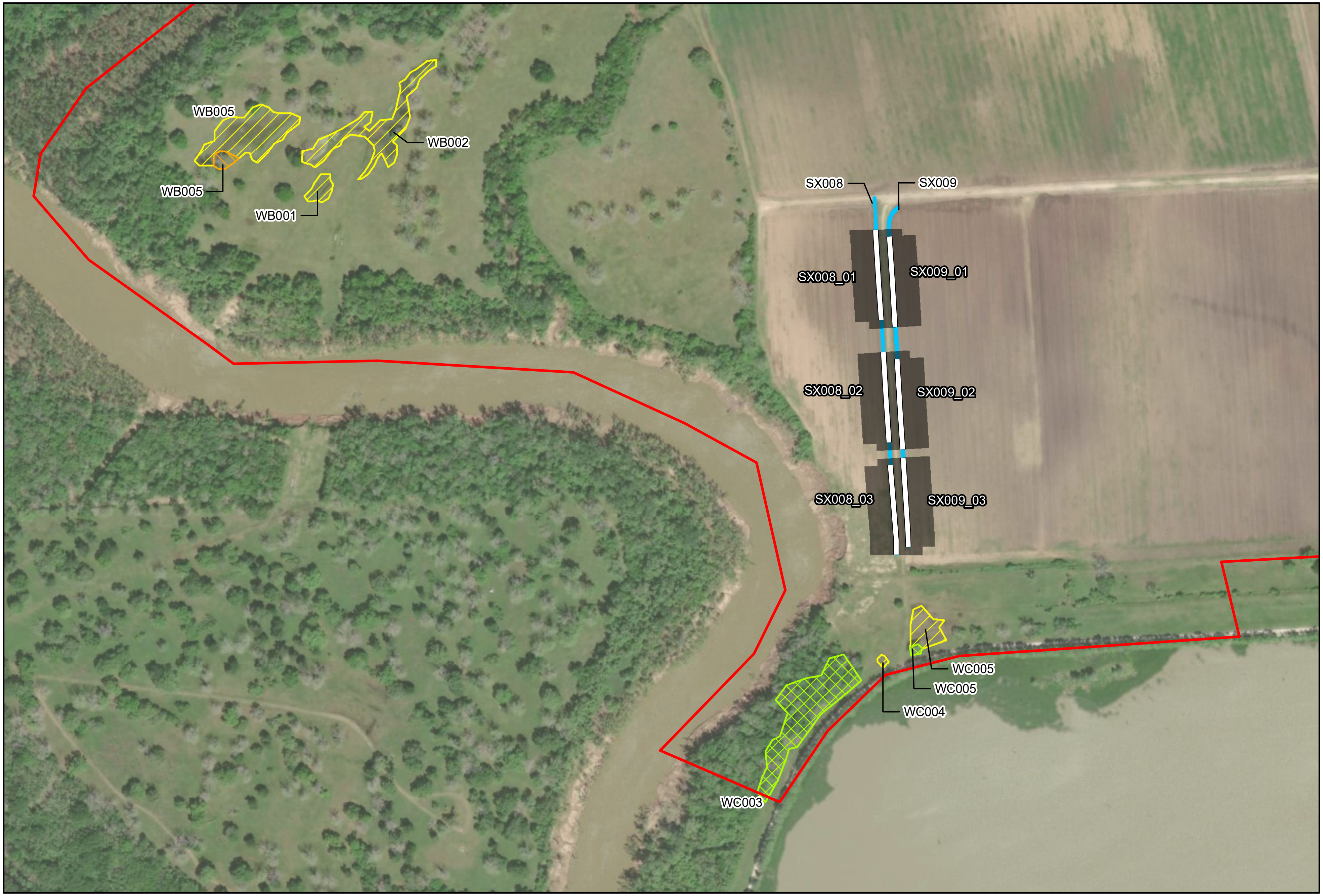
FIGURE 3

Project Boundary
Stream Transect
Stream Assessment Survey
Ephemeral Waterbody
Intermittent Waterbody
Perennial Waterbody
Emergent Wetland
Forested Wetland
Scrub-Scrub Wetland

1:6,000

Created By: K. Shields
Project Number: 52872.10
Date: 11/12/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

0 100 200 300 400 500 Feet
0 30 60 90 120 150 Meters



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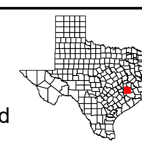
DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

LEVEL I STREAM ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 10 OF 12 FIGURE 3

Project Boundary
Stream Transect
Stream Assessment Survey
Ephemeral Waterbody
Intermittent Waterbody
Perennial Waterbody
Emergent Wetland
Forested Wetland
Scrub-Scrub Wetland



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Project Number: 52872.10
Date: 11/12/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

0 100 200 300 400 500 Feet
0 30 60 90 120 150 Meters

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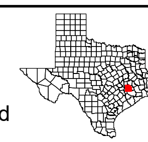
DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

LEVEL I STREAM ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 11 OF 12 FIGURE 3

- Project Boundary
- Stream Transect
- Stream Assessment Survey
- Ephemeral Waterbody
- Intermittent Waterbody
- Perennial Waterbody
- Emergent Wetland
- Forested Wetland
- Scrub-Scrub Wetland



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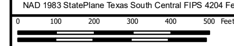

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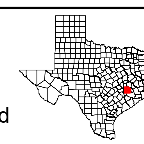
DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

LEVEL I STREAM ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 12 OF 12

FIGURE 3

- Project Boundary
- Stream Transect
- Stream Assessment Survey
- Ephemeral Waterbody
- Intermittent Waterbody
- Perennial Waterbody
- Emergent Wetland
- Forested Wetland
- Scrub-Scrub Wetland



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Project Number: 52872.10
Date: 11/12/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

0 100 200 300 400 500 Feet
0 30 60 90 120 150 Meters

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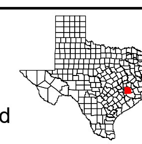
DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

LEVEL II STREAM ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 1 OF 12

FIGURE 4

- Project Boundary
- Stream Transect
- Stream Assessment Survey
- Ephemeral Waterbody
- Intermittent Waterbody
- Perennial Waterbody
- Emergent Wetland
- Forested Wetland
- Scrub-Scrub Wetland



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Date: 11/12/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

0 100 200 300 400 500 Feet

0 30 60 90 120 150 Meters

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DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

LEVEL II STREAM ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 2 OF 12 FIGURE 4

- Project Boundary
- Stream Transect
- Stream Assessment Survey
- Ephemeral Waterbody
- Intermittent Waterbody
- Perennial Waterbody
- Emergent Wetland
- Forested Wetland
- Scrub-Scrub Wetland

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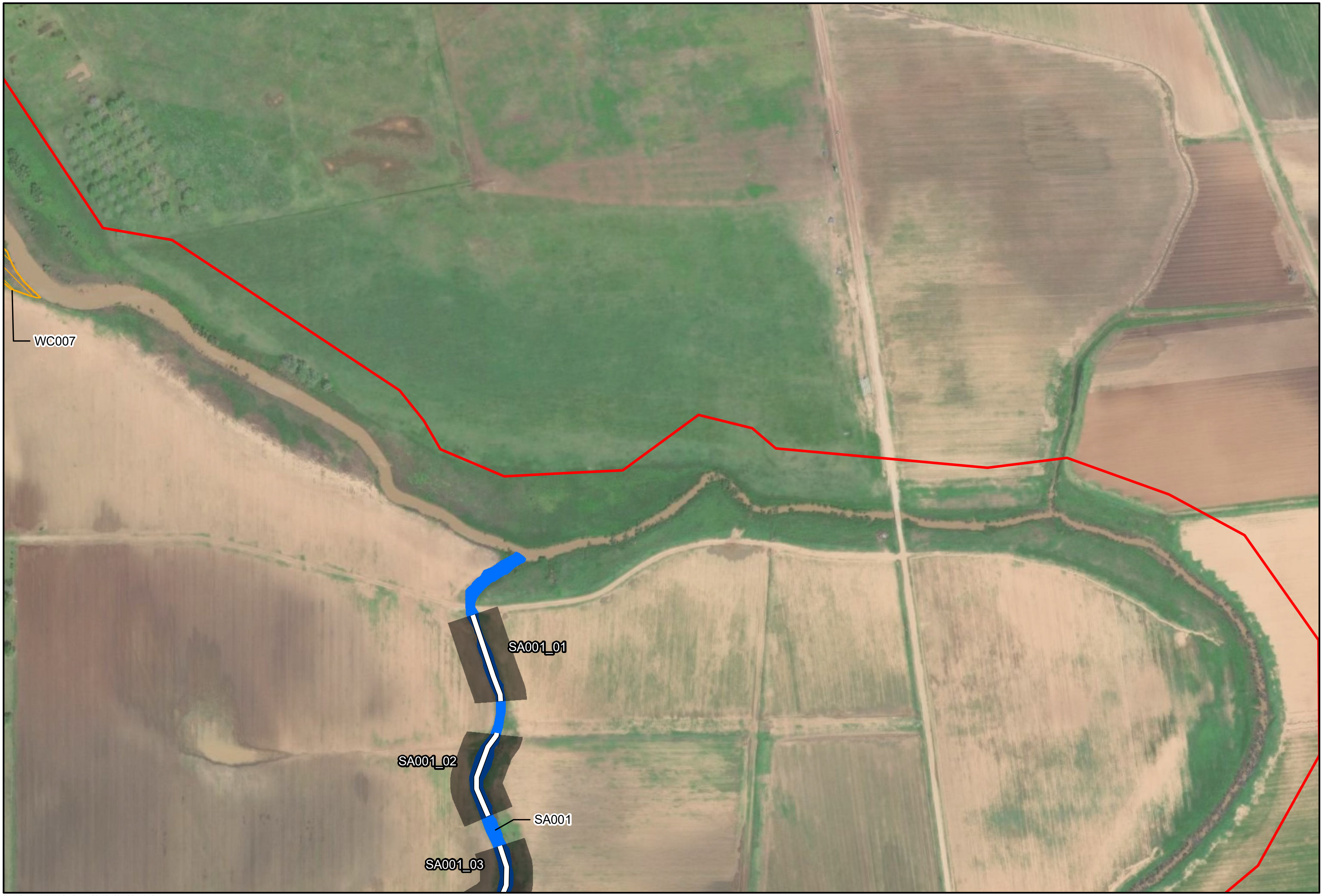

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DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

LEVEL II STREAM ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 3 OF 12

FIGURE 4

Project Boundary
Stream Transect
Stream Assessment Survey
Ephemeral Waterbody
Intermittent Waterbody
Perennial Waterbody
Emergent Wetland
Forested Wetland
Scrub-Scrub Wetland

1:6,000

Created By: K. Shields
Project Number: 52872.10
Date: 11/12/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

0 100 200 300 400 500 Feet

0 30 60 90 120 150 Meters

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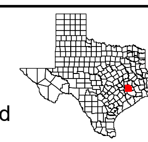
DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

LEVEL II STREAM ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 4 OF 12

FIGURE 4

Project Boundary
Stream Transect
Stream Assessment Survey
Ephemeral Waterbody
Intermittent Waterbody
Perennial Waterbody
Emergent Wetland
Forested Wetland
Scrub-Scrub Wetland



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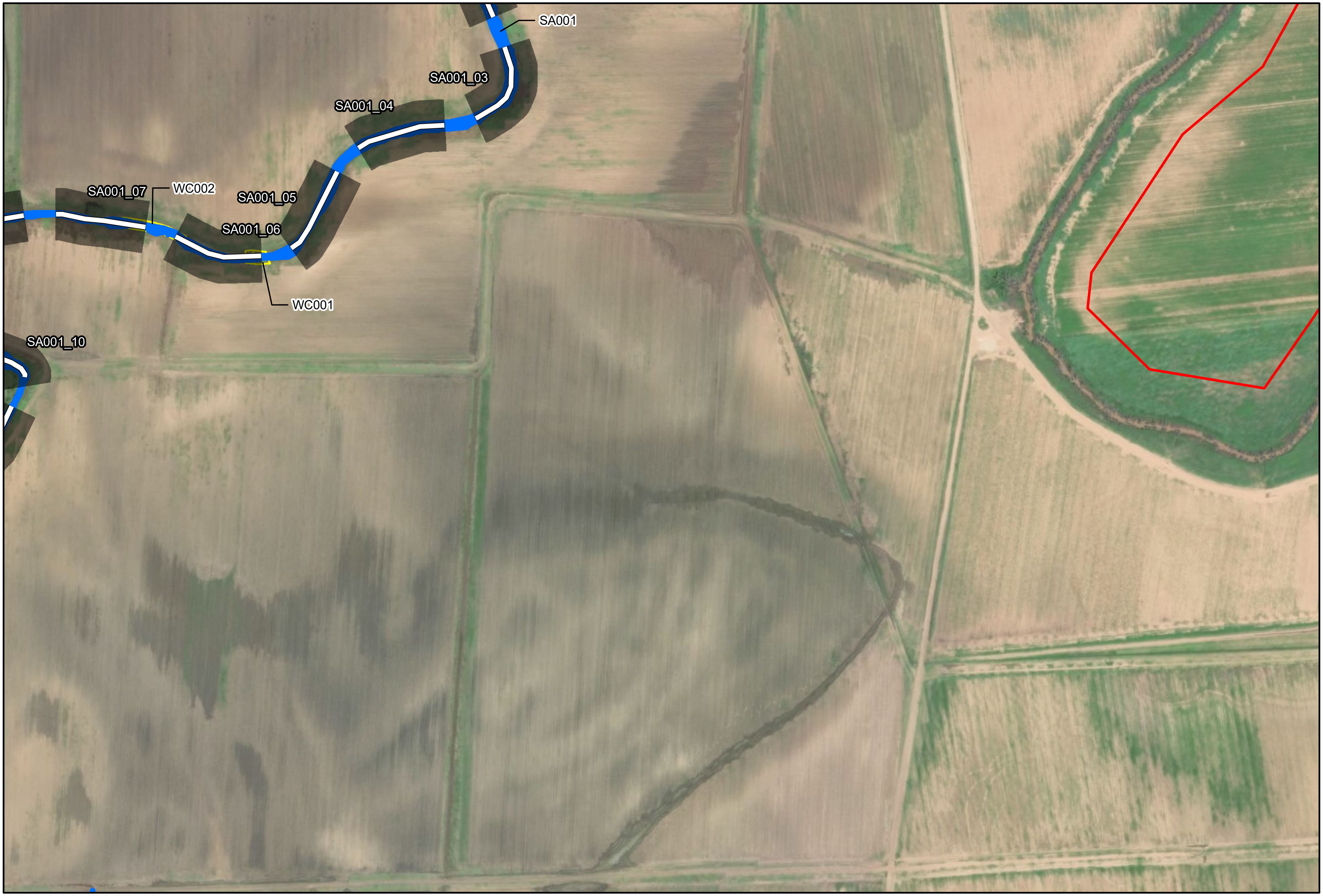

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DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

LEVEL II STREAM ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 5 OF 12

FIGURE 4

Project Boundary
Stream Transect
Stream Assessment Survey
Ephemeral Waterbody
Intermittent Waterbody
Perennial Waterbody
Emergent Wetland
Forested Wetland
Scrub-Scrub Wetland

1:6,000

Created By: K. Shields
Project Number: 52872.10
Date: 11/12/2019
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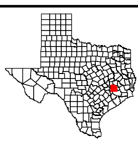

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DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

LEVEL II STREAM ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 6 OF 12

FIGURE 4

Project Boundary	Ephemeral Waterbody
Stream Transect	Intermittent Waterbody
Stream Assessment Survey	Perennial Waterbody
Emergent Wetland	
Forested Wetland	
Scrub-Scrub Wetland	

1:6,000

Created By: K. Shields
Project Number: 52872.10
Date: 11/12/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

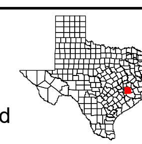
0 100 200 300 400 500 Feet
0 30 60 90 120 150 Meters

DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

LEVEL II STREAM ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 7 OF 12 FIGURE 4

- Project Boundary
- Stream Transect
- Stream Assessment Survey
- Ephemeral Waterbody
- Intermittent Waterbody
- Perennial Waterbody
- Emergent Wetland
- Forested Wetland
- Scrub-Scrub Wetland



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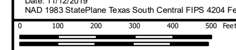
Project Number: 52872.10
Date: 11/12/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet



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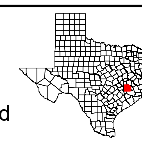
DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

LEVEL II STREAM ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 8 OF 12

FIGURE 4

Project Boundary
Stream Transect
Stream Assessment Survey
Ephemeral Waterbody
Intermittent Waterbody
Perennial Waterbody
Emergent Wetland
Forested Wetland
Scrub-Scrub Wetland



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Created By: K. Shields
Project Number: 52872.10
Date: 11/12/2019
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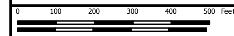

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DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

LEVEL II STREAM ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 9 OF 12

FIGURE 4

Project Boundary
Stream Transect
Stream Assessment Survey
Ephemeral Waterbody
Intermittent Waterbody
Perennial Waterbody
Emergent Wetland
Forested Wetland
Scrub-Scrub Wetland

1:6,000

Created By: K. Shields
Project Number: 52872.10
Date: 11/12/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

0 100 200 300 400 500 Feet
0 30 60 90 120 150 Meters

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DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

LEVEL II STREAM ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 10 OF 12

FIGURE 4

Legend		
Project Boundary	Ephemeral Waterbody	Emergent Wetland
Stream Transect	Intermittent Waterbody	Forested Wetland
Stream Assessment Survey	Perennial Waterbody	Scrub-Scrub Wetland

1:6,000

Created By: K. Shields
Project Number: 52872.10
Date: 11/12/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

0 100 200 300 400 500 Feet

0 30 60 90 120 150 Meters

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DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

LEVEL II STREAM ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 11 OF 12

FIGURE 4

Project Boundary
Stream Transect
Stream Assessment Survey
Ephemeral Waterbody
Intermittent Waterbody
Perennial Waterbody
Emergent Wetland
Forested Wetland
Scrub-Scrub Wetland

1:6,000

Created By: K. Shields
Project Number: 52872.10
Date: 11/12/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

0 100 200 300 400 500 Feet

0 30 60 90 120 150 Meters

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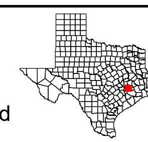
DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

LEVEL II STREAM ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 12 OF 12

FIGURE 4

Project Boundary
Stream Transect
Stream Assessment Survey
Ephemeral Waterbody
Intermittent Waterbody
Perennial Waterbody
Emergent Wetland
Forested Wetland
Scrub-Scrub Wetland



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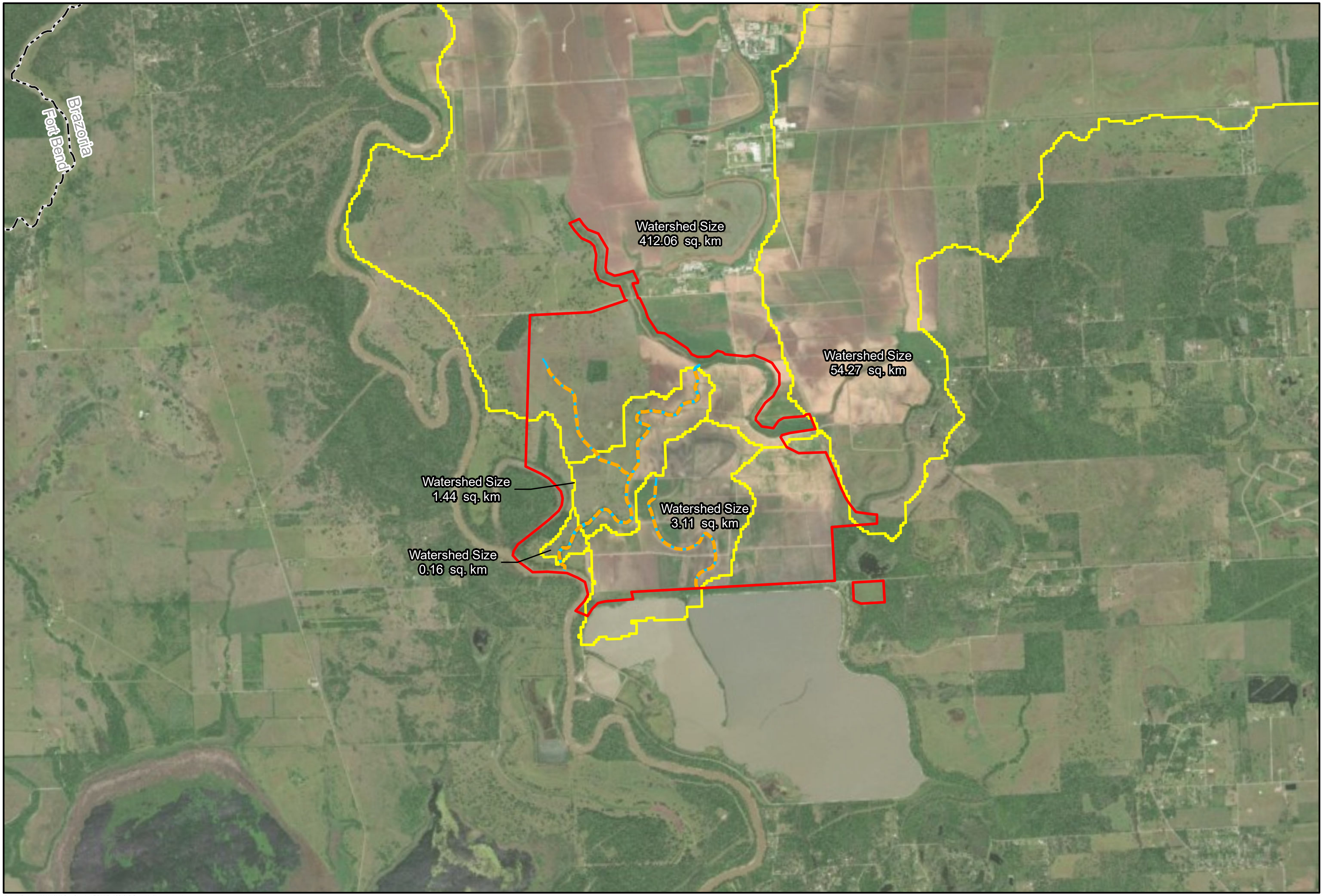
Created By: K. Shields
Project Number: 52872.10
Date: 11/12/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

0 100 200 300 400 500 Feet
0 30 60 90 120 150 Meters

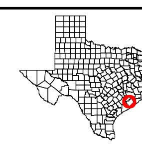


SWCA® ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

WATERSHED MAP
BRAZORIA COUNTY, TEXAS
FIGURE 5

Project Boundary
Stream Transect
Level II Assessment Stream
Watershed Boundary
County Boundary



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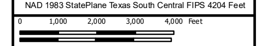

APPENDIX B

Level I Stream Assessment Data Forms

Available upon request

APPENDIX C

Level II Stream Assessment Data Forms

Available upon request

APPENDIX D

In-Stream Macroinvertebrate Observations and Hilsenhoff Biotic Index Tables

Table D-1. In-Stream Macroinvertebrate Observations and Hilsenhoff Biotic Index for SA001

Transect	Collection Method	Taxonomic Level	Common Name	Tolerance Value	Count	Subtotal
1	N/A	N/A	N/A	N/A	N/A	N/A
2	Seine 1	Gilled Snail	Order Caenogastropoda	3	3	9
2	Seine 1	Midge Fly	Family Chironomidae	6	1	6
2	Seine 1	Grass Shrimp	Order Decapoda	-	25	-
2	Seine 1	Diving Beetle	Order Coleoptera	-	1	-
2	Seine 2	Crayfish	Family Cambaridae	5	8	40
2	Seine 2	Dragonfly	Suborder Anisoptera	5	5	25
2	Seine 2	Diving Beetle	Order Coleoptera	-	41	-
2	Seine 2	Water Boatman	Suborder Heteroptera	-	42	-
2	Seine 2	Asian Clam	Order Veneroida	-	20	-
2	Seine 2	Gilled Snail	Order Caenogastropoda	3	3	9
2	Seine 3	Water Boatman	Suborder Heteroptera	-	1	-
2	Seine 3	Gilled Snail	Order Caenogastropoda	3	3	9
2	Seine 3	Crayfish	Family Cambaridae	5	5	25
2	Seine 3	Diving Beetle	Order Coleoptera	-	2	-
2	Seine 3	Asian Clam	Order Veneroida	-	2	-
2	Seine 3	Dragonfly	Suborder Anisoptera	5	1	5
2	Seine 4	Dragonfly	Suborder Anisoptera	5	1	5
2	Seine 4	Asian Clam	Order Veneroida	-	5	-
2	Seine 4	Water Boatman	Suborder Heteroptera	-	11	-
2	Seine 4	Diving Beetle	Order Coleoptera	-	6	-
2	Seine 4	Crayfish	Family Cambaridae	5	1	5
2	Seine 5	Crayfish	Family Cambaridae	5	1	5
3	Seine 1	Grass Shrimp	Order Decapoda	-	11	-
3	Seine 1	Diving Beetle	Order Coleoptera	-	3	-
3	Seine 1	Water Boatman	Suborder Heteroptera	-	43	-
3	Seine 1	Toe Biter	Order Hemiptera	-	2	-
3	Seine 1	Asian Clam	Order Veneroida	-	11	-
3	Seine 1	Gilled Snail	Order Caenogastropoda	3	5	15
3	Seine 2	Crayfish	Family Cambaridae	5	2	10
3	Seine 2	Water Boatman	Suborder Heteroptera	-	38	-
3	Seine 2	Asian Clam	Order Veneroida	-	26	-
3	Seine 2	Diving Beetle	Order Coleoptera	-	4	-
3	Seine 2	Grass Shrimp	Order Decapoda	-	14	-
3	Seine 2	Midge Fly	Family Chironomidae	6	18	108
3	Seine 2	Gilled Snail	Order Caenogastropoda	3	13	39
3	Seine 3	Asian Clam	Order Veneroida	-	10	-
3	Seine 3	Water Boatman	Suborder Heteroptera	-	42	-
3	Seine 3	Crayfish	Family Cambaridae	5	1	5

Transect	Collection Method	Taxonomic Level	Common Name	Tolerance Value	Count	Subtotal
3	Seine 3	Diving Beetle	Order Coleoptera	-	8	-
3	Seine 3	Gilled Snail	Order Caenogastropoda	3	10	30
3	Seine 3	Dragonfly	Suborder Anisoptera	5	2	10
3	Seine 4	Toe Biter	Order Hemiptera	-	1	-
3	Seine 4	Asian Clam	Order Veneroida	-	4	-
4	Seine 1	Grass Shrimp	Order Decapoda	-	22	-
4	Seine 1	Dragonfly	Suborder Anisoptera	5	3	15
4	Seine 1	Asian Clam	Order Veneroida	-	3	-
4	Seine 1	Gilled Snail	Order Caenogastropoda	3	2	6
4	Seine 2	Grass Shrimp	Order Decapoda	-	20	-
4	Seine 2	Asian Clam	Order Veneroida	-	5	-
4	Seine 2	Gilled Snail	Order Caenogastropoda	3	1	3
4	Seine 3	Crayfish	Family Cambaridae	5	1	5
4	Seine 3	Grass Shrimp	Order Decapoda	-	17	-
4	Seine 3	Asian Clam	Order Veneroida	-	1	-
4	Seine 3	Gilled Snail	Order Caenogastropoda	3	1	3
4	Seine 4	Riffle Beetle	Family Elmidae	3	1	3
4	Seine 4	Gilled Snail	Order Caenogastropoda	3	4	12
4	Seine 4	Asian Clam	Order Veneroida	-	4	-
4	Seine 4	Grass Shrimp	Order Decapoda	-	7	-
4	Seine 5	Grass Shrimp	Order Decapoda	-	17	-
4	Seine 5	Gilled Snail	Order Caenogastropoda	3	5	15
4	Seine 6	Asian Clam	Order Veneroida	-	4	-
4	Seine 6	Grass Shrimp	Order Decapoda	-	11	-
4	Seine 6	Gilled Snail	Order Caenogastropoda	3	2	6
4	Seine 6	Dragonfly	Suborder Anisoptera	5	1	5
5	Seine 1	Grass Shrimp	Order Decapoda	-	20	-
5	Seine 1	Gilled Snail	Order Caenogastropoda	3	2	6
5	Seine 1	Asian Clam	Order Veneroida	-	2	-
5	Seine 2	Grass Shrimp	Order Decapoda	-	7	-
5	Seine 3	Grass Shrimp	Order Decapoda	-	7	-
5	Seine 4	Grass Shrimp	Order Decapoda	-	47	-
5	Seine 4	Whirligig Beetle	Family Gyrinidae	6	1	6
5	Seine 4	Gilled Snail	Order Caenogastropoda	3	1	3
5	Seine 5	Gilled Snail	Order Caenogastropoda	3	2	6
5	Seine 5	Grass Shrimp	Order Decapoda	-	78	-
5	Seine 5	Whirligig Beetle	Family Gyrinidae	6	1	6
5	Seine 6	Whirligig Beetle	Family Gyrinidae	6	3	18
5	Seine 6	Grass Shrimp	Order Decapoda	-	12	-
6	Seine 1	Crayfish	Family Cambaridae	5	1	5
6	Seine 1	Whirligig Beetle	Family Gyrinidae	6	17	102

Transect	Collection Method	Taxonomic Level	Common Name	Tolerance Value	Count	Subtotal
6	Seine 1	Grass Shrimp	Order Decapoda	-	5	-
6	Seine 1	Toe Biter	Order Hemiptera	-	1	-
6	Seine 1	Gilled Snail	Order Caenogastropoda	3	1	3
6	Seine 2	Toe Biter	Order Hemiptera	-	2	-
6	Seine 2	Whirligig Beetle	Family Gyrinidae	6	4	24
6	Seine 2	Grass Shrimp	Order Decapoda	-	1	-
6	Seine 3	Grass Shrimp	Order Decapoda	-	2	-
6	Seine 4	Crayfish	Family Cambaridae	5	3	15
6	Seine 4	Grass Shrimp	Order Decapoda	-	4	-
6	Seine 4	Toe Biter	Order Hemiptera	-	3	-
6	Seine 4	Lunged Snail	Subclass Heterobranchia	7	1	7
6	Seine 6	Crayfish	Family Cambaridae	5	2	10
6	Seine 6	Lunged Snail	Subclass Heterobranchia	7	1	7
6	D-Nets	Water Boatman	Suborder Heteroptera	-	49	-
6	D-Nets	Crayfish	Family Cambaridae	5	7	35
6	D-Nets	Gilled Snail	Order Caenogastropoda	3	4	12
6	D-Nets	Crayfish	Family Cambaridae	5	5	25
6	D-Nets	Diving Beetle	Order Coleoptera	-	2	-
6	D-Nets	Toe Biter	Order Hemiptera	-	1	-
6	D-Nets	Grass Shrimp	Order Decapoda	-	1	-
6	D-Nets	Whirligig Beetle	Family Gyrinidae	6	3	18
7	Seine 1	Grass Shrimp	Order Decapoda	-	10	-
7	Seine 1	Whirligig Beetle	Family Gyrinidae	6	1	6
7	Seine 1	Lunged Snail	Subclass Heterobranchia	7	1	7
7	Seine 2	Crayfish	Family Cambaridae	5	2	10
7	Seine 2	Whirligig Beetle	Family Gyrinidae	6	25	150
7	Seine 2	Grass Shrimp	Order Decapoda	-	2	-
7	Seine 3	Grass Shrimp	Order Decapoda	-	2	-
7	Seine 4	Grass Shrimp	Order Decapoda	-	2	-
7	Seine 5	Crayfish	Family Cambaridae	5	1	5
7	Seine 5	Grass Shrimp	Order Decapoda	-	3	-
7	Seine 6	Crayfish	Family Cambaridae	5	1	5
7	Seine 6	Grass Shrimp	Order Decapoda	-	4	-
7	D-Nets	Diving Beetle	Order Coleoptera	-	3	-
7	D-Nets	Grass Shrimp	Order Decapoda	-	4	-
7	D-Nets	Water Boatman	Suborder Heteroptera	-	10	-
7	D-Nets	Crayfish	Family Cambaridae	5	22	110
7	D-Nets	Gilled Snail	Order Caenogastropoda	3	8	24
7	D-Nets	Toe Biter	Order Hemiptera	-	1	-
7	D-Nets	Whirligig Beetle	Family Gyrinidae	6	4	24

Transect	Collection Method	Taxonomic Level	Common Name	Tolerance Value	Count	Subtotal
7	D-Nets	Water Boatman	Suborder Heteroptera	-	1	-
8	D-Nets	Grass Shrimp	Order Decapoda	-	13	-
8	D-Nets	Water Boatman	Suborder Heteroptera	-	56	-
8	D-Nets	Whirligig Beetle	Family Gyrinidae	6	14	84
8	D-Nets	Crayfish	Family Cambaridae	5	6	30
8	D-Nets	Diving Beetle	Order Coleoptera	-	1	-
8	D-Nets	Toe Biter	Order Hemiptera	-	1	-
8	D-Nets	Lunged Snail	Subclass Heterobranchia	7	2	14
8	Seine 1	Whirligig Beetle	Family Gyrinidae	6	6	36
8	Seine 1	Grass Shrimp	Order Decapoda	-	51	-
8	Seine 2	Grass Shrimp	Order Decapoda	-	10	-
8	Seine 2	Lunged Snail	Subclass Heterobranchia	7	1	7
8	Seine 3	Whirligig Beetle	Family Gyrinidae	6	1	6
8	Seine 3	Grass Shrimp	Order Decapoda	-	10	-
8	Seine 4	Grass Shrimp	Order Decapoda	-	10	-
8	Seine 5	Grass Shrimp	Order Decapoda	-	11	-
8	Seine 6	Grass Shrimp	Order Decapoda	-	18	-
9	D-Nets	Whirligig Beetle	Family Gyrinidae	6	48	288
9	D-Nets	Water Boatman	Suborder Heteroptera	-	89	-
9	D-Nets	Toe Biter	Order Hemiptera	-	4	-
9	D-Nets	Lunged Snail	Subclass Heterobranchia	7	9	63
9	D-Nets	Grass Shrimp	Order Decapoda	-	10	-
9	D-Nets	Gilled Snail	Order Caenogastropoda	3	1	3
9	D-Nets	Water Boatman	Suborder Heteroptera	-	2	-
9	D-Nets	Diving Beetle	Order Coleoptera	-	5	-
9	D-Nets	Crayfish	Family Cambaridae	5	1	5
9	Seine 1	Whirligig Beetle	Family Gyrinidae	6	1	6
9	Seine 1	Crayfish	Family Cambaridae	5	1	5
9	Seine 1	Grass Shrimp	Order Decapoda	-	12	-
9	Seine 2	Whirligig Beetle	Family Gyrinidae	6	12	72
9	Seine 2	Grass Shrimp	Order Decapoda	-	58	-
9	Seine 3	Grass Shrimp	Order Decapoda	-	82	-
9	Seine 3	Whirligig Beetle	Family Gyrinidae	6	6	36
9	Seine 4	Water Boatman	Suborder Heteroptera	-	1	-
9	Seine 4	Grass Shrimp	Order Decapoda	-	232	-
9	Seine 4	Crayfish	Family Cambaridae	5	2	10
9	Seine 4	Lunged Snail	Subclass Heterobranchia	7	2	14
9	Seine 4	Water Boatman	Suborder Heteroptera	-	1	-
9	Seine 5	Water Boatman	Suborder Heteroptera	-	1	-

Transect	Collection Method	Taxonomic Level	Common Name	Tolerance Value	Count	Subtotal
9	Seine 5	Lunged Snail	Subclass Heterobranchia	7	1	7
9	Seine 6	Asian Clam	Order Veneroida	-	1	-
10	D-Nets	Diving Beetle	Order Coleoptera	-	8	-
10	D-Nets	Lunged Snail	Subclass Heterobranchia	7	10	70
10	D-Nets	Grass Shrimp	Order Decapoda	-	6	-
10	D-Nets	Water Boatman	Suborder Heteroptera	-	28	-
10	D-Nets	Whirligig Beetle	Family Gyrinidae	6	18	108
10	D-Nets	Crayfish	Family Cambaridae	5	17	85
10	D-Nets	Stonefly	Order Plecoptera	1	1	1
10	D-Nets	Asian Clam	Order Veneroida	-	1	-
10	Seine 1	Whirligig Beetle	Family Gyrinidae	6	6	36
10	Seine 1	Crayfish	Family Cambaridae	5	1	5
10	Seine 1	Grass Shrimp	Order Decapoda	-	80	-
10	Seine 2	Crayfish	Family Cambaridae	5	1	5
10	Seine 2	Lunged Snail	Subclass Heterobranchia	7	1	7
10	Seine 2	Dragonfly	Suborder Anisoptera	5	1	5
10	Seine 2	Whirligig Beetle	Family Gyrinidae	6	6	36
10	Seine 3	Lunged Snail	Subclass Heterobranchia	7	1	7
10	Seine 3	Crayfish	Family Cambaridae	5	1	5
10	Seine 3	Whirligig Beetle	Family Gyrinidae	6	1	6
10	Seine 4	Lunged Snail	Subclass Heterobranchia	7	1	7
10	Seine 5	Whirligig Beetle	Family Gyrinidae	6	5	30
11	D-Nets	Crayfish	Family Cambaridae	5	111	555
11	D-Nets	Grass Shrimp	Order Decapoda	-	3	-
11	D-Nets	Lunged Snail	Subclass Heterobranchia	7	6	42
11	D-Nets	Water Boatman	Suborder Heteroptera	-	2	-
11	D-Nets	Diving Beetle	Order Coleoptera	-	3	-
11	D-Nets	Water Boatman	Suborder Heteroptera	-	6	-
11	D-Nets	Whirligig Beetle	Family Gyrinidae	6	6	36
11	D-Nets	Toe Biter	Order Hemiptera	-	1	-
12	D-Nets	Crayfish	Family Cambaridae	5	113	565
12	D-Nets	Lunged Snail	Subclass Heterobranchia	7	8	56
12	D-Nets	Grass Shrimp	Order Decapoda	-	3	-
12	D-Nets	Water Boatman	Suborder Heteroptera	-	2	-
13	D-Nets	Crayfish	Family Cambaridae	5	87	435
13	D-Nets	Diving Beetle	Order Coleoptera	-	2	-
13	D-Nets	Lunged Snail	Subclass Heterobranchia	7	14	98

Transect	Collection Method	Taxonomic Level	Common Name	Tolerance Value	Count	Subtotal
13	D-Nets	Water Boatman	Suborder Heteroptera	-	10	-
13	D-Nets	Whirligig Beetle	Family Gyrinidae	6	22	132
13	D-Nets	Damselfly	Suborder Zygoptera	7	1	7
13	D-Nets	Water Boatman	Suborder Heteroptera	-	4	-
13	D-Nets	Dragonfly	Suborder Anisoptera	5	1	5
13	D-Nets	Asian Clam	Order Veneroida	-	1	-
13	D-Nets	Grass Shrimp	Order Decapoda	-	3	-
13	D-Nets	Diving Beetle	Order Coleoptera	-	1	-
13	D-Nets	Toe Biter	Order Hemiptera	-	2	-
14	D-Nets	Toe Biter	Order Hemiptera	-	3	-
14	D-Nets	Water Boatman	Suborder Heteroptera	-	94	-
14	D-Nets	Crayfish	Family Cambaridae	5	367	1,835
14	D-Nets	Diving Beetle	Order Coleoptera	-	15	-
14	D-Nets	Diving Beetle	Order Coleoptera	-	2	-
14	D-Nets	Lunged Snail	Subclass Heterobranchia	7	3	21
14	D-Nets	Scud	Order Amphipoda	6	3	18
14	Seine 1	Lunged Snail	Subclass Heterobranchia	7	1	7
14	Seine 1	Toe Biter	Order Hemiptera	-	1	-
14	Seine 1	Crayfish	Family Cambaridae	5	17	85
14	Seine 1	Whirligig Beetle	Family Gyrinidae	6	45	270
14	Seine 2	Lunged Snail	Subclass Heterobranchia	7	6	42
14	Seine 2	Water Boatman	Suborder Heteroptera	-	1	-
14	Seine 2	Crayfish	Family Cambaridae	5	8	40
14	Seine 3	Water Boatman	Suborder Heteroptera	-	1	-
14	Seine 3	Crayfish	Family Cambaridae	5	1	5
14	Seine 3	Whirligig Beetle	Family Gyrinidae	6	1	6
15	D-Nets	Diving Beetle	Order Coleoptera	-	4	-
15	D-Nets	Grass Shrimp	Order Decapoda	-	1	-
15	D-Nets	Whirligig Beetle	Family Gyrinidae	6	1	6
15	D-Nets	Crayfish	Family Cambaridae	5	20	100
15	D-Nets	Toe Biter	Order Hemiptera	-	1	-
15	D-Nets	Water Boatman	Suborder Heteroptera	-	5	-
15	Seine 1	Toe Biter	Order Hemiptera	-	1	-
15	Seine 1	Crayfish	Family Cambaridae	5	27	135
15	Seine 1	Grass Shrimp	Order Decapoda	-	7	-
15	Seine 1	Diving Beetle	Order Coleoptera	-	7	-
15	Seine 2	Crayfish	Family Cambaridae	5	64	320
15	Seine 2	Toe Biter	Order Hemiptera	-	1	-
15	Seine 2	Grass Shrimp	Order Decapoda	-	7	-
15	Seine 2	Diving Beetle	Order Coleoptera	-	4	-

Transect	Collection Method	Taxonomic Level	Common Name	Tolerance Value	Count	Subtotal
15	Seine 2	Lunged Snail	Subclass Heterobranchia	7	6	42
15	Seine 3	Toe Biter	Order Hemiptera	-	8	-
15	Seine 3	Crayfish	Family Cambaridae	5	39	195
15	Seine 3	Lunged Snail	Subclass Heterobranchia	7	11	77
15	Seine 3	Grass Shrimp	Order Decapoda	-	8	-
15	Seine 3	Diving Beetle	Order Coleoptera	-	1	-
15	Seine 3	Whirligig Beetle	Family Gyrinidae	6	2	12
15	Seine 3	Watersnipe Fly	Family Athericidae	4	2	8
16	D-Nets	Lunged Snail	Subclass Heterobranchia	7	7	49
16	D-Nets	Midge Fly	Family Chironomidae	6	3	18
16	D-Nets	Water Boatman	Suborder Heteroptera	-	14	-
16	D-Nets	Crayfish	Family Cambaridae	5	38	190
16	D-Nets	Diving Beetle	Order Coleoptera	-	4	-
16	D-Nets	Toe Biter	Order Hemiptera	-	7	-
16	D-Nets	Grass Shrimp	Order Decapoda	-	2	-
16	D-Nets	Asian Clam	Order Veneroida	-	1	-
16	D-Nets	Diving Beetle	Order Coleoptera	-	1	-
16	D-Nets	Sowbug	Order Isopoda	9	1	9
16	Seine 1	Crayfish	Family Cambaridae	5	2	10
16	Seine 1	Asian Clam	Order Veneroida	-	2	-
16	Seine 1	Whirligig Beetle	Family Gyrinidae	6	1	6
17	D-Nets	Crayfish	Family Cambaridae	5	111	555
17	D-Nets	Sowbug	Order Isopoda	9	3	27
17	D-Nets	Water Boatman	Suborder Heteroptera	-	4	-
17	D-Nets	Whirligig Beetle	Family Gyrinidae	6	8	48
17	D-Nets	Diving Beetle	Order Coleoptera	-	2	-
17	D-Nets	Lunged Snail	Subclass Heterobranchia	7	3	21
17	D-Nets	Asian Clam	Order Veneroida	-	2	-
17	D-Nets	Diving Beetle	Order Coleoptera	-	2	-
17	D-Nets	Scud	Order Amphipoda	6	1	6
17	Seine 1	Toe Biter	Order Hemiptera	-	3	-
17	Seine 1	Crayfish	Family Cambaridae	5	1	5
17	Seine 1	Lunged Snail	Subclass Heterobranchia	7	1	7
17	Seine 1	Asian Clam	Order Veneroida	-	1	-
17	Seine 2	Crayfish	Family Cambaridae	5	6	30
17	Seine 2	Asian Clam	Order Veneroida	-	1	-
17	Seine 2	Toe Biter	Order Hemiptera	-	1	-
17	Seine 2	Whirligig Beetle	Family Gyrinidae	6	3	18

Transect	Collection Method	Taxonomic Level	Common Name	Tolerance Value	Count	Subtotal
17	Seine 2	Lunged Snail	Subclass Heterobranchia	7	2	14
17	Seine 3	Crayfish	Family Cambaridae	5	1	5
17	Seine 3	Whirligig Beetle	Family Gyrinidae	6	10	60
17	Seine 3	Lunged Snail	Subclass Heterobranchia	7	1	7
17	Seine 4	Whirligig Beetle	Family Gyrinidae	6	2	12
17	Seine 6	Whirligig Beetle	Family Gyrinidae	6	1	6
18	D-Nets	Sowbug	Order Isopoda	9	1	9
18	D-Nets	Crayfish	Family Cambaridae	5	31	155
18	D-Nets	Diving Beetle	Order Coleoptera	-	2	-
18	D-Nets	Diving Beetle	Order Coleoptera	-	1	-
18	D-Nets	Midge Fly	Family Chironomidae	6	1	6
18	D-Nets	Water Boatman	Suborder Heteroptera	-	1	-
18	D-Nets	Lunged Snail	Subclass Heterobranchia	7	1	7
18	Seine 1	Crayfish	Family Cambaridae	5	1	5
19	D-Nets	Crayfish	Family Cambaridae	5	157	785
19	D-Nets	Lunged Snail	Subclass Heterobranchia	7	8	56
19	D-Nets	Whirligig Beetle	Family Gyrinidae	6	15	90
19	D-Nets	Midge Fly	Family Chironomidae	6	5	30
19	D-Nets	Scud	Order Amphipoda	6	18	108
19	D-Nets	Mayfly	Order Ephemeroptera	3	1	3
19	D-Nets	Dragonfly	Suborder Anisoptera	5	1	5
19	D-Nets	Water Boatman	Suborder Heteroptera	-	19	-
19	D-Nets	Diving Beetle	Order Coleoptera	-	3	-
19	Seine 1	Crayfish	Family Cambaridae	5	3	15
19	Seine 1	Whirligig Beetle	Family Gyrinidae	6	4	24
19	Seine 2	Crayfish	Family Cambaridae	5	4	20
19	Seine 3	Crayfish	Family Cambaridae	5	3	15
19	Seine 3	Whirligig Beetle	Family Gyrinidae	6	5	30
19	Seine 3	Toe Biter	Order Hemiptera	-	1	-
19	Seine 4	Whirligig Beetle	Family Gyrinidae	6	3	18
19	Seine 4	Crayfish	Family Cambaridae	5	4	20
20	D-Nets	Crayfish	Family Cambaridae	5	131	655
20	D-Nets	Scud	Order Amphipoda	6	1	6
20	D-Nets	Sowbug	Order Isopoda	9	2	18
20	D-Nets	Water Boatman	Suborder Heteroptera	-	3	-
20	D-Nets	Diving Beetle	Order Coleoptera	-	1	-
20	D-Nets	Asian Clam	Order Veneroida	-	11	-
20	D-Nets	Lunged Snail	Subclass Heterobranchia	7	1	7
21	D-Nets	Crayfish	Family Cambaridae	5	175	875

Transect	Collection Method	Taxonomic Level	Common Name	Tolerance Value	Count	Subtotal
21	D-Nets	Lunged Snail	Subclass Heterobranchia	7	3	21
21	D-Nets	Asian Clam	Order Veneroida	-	4	-
21	D-Nets	Water Boatman	Suborder Heteroptera	-	3	-
21	D-Nets	Diving Beetle	Order Coleoptera	-	1	-
22	D-Nets	Whirligig Beetle	Family Gyrinidae	6	2	12
22	D-Nets	Crayfish	Family Cambaridae	5	184	920
22	D-Nets	Water Boatman	Suborder Heteroptera	-	3	-
22	D-Nets	Asian Clam	Order Veneroida	-	2	-
22	D-Nets	Lunged Snail	Subclass Heterobranchia	7	1	7
22	D-Nets	Diving Beetle	Order Coleoptera	-	3	-
22	D-Nets	Toe Biter	Order Hemiptera	-	1	-
23	D-Nets	Crayfish	Family Cambaridae	5	126	630
23	D-Nets	Midge Fly	Family Chironomidae	6	1	6
23	D-Nets	Diving Beetle	Order Coleoptera	-	2	-
23	D-Nets	Lunged Snail	Subclass Heterobranchia	7	1	7
23	D-Nets	Asian Clam	Order Veneroida	-	5	-
23	D-Nets	Water Boatman	Suborder Heteroptera	-	2	-
24	D-Nets	Crayfish	Family Cambaridae	5	87	435
24	D-Nets	Diving Beetle	Order Coleoptera	-	7	-
24	D-Nets	Scud	Order Amphipoda	6	2	12
24	D-Nets	Water Boatman	Suborder Heteroptera	-	8	-
24	D-Nets	Sowbug	Order Isopoda	9	2	18
24	D-Nets	Lunged Snail	Subclass Heterobranchia	7	7	49
24	D-Nets	Midge Fly	Family Chironomidae	6	1	6
25	D-Nets	Dragonfly	Suborder Anisoptera	5	3	15
25	D-Nets	Diving Beetle	Order Coleoptera	-	13	-
25	D-Nets	Lunged Snail	Subclass Heterobranchia	7	1	7
25	D-Nets	Diving Beetle	Order Coleoptera	-	10	-
25	Seine 1	Diving Beetle	Order Coleoptera	-	6	-
25	Seine 1	Grass Shrimp	Order Decapoda	-	46	-
26	N/A	N/A	N/A	N/A	N/A	-
27	N/A	N/A	N/A	N/A	N/A	-
28	D-Nets	Toe Biter	Order Hemiptera	-	1	-
28	D-Nets	Midge Fly	Family Chironomidae	6	3	18
Transect 1		Total			N/A	N/A
		HBI Value				N/A
		Macroinvertebrate Variable (MV) Score				**Severe - 1.00**

Transect	Collection Method	Taxonomic Level	Common Name	Tolerance Value	Count	Subtotal
Transect 2		Total			32	143
		HBI Value				4.47
		Macroinvertebrate Variable (MV) Score				**Suboptimal - 4.00**
Transect 3		Total			51	217
		HBI Value				4.25
		Macroinvertebrate Variable (MV) Score				**Suboptimal - 4.00**
Transect 4		Total			21	73
		HBI Value				3.48
		Macroinvertebrate Variable (MV) Score				**Optimal - 5.00**
Transect 5		Total			10	45
		HBI Value				4.50
		Macroinvertebrate Variable (MV) Score				**Suboptimal - 4.00**
Transect 6		Total			49	263
		HBI Value				5.37
		Macroinvertebrate Variable (MV) Score				**Poor - 2.00**
Transect 7		Total			65	341
		HBI Value				5.25
		Macroinvertebrate Variable (MV) Score				**Marginal - 3.00**
Transect 8		Total			30	177
		HBI Value				5.90
		Macroinvertebrate Variable (MV) Score				**Poor - 2.00**
Transect 9		Total			84	509
		HBI Value				6.06
		Macroinvertebrate Variable (MV) Score				**Poor - 2.00**
Transect 10		Total			71	413
		HBI Value				5.82
		Macroinvertebrate Variable (MV) Score				**Poor - 2.00**
Transect 11		Total			123	633
		HBI Value				5.15
		Macroinvertebrate Variable (MV) Score				**Marginal - 3.00**
Transect 12		Total			121	621
		HBI Value				5.13
		Macroinvertebrate Variable (MV) Score				**Marginal - 3.00**
Transect 13		Total			125	677
		HBI Value				5.42
		Macroinvertebrate Variable (MV) Score				**Poor - 2.00**
Transect 14		Total			452	2,329

Transect	Collection Method	Taxonomic Level	Common Name	Tolerance Value	Count	Subtotal
		HBI Value				5.15
		Macroinvertebrate Variable (MV) Score				**Marginal - 3.00**
Transect 15		Total			172	895
		HBI Value				5.20
		Macroinvertebrate Variable (MV) Score				**Marginal - 3.00**
Transect 16		Total			52	282
		HBI Value				5.42
		Macroinvertebrate Variable (MV) Score				**Poor - 2.00**
Transect 17		Total			154	821
		HBI Value				5.33
		Macroinvertebrate Variable (MV) Score				**Poor - 2.00**
Transect 18		Total			35	182
		HBI Value				5.20
		Macroinvertebrate Variable (MV) Score				**Marginal - 3.00**
Transect 19		Total			232	1,219
		HBI Value				5.25
		Macroinvertebrate Variable (MV) Score				**Marginal - 3.00**
Transect 20		Total			135	686
		HBI Value				5.08
		Macroinvertebrate Variable (MV) Score				**Marginal - 3.00**
Transect 21		Total			178	896
		HBI Value				5.03
		Macroinvertebrate Variable (MV) Score				**Marginal - 3.00**
Transect 22		Total			187	939
		HBI Value				5.02
		Macroinvertebrate Variable (MV) Score				**Marginal - 3.00**
Transect 23		Total			128	643
		HBI Value				5.02
		Macroinvertebrate Variable (MV) Score				**Marginal - 3.00**
Transect 24		Total			99	520
		HBI Value				5.25
		Macroinvertebrate Variable (MV) Score				**Marginal - 3.00**
Transect 25		Total			4	22
		HBI Value				5.50
		Macroinvertebrate Variable (MV) Score				**Poor - 2.00**
Transect 26		Total			N/A	N/A

Transect	Collection Method	Taxonomic Level	Common Name	Tolerance Value	Count	Subtotal
		HBI Value				N/A
		Macroinvertebrate Variable (MV) Score				**Severe - 1.00**
Transect 27		Total			N/A	N/A
		HBI Value				N/A
		Macroinvertebrate Variable (MV) Score				**Severe - 1.00**
Transect 28		Total			4	18
		HBI Value				4.50
		Macroinvertebrate Variable (MV) Score				**Suboptimal - 4.00**

Table D-2. In-Stream Macroinvertebrate Observations and Hilsenhoff Biotic Index for SA003

Transect	Collection Method	Common Name	Taxonomic Level	Tolerance Value	Count	Subtotal
1	D-Nets	Diving Beetle	Order Coleoptera	-	1	-
1	D-Nets	Grass Shrimp	Order Decapoda	-	1148	-
1	D-Nets	Midge Fly	Family Chironomidae	6	307	1,842
1	D-Nets	Horse Fly	Order Diptera	-	3	-
1	D-Nets	Diving Beetle	Order Coleoptera	-	1249	-
1	Seine 1	Diving Beetle	Order Coleoptera	-	1	-
1	Seine 1	Diving Beetle	Order Coleoptera	-	2	-
1	Seine 1	Crayfish	Family Cambaridae	5	282	1,410
1	Seine 1	Diving Beetle	Order Coleoptera	-	60	-
2	N/A	N/A	N/A	N/A	N/A	N/A
3	N/A	N/A	N/A	N/A	N/A	N/A
4	N/A	N/A	N/A	N/A	N/A	N/A
5	N/A	N/A	N/A	N/A	N/A	N/A
6	D-Nets	Diving Beetle	Order Coleoptera	-	53	-
6	D-Nets	Dragonfly	Suborder Anisoptera	5	19	95
6	D-Nets	Grass Shrimp	Order Decapoda	-	60	-
6	D-Nets	Midge Fly	Family Chironomidae	6	37	222
6	D-Nets	Mussel	Subclass Heterodonta	6	18	108
6	D-Nets	Diving Beetle	Order Coleoptera	-	61	-
6	D-Nets	Water Boatman	Suborder Heteroptera	-	4	-
6	D-Nets	Gilled Snail	Order Caenogastropoda	3	1	3
6	D-Nets	Lunged Snail	Subclass Heterobranchia	7	1	7
6	Seine 1	Mayfly	Order Ephemeroptera	3	9	27
6	Seine 1	Grass Shrimp	Order Decapoda	-	44	-
6	Seine 1	Mussel	Subclass Heterodonta	6	5	30
6	Seine 2	Grass Shrimp	Order Decapoda	-	40	-
6	Seine 3	Dragonfly	Suborder Anisoptera	5	1	5
6	Seine 3	Grass Shrimp	Order Decapoda	-	40	-
6	Seine 4	Whirligig Beetle	Family Gyrinidae	6	3	18
6	Seine 4	Mussel	Subclass Heterodonta	6	1	6
6	Seine 4	Grass Shrimp	Order Decapoda	-	50	-
6	Seine 5	Water Boatman	Suborder Heteroptera	-	1	-
6	Seine 5	Grass Shrimp	Order Decapoda	-	70	-
6	Seine 6	Mussel	Subclass Heterodonta	6	8	48
6	Seine 6	Grass Shrimp	Order Decapoda	-	60	-
6	Seine 6	Lunged Snail	Subclass Heterobranchia	7	1	7
7	N/A	N/A	N/A	N/A	N/A	N/A
8	N/A	N/A	N/A	N/A	N/A	N/A
9	N/A	N/A	N/A	N/A	N/A	N/A
10	N/A	N/A	N/A	N/A	N/A	N/A

Transect	Collection Method	Common Name	Taxonomic Level	Tolerance Value	Count	Subtotal
11	N/A	N/A	N/A	N/A	N/A	N/A
12	N/A	N/A	N/A	N/A	N/A	N/A
Transect 1		Total			589	3,252
		HBI Value				5.52
		Macroinvertebrate Variable (MV) Score				**Poor - 2.00**
Transect 2		Total			N/A	N/A
		HBI Value				N/A
		Macroinvertebrate Variable (MV) Score				**Severe - 1.00**
Transect 3		Total			N/A	N/A
		HBI Value				N/A
		Macroinvertebrate Variable (MV) Score				**Severe - 1.00**
Transect 4		Total			N/A	N/A
		HBI Value				N/A
		Macroinvertebrate Variable (MV) Score				**Severe - 1.00**
Transect 5		Total			N/A	N/A
		HBI Value				N/A
		Macroinvertebrate Variable (MV) Score				**Severe - 1.00**
Transect 6		Total			104	576
		HBI Value				5.54
		Macroinvertebrate Variable (MV) Score				**Poor - 2.00**
Transect 7		Total			N/A	N/A
		HBI Value				N/A
		Macroinvertebrate Variable (MV) Score				**Severe - 1.00**
Transect 8		Total			N/A	N/A
		HBI Value				N/A
		Macroinvertebrate Variable (MV) Score				**Severe - 1.00**
Transect 9		Total			N/A	N/A
		HBI Value				N/A
		Macroinvertebrate Variable (MV) Score				**Severe - 1.00**
Transect 10		Total			N/A	N/A
		HBI Value				N/A
		Macroinvertebrate Variable (MV) Score				**Severe - 1.00**
Transect 11		Total			N/A	N/A
		HBI Value				N/A

	Macroinvertebrate Variable (MV) Score		**Severe - 1.00**
Transect 12	Total	N/A	N/A
	HBI Value		N/A
	Macroinvertebrate Variable (MV) Score		**Severe - 1.00**

Table D-3. In-Stream Macroinvertebrate Observations and Hilsenhoff Biotic Index for SX014

Transect	Collection Method	Common Name	Taxonomic Level	Tolerance Value	Count	Subtotal
1	N/A	N/A	N/A	N/A	N/A	N/A
2	N/A	N/A	N/A	N/A	N/A	N/A
3	N/A	N/A	N/A	N/A	N/A	N/A
4	D-Nets	Diving Beetle	Order Coleoptera	-	4	-
5	N/A	N/A	N/A	N/A	N/A	N/A
6	N/A	N/A	N/A	N/A	N/A	N/A
7	N/A	N/A	N/A	N/A	N/A	N/A
8	N/A	N/A	N/A	N/A	N/A	N/A
9	N/A	N/A	N/A	N/A	N/A	N/A
10	N/A	N/A	N/A	N/A	N/A	N/A
11	N/A	N/A	N/A	N/A	N/A	N/A
12	D-Nets	Midge Fly	Family Chironomidae	6	7	42
12	D-Nets	Diving Beetle	Order Coleoptera	-	44	-
12	D-Nets	Grass Shrimp	Order Decapoda	-	35	-
12	D-Nets	Asian Clam	Order Veneroida	-	12	-
12	D-Nets	Leech	Subclass Hirudinea	8	9	72
12	D-Nets	Dragonfly	Suborder Anisoptera	5	2	10
13	N/A	N/A	N/A	N/A	N/A	N/A
14	N/A	N/A	N/A	N/A	N/A	N/A
15	N/A	N/A	N/A	N/A	N/A	N/A
Transect 1		Total			N/A	N/A
		HBI Value				N/A
		Macroinvertebrate Variable (MV) Score				**Severe - 1.00**
Transect 2		Total			N/A	N/A
		HBI Value				N/A
		Macroinvertebrate Variable (MV) Score				**Severe - 1.00**
Transect 3		Total			N/A	N/A
		HBI Value				N/A
		Macroinvertebrate Variable (MV) Score				**Severe - 1.00**
Transect 4		Total			0	0
		HBI Value				0.00
		Macroinvertebrate Variable (MV) Score				***Severe - 1.00**
Transect 5		Total			N/A	N/A
		HBI Value				N/A
		Macroinvertebrate Variable (MV) Score				**Severe - 1.00**
Transect 6		Total			N/A	N/A

	HBI Value		N/A
	Macroinvertebrate Variable (MV) Score		**Severe - 1.00**
Transect 7	Total	N/A	N/A
	HBI Value		N/A
	Macroinvertebrate Variable (MV) Score		**Severe - 1.00**
Transect 8	Total	N/A	N/A
	HBI Value		N/A
	Macroinvertebrate Variable (MV) Score		**Severe - 1.00**
Transect 9	Total	N/A	N/A
	HBI Value		N/A
	Macroinvertebrate Variable (MV) Score		**Severe - 1.00**
Transect 10	Total	N/A	N/A
	HBI Value		N/A
	Macroinvertebrate Variable (MV) Score		**Severe - 1.00**
Transect 11	Total	N/A	N/A
	HBI Value		N/A
	Macroinvertebrate Variable (MV) Score		**Severe - 1.00**
Transect 12	Total	18	124
	HBI Value		6.89
	Macroinvertebrate Variable (MV) Score		**Poor - 2.00**
Transect 13	Total	N/A	N/A
	HBI Value		N/A
	Macroinvertebrate Variable (MV) Score		**Severe - 1.00**
Transect 14	Total	N/A	N/A
	HBI Value		N/A
	Macroinvertebrate Variable (MV) Score		**Severe - 1.00**
Transect 15	Total	N/A	N/A
	HBI Value		N/A
	Macroinvertebrate Variable (MV) Score		**Severe - 1.00**

* While taxon are present within Transect 4, these taxa do not correspond to a tolerance value, and therefore, results in a score of Severe (1.00).

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APPENDIX E

In-Stream Fish Observations Tables

Table E-1. In-Stream Fish Observations for SA001

Transect	Collection Method	Family	Taxonomic Level	Common Name	Tolerance Level	Trophic Group	Native/Non-Native	Count
1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	Seine 1	Cichlidae	*Oreochromis aureus*	Blue Tilapia	Tolerant	Omnivore	Non-Native	3
2	Seine 1	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	108
2	Seine 2	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	71
2	Seine 2	Cichlidae	*Oreochromis aureus*	Blue Tilapia	Tolerant	Omnivore	Non-Native	4
2	Seine 3	Cichlidae	*Oreochromis aureus*	Blue Tilapia	Tolerant	Omnivore	Non-Native	15
2	Seine 3	Cyprinidae	*Hybognathus nuchalis*	Mississippi Silvery Minnow	Tolerant	Omnivore	Native	1
2	Seine 3	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	19
2	Seine 4	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	31
2	Seine 5	Cichlidae	*Oreochromis aureus*	Blue Tilapia	Tolerant	Omnivore	Non-Native	2
2	Seine 5	Cyprinidae	*Hybognathus nuchalis*	Mississippi Silvery Minnow	Tolerant	Omnivore	Native	1
2	Seine 5	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	97
3	Seine 1	Cichlidae	*Oreochromis aureus*	Blue Tilapia	Tolerant	Omnivore	Non-Native	87
3	Seine 1	Cyprinidae	*Hybognathus nuchalis*	Mississippi Silvery Minnow	Tolerant	Omnivore	Native	8
3	Seine 1	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	328
3	Seine 2	Cichlidae	*Oreochromis aureus*	Blue Tilapia	Tolerant	Omnivore	Non-Native	69
3	Seine 2	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	147
3	Seine 2	Cyprinidae	*Hybognathus nuchalis*	Mississippi Silvery Minnow	Tolerant	Omnivore	Native	3
3	Seine 3	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	204
3	Seine 3	Cichlidae	*Oreochromis aureus*	Blue Tilapia	Tolerant	Omnivore	Non-Native	10
3	Seine 3	Cyprinidae	*Hybognathus nuchalis*	Mississippi Silvery Minnow	Tolerant	Omnivore	Native	1
3	Seine 4	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	172
3	Seine 4	Cichlidae	*Oreochromis aureus*	Blue Tilapia	Tolerant	Omnivore	Non-Native	6
3	Seine 4	Cyprinidae	*Hybognathus nuchalis*	Mississippi Silvery Minnow	Tolerant	Omnivore	Native	1
4	Seine 1	Cichlidae	*Oreochromis aureus*	Blue Tilapia	Tolerant	Omnivore	Non-Native	5
4	Seine 1	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	37
4	Seine 1	Lepisosteidae	*Atractosteus spatula*	Alligator Gar	Tolerant	Piscivore	Native	1

Transec t	Collection Method	Family	Taxonomic Level	Common Name	Tolerance Level	Trophic Group	Native/Non-Native	Count
4	Seine 2	Ictaluridae	*Ameiurus natalis*	Yellow Bullhead	-	Omnivore	Native	1
4	Seine 2	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	31
4	Seine 2	Cichlidae	*Oreochromis aureus*	Blue Tilapia	Tolerant	Omnivore	Non-Native	2
4	Seine 2	Cyprinidae	*Hybognathus nuchalis*	Mississippi Silvery Minnow	Tolerant	Omnivore	Native	1
4	Seine 3	Ictaluridae	*Ictalurus punctatus*	Channel Catfish	Tolerant	Omnivore	Native	1
4	Seine 3	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	18
4	Seine 3	Cichlidae	*Oreochromis aureus*	Blue Tilapia	Tolerant	Omnivore	Non-Native	2
4	Seine 3	Cyprinidae	*Hybognathus nuchalis*	Mississippi Silvery Minnow	Tolerant	Omnivore	Native	3
4	Seine 4	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	51
4	Seine 4	Cichlidae	*Oreochromis aureus*	Blue Tilapia	Tolerant	Omnivore	Non-Native	10
4	Seine 5	Lepisosteidae	*Atractosteus spatula*	Alligator Gar	Tolerant	Piscivore	Native	1
4	Seine 5	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	37
4	Seine 5	Cichlidae	*Oreochromis aureus*	Blue Tilapia	Tolerant	Omnivore	Non-Native	10
4	Seine 6	Cyprinidae	*Cyprinus carpio*	Common Carp	Tolerant	Omnivore	Non-Native	3
4	Seine 6	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	41
4	Seine 6	Cichlidae	*Oreochromis aureus*	Blue Tilapia	Tolerant	Omnivore	Non-Native	17
5	Seine 1	Cyprinidae	*Cyprinus carpio*	Common Carp	Tolerant	Omnivore	Non-Native	2
5	Seine 1	Cichlidae	*Oreochromis aureus*	Blue Tilapia	Tolerant	Omnivore	Non-Native	19
5	Seine 1	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	7
5	Seine 2	Cyprinidae	*Cyprinus carpio*	Common Carp	Tolerant	Omnivore	Non-Native	1
5	Seine 2	Centrarchidae	*Lepomis macrochirus*	Bluegill	Tolerant	Invertivore	Native	1
5	Seine 2	Cichlidae	*Oreochromis aureus*	Blue Tilapia	Tolerant	Omnivore	Non-Native	29
5	Seine 2	Cyprinidae	*Hybognathus nuchalis*	Mississippi Silvery Minnow	Tolerant	Omnivore	Native	1
5	Seine 2	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	18
5	Seine 3	Cyprinidae	*Hybognathus nuchalis*	Mississippi Silvery Minnow	Tolerant	Omnivore	Native	1
5	Seine 3	Cichlidae	*Oreochromis aureus*	Blue Tilapia	Tolerant	Omnivore	Non-Native	16
5	Seine 3	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	11
5	Seine 4	Cichlidae	*Oreochromis aureus*	Blue Tilapia	Tolerant	Omnivore	Non-Native	27
5	Seine 4	Cyprinidae	*Hybognathus nuchalis*	Mississippi Silvery Minnow	Tolerant	Omnivore	Native	2

Transect	Collection Method	Family	Taxonomic Level	Common Name	Tolerance Level	Trophic Group	Native/Non-Native	Count
5	Seine 4	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	34
5	Seine 4	Centrarchidae	*Lepomis macrochirus*	Bluegill	Tolerant	Invertivore	Native	1
5	Seine 5	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	70
5	Seine 5	Cyprinidae	*Hybognathus nuchalis*	Mississippi Silvery Minnow	Tolerant	Omnivore	Native	15
5	Seine 5	Cichlidae	*Oreochromis aureus*	Blue Tilapia	Tolerant	Omnivore	Non-Native	17
5	Seine 5	Centrarchidae	*Lepomis macrochirus*	Bluegill	Tolerant	Invertivore	Native	3
5	Seine 6	Cyprinidae	*Hybognathus nuchalis*	Mississippi Silvery Minnow	Tolerant	Omnivore	Native	4
5	Seine 6	Centrarchidae	*Lepomis macrochirus*	Bluegill	Tolerant	Invertivore	Native	2
5	Seine 6	Cichlidae	*Oreochromis aureus*	Blue Tilapia	Tolerant	Omnivore	Non-Native	3
5	Seine 6	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	25
6	Seine 1	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	76
6	Seine 1	Centrarchidae	*Lepomis macrochirus*	Bluegill	Tolerant	Invertivore	Native	1
6	Seine 1	Cyprinidae	*Hybognathus nuchalis*	Mississippi Silvery Minnow	Tolerant	Omnivore	Native	14
6	Seine 2	Cichlidae	*Oreochromis aureus*	Blue Tilapia	Tolerant	Omnivore	Non-Native	1
6	Seine 2	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	69
6	Seine 2	Cyprinidae	*Hybognathus nuchalis*	Mississippi Silvery Minnow	Tolerant	Omnivore	Native	2
6	Seine 3	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	75
6	Seine 3	Ictaluridae	*Ameiurus natalis*	Yellow Bullhead	-	Omnivore	Native	1
6	Seine 3	Cyprinidae	*Hybognathus nuchalis*	Mississippi Silvery Minnow	Tolerant	Omnivore	Native	3
6	Seine 4	Cichlidae	*Oreochromis aureus*	Blue Tilapia	Tolerant	Omnivore	Non-Native	1
6	Seine 4	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	28
6	Seine 4	Cyprinidae	*Hybognathus nuchalis*	Mississippi Silvery Minnow	Tolerant	Omnivore	Native	1
6	Seine 5	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	72
6	Seine 5	Cyprinidae	*Hybognathus nuchalis*	Mississippi Silvery Minnow	Tolerant	Omnivore	Native	1
6	Seine 5	Centrarchidae	*Lepomis macrochirus*	Bluegill	Tolerant	Invertivore	Native	1
6	Seine 6	Cyprinidae	*Cyprinus carpio*	Common Carp	Tolerant	Omnivore	Non-Native	1
6	Seine 6	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	12
6	D-Nets	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	56
6	D-Nets	Cyprinidae	*Hybognathus nuchalis*	Mississippi Silvery Minnow	Tolerant	Omnivore	Native	4

Transect	Collection Method	Family	Taxonomic Level	Common Name	Tolerance Level	Trophic Group	Native/Non-Native	Count
6	D-Nets	Centrarchidae	*Lepomis macrochirus*	Bluegill	Tolerant	Invertivore	Native	1
7	Seine 1	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	11
7	Seine 2	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	38
7	Seine 3	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	10
7	Seine 4	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	2
7	Seine 4	Cyprinidae	*Hybognathus nuchalis*	Mississippi Silvery Minnow	Tolerant	Omnivore	Native	2
7	Seine 5	Centrarchidae	*Lepomis macrochirus*	Bluegill	Tolerant	Invertivore	Native	2
7	Seine 5	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	37
7	Seine 6	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	14
7	D-Nets	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	22
8	D-Nets	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	22
8	Seine 1	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	82
8	Seine 2	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	34
8	Seine 2	Centrarchidae	*Lepomis macrochirus*	Bluegill	Tolerant	Invertivore	Native	1
8	Seine 3	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	34
8	Seine 4	Cichlidae	*Oreochromis aureus*	Blue Tilapia	Tolerant	Omnivore	Non-Native	1
8	Seine 4	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	32
8	Seine 5	Cyprinidae	*Hybognathus nuchalis*	Mississippi Silvery Minnow	Tolerant	Omnivore	Native	2
8	Seine 5	Centrarchidae	*Lepomis cyanellus*	Green Sunfish	Tolerant	Piscivore	Native	2
8	Seine 5	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	48
8	Seine 6	Cyprinidae	*Hybognathus nuchalis*	Mississippi Silvery Minnow	Tolerant	Omnivore	Native	3
8	Seine 6	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	68
8	Seine 6	Centrarchidae	*Lepomis macrochirus*	Bluegill	Tolerant	Invertivore	Native	2
8	Seine 6	Centrarchidae	*Lepomis cyanellus*	Green Sunfish	Tolerant	Piscivore	Native	4
8	Seine 6	Cichlidae	*Oreochromis aureus*	Blue Tilapia	Tolerant	Omnivore	Non-Native	4
9	D-Nets	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	30
9	Seine 1	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	70
9	Seine 1	Centrarchidae	*Lepomis cyanellus*	Green Sunfish	Tolerant	Piscivore	Native	3
9	Seine 1	Cyprinidae	*Hybognathus nuchalis*	Mississippi Silvery Minnow	Tolerant	Omnivore	Native	1

Transect	Collection Method	Family	Taxonomic Level	Common Name	Tolerance Level	Trophic Group	Native/Non-Native	Count
9	Seine 2	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	93
9	Seine 2	Cyprinidae	*Cyprinus carpio*	Common Carp	Tolerant	Omnivore	Non-Native	1
9	Seine 2	Centrarchidae	*Lepomis macrochirus*	Bluegill	Tolerant	Invertivore	Native	2
9	Seine 3	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	58
9	Seine 3	Centrarchidae	*Lepomis cyanellus*	Green Sunfish	Tolerant	Piscivore	Native	2
9	Seine 4	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	56
9	Seine 5	Ictaluridae	*Ictalurus punctatus*	Channel Catfish	Tolerant	Omnivore	Native	3
9	Seine 5	Centrarchidae	*Lepomis macrochirus*	Bluegill	Tolerant	Invertivore	Native	4
9	Seine 5	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	9
9	Seine 6	Aphredoderidae	*Aphredoderus sayanus*	Pirate Perch	-	Invertivore	Native	1
9	Seine 6	Cyprinidae	*Hybognathus nuchalis*	Mississippi Silvery Minnow	Tolerant	Omnivore	Native	3
9	Seine 6	Ictaluridae	*Ictalurus punctatus*	Channel Catfish	Tolerant	Omnivore	Native	1
9	Seine 6	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	4
9	Seine 6	Centrarchidae	*Lepomis macrochirus*	Bluegill	Tolerant	Invertivore	Native	1
10	D-Nets	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	4
10	Seine 1	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	12
10	Seine 2	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	12
10	Seine 2	Ictaluridae	*Ictalurus punctatus*	Channel Catfish	Tolerant	Omnivore	Native	2
10	Seine 2	Centrarchidae	*Lepomis cyanellus*	Green Sunfish	Tolerant	Piscivore	Native	1
10	Seine 3	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	15
10	Seine 3	Centrarchidae	*Lepomis macrochirus*	Bluegill	Tolerant	Invertivore	Native	3
10	Seine 4	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	35
10	Seine 4	Centrarchidae	*Lepomis macrochirus*	Bluegill	Tolerant	Invertivore	Native	2
10	Seine 5	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	71
10	Seine 6	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	64
11	D-Nets	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	1
12	D-Nets	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	2
13	D-Nets	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	4
14	D-Nets	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	23

Transec t	Collection Method	Family	Taxonomic Level	Common Name	Tolerance Level	Trophic Group	Native/Non-Native	Count
14	Seine 1	Poeciliidae	*Poecilia latipinna*	Sailfin Molly	Tolerant	Omnivore	Native	1
14	Seine 1	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	10
14	Seine 2	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	15
14	Seine 3	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	11
15	D-Nets	Poeciliidae	*Poecilia latipinna*	Sailfin Molly	Tolerant	Omnivore	Native	2
15	Seine 1	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	3
15	Seine 2	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	2
15	Seine 3	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	2
16	N/A	N/A	*N/A*	N/A	N/A	N/A	N/A	N/A
17	Seine 3	Ictaluridae	*Ameiurus natalis*	Yellow Bullhead	-	Omnivore	Native	1
17	Seine 5	Atherinopsidae	*Labidesthes sicculus*	Brook silverside	Intolerant	Invertivore	Native	1
18	Seine 1	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	2
19	Seine 1	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	2
19	Seine 3	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	2
19	Seine 4	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	1
20	D-Nets	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	3
21	N/A	N/A	*N/A*	N/A	N/A	N/A	N/A	N/A
22	N/A	N/A	*N/A*	N/A	N/A	N/A	N/A	N/A
23	N/A	N/A	*N/A*	N/A	N/A	N/A	N/A	N/A
24	D-Nets	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	6
25	Seine 1	Cichlidae	*Oreochromis aureus*	Blue tilapia	Tolerant	Omnivore	Non-Native	11
25	Seine 1	Centrarchidae	*Pomoxis annularis*	White crappie	-	Piscivore	Native	12
25	Seine 1	Aphredoderidae	*Aphredoderus sayanus*	Pirate perch	-	Invertivore	Native	2
25	Seine 1	Cyprinidae	*Cyprinus carpio*	Common carp	Tolerant	Omnivore	Non-Native	6
25	Seine 1	Centrarchidae	*Lepomis macrochirus*	Bluegill	Tolerant	Invertivore	Native	4
25	Seine 1	Ictaluridae	*Ictalurus punctatus*	Channel catfish	Tolerant	Omnivore	Native	5
25	Seine 1	Mugilidae	*Mugil cephalus*	Striped mullet	-	Omnivore	Native	10
25	Seine 1	Poeciliidae	*Poecilia latipinna*	Sailfin molly	Tolerant	Omnivore	Native	1
25	Seine 1	Loricariidae	*Hypostomus plecostomus*	Suckermouth Catfish	Tolerant	Herbivore	Non-Native	1

Transect	Collection Method	Family	Taxonomic Level	Common Name	Tolerance Level	Trophic Group	Native/Non-Native	Count
25	Seine 1	Clupeidae	*Dorosoma cepedianum*	Gizzard shad	Tolerant	Omnivore	Native	1
25	Seine 1	Centrarchidae	*Lepomis gulosus*	Warmouth	Tolerant	Piscivore	Native	2
25	Seine 1	Poeciliidae	*Gambusia affinis*	Western mosquitofish	Tolerant	Invertivore	Native	30
25	Seine 2	Centrarchidae	*Lepomis megalotis*	Longear sunfish	-	Invertivore	Native	1
25	Seine 2	Centrarchidae	*Lepomis humilis*	Orangespotted sunfish	-	Invertivore	Native	1
26	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
27	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
28	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Transect 1 Subtotal								N/A
Transect 2 Subtotal								352
Transect 3 Subtotal								1,036
Transect 4 Subtotal								272
Transect 5 Subtotal								309
Transect 6 Subtotal								420
Transect 7 Subtotal								138
Transect 8 Subtotal								339
Transect 9 Subtotal								342
Transect 10 Subtotal								221
Transect 11 Subtotal								1
Transect 12 Subtotal								2
Transect 13 Subtotal								4
Transect 14 Subtotal								60
Transect 15 Subtotal								9
Transect 16 Subtotal								N/A
Transect 17 Subtotal								2
Transect 18 Subtotal								2
Transect 19 Subtotal								5
Transect 20 Subtotal								3
Transect 21 Subtotal								N/A

Transect 22 Subtotal	N/A
Transect 23 Subtotal	N/A
Transect 24 Subtotal	6
Transect 25 Subtotal	87
Transect 26 Subtotal	N/A
Transect 27 Subtotal	N/A
Transect 28 Subtotal	N/A
Total	3,610

Table E-2. In-Stream Fish Observations for SA003

Transect	Collection Method	Family	Taxonomic Level	Common Name	Tolerance Level	Trophic Group	Native/Non-Native	Count
1	D-Nets	Poeciliidae	Gambusia affinis	Western Mosquitofish	Tolerant	Invertivore	Native	34
1	D-Nets	Poeciliidae	Poecilia latipinna	Sailfin Molly	Tolerant	Omnivore	Native	1
1	D-Nets	Centrarchidae	Lepomis macrochirus	Bluegill	Tolerant	Invertivore	Native	1
1	Seine 1	Cyprinidae	Cyprinus carpio	Common Carp	Tolerant	Omnivore	Non-Native	4
1	Seine 1	Cichlidae	Oreochromis aureus	Blue Tilapia	Tolerant	Omnivore	Non-Native	3
1	Seine 1	Poeciliidae	Poecilia latipinna	Sailfin Molly	Tolerant	Omnivore	Native	51
1	Seine 1	Centrarchidae	Lepomis humilis	Orangespotted Sunfish	-	Invertivore	Native	1
1	Seine 1	Centrarchidae	Lepomis macrochirus	Bluegill	Tolerant	Invertivore	Native	3
1	Seine 1	Poeciliidae	Gambusia affinis	Western Mosquitofish	Tolerant	Invertivore	Native	10
2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6	D-Nets	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	47
6	D-Nets	Centrarchidae	*Lepomis humilis*	Orangespotted Sunfish	-	Invertivore	Native	2
6	D-Nets	Poeciliidae	*Poecilia latipinna*	Sailfin Molly	Tolerant	Omnivore	Native	1
6	D-Nets	Centrarchidae	*Lepomis macrochirus*	Bluegill	Tolerant	Invertivore	Native	6
6	Seine 1	Centrarchidae	*Lepomis gulosus*	Warmouth	Tolerant	Piscivore	Native	6
6	Seine 1	Centrarchidae	*Pomoxis annularis*	White Crappie	-	Piscivore	Native	17
6	Seine 1	Centrarchidae	*Lepomis macrochirus*	Bluegill	Tolerant	Invertivore	Native	21
6	Seine 1	Centrarchidae	*Micropterus salmoides*	Largemouth Bass	-	Piscivore	Native	1
6	Seine 1	Cichlidae	*Oreochromis aureus*	Blue Tilapia	Tolerant	Omnivore	Non-Native	1
6	Seine 1	Ictaluridae	*Ameiurus natalis*	Yellow Bullhead	-	Omnivore	Native	1
6	Seine 1	Centrarchidae	*Lepomis humilis*	Orangespotted Sunfish	-	Invertivore	Native	26
6	Seine 1	Ictaluridae	*Ictalurus punctatus*	Channel Catfish	Tolerant	Omnivore	Native	1
6	Seine 1	Catostomidae	*Carpiodes carpio*	River Carpsucker	Tolerant	Omnivore	Native	1
6	Seine 1	Centrarchidae	*Lepomis microlophus*	Redear Sunfish	-	Invertivore	Native	1
6	Seine 1	Clupeidae	*Dorosoma petenense*	Threadfin Shad	-	Omnivore	Native	1

Transect	Collection Method	Family	Taxonomic Level	Common Name	Tolerance Level	Trophic Group	Native/Non-Native	Count
6	Seine 1	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	21
6	Seine 2	Centrarchidae	*Pomoxis annularis*	White Crappie	-	Piscivore	Native	9
6	Seine 2	Atherinopsidae	*Labidesthes sicculus*	Brook Silverside	Intolerant	Invertivore	Native	2
6	Seine 2	Catostomidae	*Carpiodes carpio*	River Carpsucker	Tolerant	Omnivore	Native	1
6	Seine 2	Centrarchidae	*Lepomis megalotis*	Longear Sunfish	-	Invertivore	Native	11
6	Seine 2	Centrarchidae	*Lepomis macrochirus*	Bluegill	Tolerant	Invertivore	Native	17
6	Seine 2	Centrarchidae	*Lepomis gulosus*	Warmouth	Tolerant	Piscivore	Native	3
6	Seine 2	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	30
6	Seine 3	Centrarchidae	*Pomoxis annularis*	White Crappie	-	Piscivore	Native	10
6	Seine 3	Centrarchidae	*Lepomis macrochirus*	Bluegill	Tolerant	Invertivore	Native	16
6	Seine 3	Clupeidae	*Dorosoma cepedianum*	Gizzard Shad	Tolerant	Omnivore	Native	1
6	Seine 3	Centrarchidae	*Lepomis megalotis*	Longear Sunfish	-	Invertivore	Native	2
6	Seine 3	Centrarchidae	*Lepomis humilis*	Orangespotted Sunfish	-	Invertivore	Native	17
6	Seine 3	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	34
6	Seine 3	Centrarchidae	*Lepomis gulosus*	Warmouth	Tolerant	Piscivore	Native	1
6	Seine 4	Centrarchidae	*Lepomis macrochirus*	Bluegill	Tolerant	Invertivore	Native	12
6	Seine 4	Mugilidae	*Mugil cephalus*	Striped Mullet	-	Omnivore	Native	2
6	Seine 4	Centrarchidae	*Pomoxis annularis*	White Crappie	-	Piscivore	Native	6
6	Seine 4	Centrarchidae	*Lepomis humilis*	Orangespotted Sunfish	-	Invertivore	Native	15
6	Seine 4	Centrarchidae	*Lepomis gulosus*	Warmouth	Tolerant	Piscivore	Native	5
6	Seine 4	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	31
6	Seine 4	Clupeidae	*Dorosoma petenense*	Threadfin Shad	-	Omnivore	Native	1
6	Seine 5	Centrarchidae	*Lepomis humilis*	Orangespotted Sunfish	-	Invertivore	Native	18
6	Seine 5	Centrarchidae	*Pomoxis annularis*	White Crappie	-	Piscivore	Native	10
6	Seine 5	Centrarchidae	*Lepomis macrochirus*	Bluegill	Tolerant	Invertivore	Native	2
6	Seine 5	Centrarchidae	*Lepomis gulosus*	Warmouth	Tolerant	Piscivore	Native	2
6	Seine 5	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	50
6	Seine 6	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	42
6	Seine 6	Catostomidae	*Carpiodes carpio*	River Carpsucker	Tolerant	Omnivore	Native	1

Transect	Collection Method	Family	Taxonomic Level	Common Name	Tolerance Level	Trophic Group	Native/Non-Native	Count
6	Seine 6	Centrarchidae	*Pomoxis annularis*	White Crappie	-	Piscivore	Native	10
6	Seine 6	Centrarchidae	*Lepomis macrochirus*	Bluegill	Tolerant	Invertivore	Native	23
6	Seine 6	Centrarchidae	*Lepomis humilis*	Orangespotted Sunfish	-	Invertivore	Native	12
6	Seine 6	Centrarchidae	*Lepomis gulosus*	Warmouth	Tolerant	Piscivore	Native	2
7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
14	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
15	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Transect 1								*108*
Transect 2								*N/A*
Transect 3								*N/A*
Transect 4								*N/A*
Transect 5								*N/A*
Transect 6								*552*
Transect 7								*N/A*
Transect 8								*N/A*
Transect 9								*N/A*
Transect 10								*N/A*
Transect 11								*N/A*
Transect 12								*N/A*
Transect 13								*N/A*
Transect 14								*N/A*
Transect 15								*N/A*

Transect	Collection Method	Family	Taxonomic Level	Common Name	Tolerance Level	Trophic Group	Native/Non-Native	Count
Total								**660**

Table E-3. In-Stream Fish Observations for SX014

Transect	Collection Method	Family	Taxonomic Level	Common Name	Tolerance Level	Trophic Group	Native/Non-Native	Count
1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12	D-Nets	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	7
12	Seine 1	Poeciliidae	*Gambusia affinis*	Western Mosquitofish	Tolerant	Invertivore	Native	206
12	Seine 1	Cichlidae	*Oreochromis aureus*	Blue tilapia	Tolerant	Omnivore	Non-Native	9
12	Seine 1	Cyprinidae	*Cyprinella lutrensis*	Red shiner	Tolerant	Invertivore	Native	1
12	Seine 1	Centrarchidae	*Lepomis cyanellus*	Green sunfish	Tolerant	Piscivore	Native	1
12	Seine 1	Centrarchidae	*Lepomis macrochirus*	Bluegill	Tolerant	Invertivore	Native	4
12	Seine 1	Poeciliidae	*Poecilia latipinna*	Sailfin molly	Tolerant	Omnivore	Native	60
13	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
14	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
15	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Transect 1 Subtotal								*N/A*
Transect 2 Subtotal								*N/A*
Transect 3 Subtotal								*N/A*
Transect 4 Subtotal								*N/A*
Transect 5 Subtotal								*N/A*
Transect 6 Subtotal								*N/A*

Transect	Collection Method	Family	Taxonomic Level	Common Name	Tolerance Level	Trophic Group	Native/Non-Native	Count
Transect 7 Subtotal								*N/A*
Transect 8 Subtotal								*N/A*
Transect 9 Subtotal								*N/A*
Transect 10 Subtotal								*N/A*
Transect 11 Subtotal								*N/A*
Transect 12 Subtotal								*288*
Transect 13 Subtotal								*N/A*
Transect 14 Subtotal								*N/A*
Transect 15 Subtotal								*N/A*
Total								**288**

APPENDIX F

Ecoregion 34: West Gulf Coastal Plain Metric Tables

Table F-1. Ecoregion 34: Western Gulf Coastal Plain Metric for SA001 – Transects 1 to 10

Metric	Scoring Criteria			1		2		3		4		5	
	5	3	1	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
1. Total number of fish species	See Figure Below			--	--	2	**1**	2	**1**	5	**3**	4	**1**
2. Number of native cyprinid species	>2	2	<2	--	--	1	**1**	1	**1**	1	**1**	1	**1**
3. Number of benthic invertivore species	>1	1	0	--	--	0	**1**	0	**1**	0	**1**	0	**1**
4. Number of sunfish species	>3	2-3	<2	--	--	0	**1**	0	**1**	0	**1**	1	**1**
5. Number of intolerant species	>1	-	0	--	--	0	**1**	0	**1**	0	**1**	0	**1**
6. Percent of individuals as tolerant species (excluding western mosquitofish *Gambusia affinis*)	<26%	26-50%	>50%	--	--	100%	**1**	100%	**1**	80%	**1**	100%	**1**
7. Percent of individuals as omnivores	<9%	9-16%	>16%	--	--	55%	**1**	67%	**1**	58%	**1**	57%	**1**
8. Percent of individuals as invertivores	>65%	33-65%	<33%	--	--	45%	**3**	33%	**3**	32%	**1**	43%	**3**
9. Number of individuals in sample													
a. Number of individuals per seine haul	>174.7	87.4-174.7	<87.4	--	--	65.6	**1**	46	**1**	37.3	**1**	33	**1**
b. Number of individuals per minute electrofishing	>7.7	3.9-7.7	<3.9	--	--	--	--	--	--	--	--	--	--
10. Percent of individuals as non-native species	<1.4%	1.4-2.7%	>2.7%	--	--	36%	**1**	33%	**1**	37%	**1**	35%	**1**
11. Percent of individuals with disease or other anomaly	<0.6%	0.6-1.0%	>1.0%	--	--	0%	**5**	0%	**5**	0%	**5**	0%	**5**
Sum of Score:					--		**17**		**17**		**17**		**17**
Aquatic Life Use Score:					**Severe**		**Limited**		**Limited**		**Limited**		**Limited**
Fish Variable Score:					**1**		**2**		**2**		**2**		**2**

Metric	Scoring Criteria			6		7		8		9		10	
	5	3	1	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
1. Total number of fish species	See Figure Below			5	**3**	3	**1**	4	**1**	7	**3**	4	**1**
2. Number of native cyprinid species	>2	2	<2	1	**1**	1	**1**	1	**1**	1	**1**	0	**1**
3. Number of benthic invertivore species	>1	1	0	0	**1**	0	**1**	0	**1**	0	**1**	0	**1**
4. Number of sunfish species	>3	2-3	<2	1	**1**	1	**1**	2	**3**	2	**3**	2	**3**
5. Number of intolerant species	>1	-	0	0	**1**	0	**1**	0	**1**	0	**1**	0	**1**
6. Percent of individuals as tolerant species (excluding western mosquitofish *Gambusia affinis*)	<26%	26-50%	>50%	91%	**1**	100%	**1**	100%	**1**	91%	**1**	100%	**1**
7. Percent of individuals as omnivores	<9%	9-16%	>16%	50%	**1**	11%	**3**	27%	**1**	28%	**1**	9%	**3**
8. Percent of individuals as invertivores	>65%	33-65%	<33%	50%	**3**	89%	**5**	60%	**3**	61%	**3**	82%	**5**
9. Number of individuals in sample													
a. Number of individuals per seine haul	>174.7	87.4-174.7	<87.4	59.7	**1**	19.3	**1**	52	**1**	52	**1**	36.2	**1**
b. Number of individuals per minute electrofishing	>7.7	3.9-7.7	<3.9	--	--	--	--	--	--	--	--	--	--
10. Percent of individuals as non-native species	<1.4%	1.4-2.7%	>2.7%	15%	**1**	0%	**5**	13%	**1**	6%	**1**	0%	**5**
11. Percent of individuals with disease or other anomaly	<0.6%	0.6-1.0%	>1.0%	0%	**5**	0%	**5**	0%	**5**	0%	**5**	0%	**5**
Sum of Score:					**19**		**25**		**19**		**21**		**27**
Aquatic Life Use Score:					**Limited**		**Limited**		**Limited**		**Limited**		**Limited**
Fish Variable Score:					**2**		**2**		**2**		**2**		**2**

Table F-2. Ecoregion 34: Western Gulf Coastal Plain Metric for SA001 – Transects 11 to 20

Metric	Scoring Criteria			11		12		13		14		15	
	5	3	1	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
1. Total number of fish species	See Figure Below			1	1	1	1	1	1	2	1	2	1
2. Number of native cyprinid species	>2	2	<2	0	1	0	1	0	1	0	1	0	1
3. Number of benthic invertivore species	>1	1	0	0	1	0	1	0	1	0	1	0	1
4. Number of sunfish species	>3	2-3	<2	0	1	0	1	0	1	0	1	0	1
5. Number of intolerant species	>1	-	0	0	1	0	1	0	1	0	1	0	1
6. Percent of individuals as tolerant species (excluding western mosquitofish *Gambusia affinis*)	<26%	26-50%	>50%	0%	5	0%	5	0%	5	100%	1	100%	1
7. Percent of individuals as omnivores	<9%	9-16%	>16%	0%	5	0%	5	0%	5	20%	1	25%	1
8. Percent of individuals as invertivores	>65%	33-65%	<33%	100%	5	100%	5	100%	5	80%	5	75%	5
9. Number of individuals in sample													
a. Number of individuals per seine haul	>174.7	87.4-174.7	<87.4	0	1	0	1	0	1	12.3	1	2.3	1
b. Number of individuals per minute electrofishing	>7.7	3.9-7.7	<3.9	--	--	--	--	--	--	--	--	--	--
10. Percent of individuals as non-native species	<1.4%	1.4-2.7%	>2.7%	0%	5	0%	5	0%	5	0%	5	0%	5
11. Percent of individuals with disease or other anomaly	<0.6%	0.6-1.0%	>1.0%	0%	5	0%	5	0%	5	0%	5	0%	5
Sum of Score:					31		31		31		23		23
Aquatic Life Use Score:					Intermediate		Intermediate		Intermediate		Limited		Limited
Fish Variable Score:					3		3		3		2		2

Metric	Scoring Criteria			16		17		18		19		20	
	5	3	1	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
1. Total number of fish species	See Figure Below			0	0	1	1	1	1	1	1	1	1
2. Number of native cyprinid species	>2	2	<2	0	0	0	1	0	1	0	1	0	1
3. Number of benthic invertivore species	>1	1	0	0	0	0	1	0	1	0	1	0	1
4. Number of sunfish species	>3	2-3	<2	0	0	0	1	0	1	0	1	0	1
5. Number of intolerant species	>1	-	0	0	0	0	1	0	1	0	1	0	1
6. Percent of individuals as tolerant species (excluding western mosquitofish *Gambusia affinis*)	<26%	26-50%	>50%	0%	0	100%	1	0%	5	0%	5	0%	5
7. Percent of individuals as omnivores	<9%	9-16%	>16%	0%	0	50%	1	0%	5	0%	5	0%	5
8. Percent of individuals as invertivores	>65%	33-65%	<33%	0%	0	50%	3	100%	5	100%	5	100%	5
9. Number of individuals in sample													
a. Number of individuals per seine haul	>174.7	87.4-174.7	<87.4	0	0	1	1	2	1	1.7	1	0	1
b. Number of individuals per minute electrofishing	>7.7	3.9-7.7	<3.9	--	--	--	--	--	--	--	--	--	--
10. Percent of individuals as non-native species	<1.4%	1.4-2.7%	>2.7%	0%	0	0%	5	0%	5	0%	5	0%	5
11. Percent of individuals with disease or other anomaly	<0.6%	0.6-1.0%	>1.0%	0%	0	0%	5	0%	5	0%	5	0%	5
Sum of Score:					0		21		31		31		31
Aquatic Life Use Score:					Severe		Limited		Intermediate		Intermediate		Intermediate
Fish Variable Score:					1		2		3		3		3

Table F-3. Ecoregion 34: Western Gulf Coastal Plain Metric for SA001 – Transects 21 to 28

Metric	Scoring Criteria			21		22		23		24		25	
	5	3	1	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
1. Total number of fish species		See Figure Below		0	0	0	0	0	0	1	1	10	5
2. Number of native cyprinid species	>2	2	<2	0	0	0	0	0	0	0	1	0	1
3. Number of benthic invertivore species	>1	1	0	0	0	0	0	0	0	0	1	0	1
4. Number of sunfish species	>3	2-3	<2	0	0	0	0	0	0	0	1	5	5
5. Number of intolerant species	>1	-	0	0	0	0	0	0	0	0	1	0	1
6. Percent of individuals as tolerant species (excluding western mosquitofish *Gambusia affinis*)	<26%	26-50%	>50%	0%	0	0%	0	0%	0	0%	5	56%	1
7. Percent of individuals as omnivores	<9%	9-16%	>16%	0%	0	0%	0	0%	0	0%	5	43%	1
8. Percent of individuals as invertivores	>65%	33-65%	<33%	0%	0	0%	0	0%	0	100%	5	36%	3
9. Number of individuals in sample													
a. Number of individuals per seine haul	>174.7	87.4-174.7	<87.4	0	0	0	0	0	0	0	1	6	1
b. Number of individuals per minute electrofishing	>7.7	3.9-7.7	<3.9	--	--	--	--	--	--	--	--	--	--
10. Percent of individuals as non-native species	<1.4%	1.4-2.7%	>2.7%	0%	0	0%	0	0%	0	0%	5	21%	1
11. Percent of individuals with disease or other anomaly	<0.6%	0.6-1.0%	>1.0%	0%	0	0%	0	0%	0	0%	5	0%	5
Sum of Score:					0		0		0		31		25
Aquatic Life Use Score:					Severe		Severe		Severe		Intermediate		Limited
Fish Variable Score:					1		1		1		3		2

Metric	Scoring Criteria			26		27		28	
	5	3	1	Value	Score	Value	Score	Value	Score
1. Total number of fish species		See Figure Below		0	0	0	0	0	0
2. Number of native cyprinid species	>2	2	<2	0	0	0	0	0	0
3. Number of benthic invertivore species	>1	1	0	0	0	0	0	0	0
4. Number of sunfish species	>3	2-3	<2	0	0	0	0	0	0
5. Number of intolerant species	>1	-	0	0	0	0	0	0	0
6. Percent of individuals as tolerant species (excluding western mosquitofish *Gambusia affinis*)	<26%	26-50%	>50%	0%	0	0%	0	0%	0
7. Percent of individuals as omnivores	<9%	9-16%	>16%	0%	0	0%	0	0%	0
8. Percent of individuals as invertivores	>65%	33-65%	<33%	0%	0	0%	0	0%	0
9. Number of individuals in sample									
a. Number of individuals per seine haul	>174.7	87.4-174.7	<87.4	0	0	0	0	0	0
b. Number of individuals per minute electrofishing	>7.7	3.9-7.7	<3.9	--	--	--	--	--	--
10. Percent of individuals as non-native species	<1.4%	1.4-2.7%	>2.7%	0%	0	0%	0	0%	0
11. Percent of individuals with disease or other anomaly	<0.6%	0.6-1.0%	>1.0%	0%	0	0%	0	0%	0
Sum of Score:					--		--		--
Aquatic Life Use Score:					Severe		Severe		Severe
Fish Variable Score:					1		1		1

Table F-4. Ecoregion 34: Western Gulf Coastal Plain Metric for SA003 – Transects 1 to 10

Metric	Scoring Criteria			1		2		3		4		5	
	5	3	1	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
1. Total number of fish species	See Figure Below			6	3	0	0	0	0	0	0	0	0
2. Number of native cyprinid species	>2	2	<2	0	1	0	0	0	0	0	0	0	0
3. Number of benthic invertivore species	>1	1	0	0	0	0	0	0	0	0	0	0	0
4. Number of sunfish species	>3	2-3	<2	2	3	0	0	0	0	0	0	0	0
5. Number of intolerant species	>1	-	0	0	0	0	0	0	0	0	0	0	0
6. Percent of individuals as tolerant species (excluding western mosquitofish *Gambusia affinis*)	<26%	26-50%	>50%	83%	1	0	0	0	0	0	0	0	0
7. Percent of individuals as omnivores	<9%	9-16%	>16%	44%	1	0	0	0	0	0	0	0	0
8. Percent of individuals as invertivores	>65%	33-65%	<33%	56%	3	0	0	0	0	0	0	0	0
9. Number of individuals in sample													
a. Number of individuals per seine haul	>174.7	87.4-174.7	<87.4	69	1	0	0	0	0	0	0	0	0
b. Number of individuals per minute electrofishing	>7.7	3.9-7.7	<3.9	--	--	--	--	--	--	--	--	--	--
10. Percent of individuals as non-native species	<1.4%	1.4-2.7%	>2.7%	22%	1	0	0	0	0	0	0	0	0
11. Percent of individuals with disease or other anomaly	<0.6%	0.6-1.0%	>1.0%	0%	5	0	0	0	0	0	0	0	0
Sum of Score:					19		0		0		0		0
Aquatic Life Use Score:					Limited		Severe		Severe		Severe		Severe
Fish Variable Score:					2		1		1		1		1

Metric	Scoring Criteria			6		7		8		9		10	
	5	3	1	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
1. Total number of fish species	See Figure Below			17	5	0	0	0	0	0	0	0	0
2. Number of native cyprinid species	>2	2	<2	0	1	0	0	0	0	0	0	0	0
3. Number of benthic invertivore species	>1	1	0	0	0	0	0	0	0	0	0	0	0
4. Number of sunfish species	>3	2-3	<2	7	5	0	0	0	0	0	0	0	0
5. Number of intolerant species	>1	-	0	0	0	0	0	0	0	0	0	0	0
6. Percent of individuals as tolerant species (excluding western mosquitofish *Gambusia affinis*)	<26%	26-50%	>50%	47%	3	0	0	0	0	0	0	0	0
7. Percent of individuals as omnivores	<9%	9-16%	>16%	23%	1	0	0	0	0	0	0	0	0
8. Percent of individuals as invertivores	>65%	33-65%	<33%	50%	3	0	0	0	0	0	0	0	0
9. Number of individuals in sample													
a. Number of individuals per seine haul	>174.7	87.4-174.7	<87.4	80.8	1	0	0	0	0	0	0	0	0
b. Number of individuals per minute electrofishing	>7.7	3.9-7.7	<3.9	--	--	--	--	--	--	--	--	--	--
10. Percent of individuals as non-native species	<1.4%	1.4-2.7%	>2.7%	2.1%	3	0	0	0	0	0	0	0	0
11. Percent of individuals with disease or other anomaly	<0.6%	0.6-1.0%	>1.0%	0%	5	0	0	0	0	0	0	0	0
Sum of Score:					27		0		0		0		0
Aquatic Life Use Score:					Limited		Severe		Severe		Severe		Severe
Fish Variable Score:					2		1		1		1		1

Table F-5. Ecoregion 34: Western Gulf Coastal Plain Metric for SA003 – Transects 11 to 12

Metric	Scoring Criteria			11		12	
	5	3	1	Value	Score	Value	Score
1. Total number of fish species	See Figure Below			0	**0**	0	**0**
2. Number of native cyprinid species	>2	2	<2	0	**0**	0	**0**
3. Number of benthic invertivore species	>1	1	0	0	**0**	0	**0**
4. Number of sunfish species	>3	2-3	<2	0	**0**	0	**0**
5. Number of intolerant species	>1	-	0	0	**0**	0	**0**
6. Percent of individuals as tolerant species (excluding western mosquitofish *Gambusia affinis*)	<26%	26-50%	>50%	0	**0**	0	**0**
7. Percent of individuals as omnivores	<9%	9-16%	>16%	0	**0**	0	**0**
8. Percent of individuals as invertivores	>65%	33-65%	<33%	0	**0**	0	**0**
9. Number of individuals in sample							
a. Number of individuals per seine haul	>174.7	87.4-174.7	<87.4	0	**0**	0	**0**
b. Number of individuals per minute electrofishing	>7.7	3.9-7.7	<3.9	--	**--**	--	**--**
10. Percent of individuals as non-native species	<1.4%	1.4-2.7%	>2.7%	0	**0**	0	**0**
11. Percent of individuals with disease or other anomaly	<0.6%	0.6-1.0%	>1.0%	0	**0**	0	**0**
Sum of Score:					**0**		**0**
Aquatic Life Use Score:					**Severe**		**Severe**
Fish Variable Score:					**1**		**1**

Table F-6. Ecoregion 34: Western Gulf Coastal Plain Metric for SX014 – Transects 1 to 10

Metric	Scoring Criteria			1		2		3		4		5	
	5	3	1	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
1. Total number of fish species	See Figure Below			0	0	0	0	0	0	0	0	0	0
2. Number of native cyprinid species	>2	2	<2	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**
3. Number of benthic invertivore species	>1	1	0	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**
4. Number of sunfish species	>3	2-3	<2	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**
5. Number of intolerant species	>1	-	0	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**
6. Percent of individuals as tolerant species (excluding western mosquitofish *Gambusia affinis*)	<26%	26-50%	>50%	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**
7. Percent of individuals as omnivores	<9%	9-16%	>16%	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**
8. Percent of individuals as invertivores	>65%	33-65%	<33%	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**
9. Number of individuals in sample													
a. Number of individuals per seine haul	>174.7	87.4-174.7	<87.4	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**
b. Number of individuals per minute electrofishing	>7.7	3.9-7.7	<3.9	--	**--**	--	**--**	--	**--**	--	**--**	--	**--**
10. Percent of individuals as non-native species	<1.4%	1.4-2.7%	>2.7%	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**
11. Percent of individuals with disease or other anomaly	<0.6%	0.6-1.0%	>1.0%	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**
Sum of Score:					**0**		**0**		**0**		**0**		**0**
Aquatic Life Use Score:					**Severe**		**Severe**		**Severe**		**Severe**		**Severe**
Fish Variable Score:					**1**		**1**		**1**		**1**		**1**

Metric	Scoring Criteria			6		7		8		9		10	
	5	3	1	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
1. Total number of fish species	See Figure Below			0	**0**	0	**0**	0	**0**	0	**0**	0	**0**
2. Number of native cyprinid species	>2	2	<2	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**
3. Number of benthic invertivore species	>1	1	0	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**
4. Number of sunfish species	>3	2-3	<2	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**
5. Number of intolerant species	>1	-	0	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**
6. Percent of individuals as tolerant species (excluding western mosquitofish *Gambusia affinis*)	<26%	26-50%	>50%	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**
7. Percent of individuals as omnivores	<9%	9-16%	>16%	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**
8. Percent of individuals as invertivores	>65%	33-65%	<33%	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**
9. Number of individuals in sample													
a. Number of individuals per seine haul	>174.7	87.4-174.7	<87.4	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**
b. Number of individuals per minute electrofishing	>7.7	3.9-7.7	<3.9	--	**--**	--	**--**	--	**--**	--	**--**	--	**--**
10. Percent of individuals as non-native species	<1.4%	1.4-2.7%	>2.7%	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**
11. Percent of individuals with disease or other anomaly	<0.6%	0.6-1.0%	>1.0%	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**
Sum of Score:					**0**		**0**		**0**		**0**		**0**
Aquatic Life Use Score:					**Severe**		**Severe**		**Severe**		**Severe**		**Severe**
Fish Variable Score:					**1**		**1**		**1**		**1**		**1**

Table F-7. Ecoregion 34: Western Gulf Coastal Plain Metric for SX014 – Transects 11 to 15

Metric	Scoring Criteria			11		12		13		14		15	
	5	3	1	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
1. Total number of fish species	See Figure Below			0	**0**	6	**3**	0	**0**	0	**0**	0	**0**
2. Number of native cyprinid species	>2	2	<2	0	**0**	0	**1**	0	**0**	0	**0**	0	**0**
3. Number of benthic invertivore species	>1	1	0	0	**0**	0	**1**	0	**0**	0	**0**	0	**0**
4. Number of sunfish species	>3	2-3	<2	0	**0**	2	**3**	0	**0**	0	**0**	0	**0**
5. Number of intolerant species	>1	-	0	0	**0**	0	**1**	0	**0**	0	**0**	0	**0**
6. Percent of individuals as tolerant species (excluding western mosquitofish *Gambusia affinis*)	<26%	26-50%	>50%	0	**0**	1	**1**	0	**0**	0	**0**	0	**0**
7. Percent of individuals as omnivores	<9%	9-16%	>16%	0	**0**	29%	**1**	0	**0**	0	**0**	0	**0**
8. Percent of individuals as invertivores	>65%	33-65%	<33%	0	**0**	57%	**3**	0	**0**	0	**0**	0	**0**
9. Number of individuals in sample													
a. Number of individuals per seine haul	>174.7	87.4-174.7	<87.4	0	**0**	281.0	**5**	0	**0**	0	**0**	0	**0**
b. Number of individuals per minute electrofishing	>7.7	3.9-7.7	<3.9	--	**--**	--	**--**	--	**--**	--	**--**	--	**--**
10. Percent of individuals as non-native species	<1.4%	1.4-2.7%	>2.7%	0	**0**	14.3%	**1**	0	**0**	0	**0**	0	**0**
11. Percent of individuals with disease or other anomaly	<0.6%	0.6-1.0%	>1.0%	0	**0**	0	**5**	0	**0**	0	**0**	0	**0**
Sum of Score:					**0**		**25**		**0**		**0**		**0**
Aquatic Life Use Score:					**Severe**		**Limitied**		**Severe**		**Severe**		**Severe**
Fish Variable Score:					**1**		**2**		**1**		**1**		**1**

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APPENDIX E

Interim Hydrogeomorphic Functional Assessment Report

Interim Hydrogeomorphic Functional Assessment Report for the Dow Harris Reservoir Expansion Project in Brazoria County, Texas

USACE FILE NO. SWG-2016-01027

OCTOBER 2021

PREPARED FOR

Dow Chemical Company

PREPARED BY

SWCA Environmental Consultants

INTERIM HYDROGEOMORPHIC FUNCTIONAL ASSESSMENT REPORT FOR THE DOW HARRIS RESERVOIR EXPANSION PROJECT IN BRAZORIA COUNTY, TEXAS

Prepared for

Dow Chemical Company
Texas Innovation Center
332 SH 332 E
Lake Jackson, Texas 77566

Prepared by

SWCA Environmental Consultants
10245 West Little York Road, Suite 600
Houston, Texas 77040
(281) 617- 3217
www.swca.com

SWCA Project No. 052872
USACE File No. SWG-2016-01027

October 2021

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1 INTRODUCTION

At the request of Dow Chemical Company, SWCA Environmental Consultants (SWCA) performed an interim hydrogeomorphic (iHGM) functional assessment of wetlands for the proposed Dow Harris Reservoir Expansion Project (Project) located in Brazoria County, Texas. The tract is 4.3 miles northwest of Chenango, Texas, and 4.8 miles west of the intersection of Hwy 288 and North Velasco Street (Figure 1, Appendix A). The site is located inside the U.S. Geological Survey (USGS) 7.5-minute quadrangles for Otey, Texas and East Columbia, Texas. The approximate center of the project is located at latitude 29.2642˚ north and longitude 95.5454˚ west (Figure 1, Appendix A). The tract extends from north of the existing Harris Reservoir to the western edge of Otey, Texas. Please refer to the Vicinity Map (Figure 1) and Wetland Delineation Map (Figure 2) in Appendix A for the locations and settings of the survey area.

The purpose of this functional assessment is to determine the functional capacities of wetlands within the property. In June and July 2019, SWCA conducted an on-site iHGM functional assessment concurrent with the wetland delineation. Field personnel collected data to determine the sub-index values for the variables associated with the Herbaceous/Shrub and Forested iHGM models. The iHGM models provide mechanisms through which generally defined functions are quantified for comparative purposes. Within this framework, major classes of wetland functions are described as indices, which can be compared to other wetlands. This report describes the methods and results of the functional assessment conducted for the Dow Harris Reservoir Expansion Project.

2 METHODS

2.1 iHGM Assessment

The iHGM uses multiple variables to evaluate three ecological functions that describe, and measure, forested and herbaceous/shrub riverine wetlands in the U.S. Army Corps of Engineers (USACE) Galveston District. These three functional capacity indices (FCI) are used to quantify potential impacts for each wetland assessment area (WAA) associated with a project. For this project, SWCA applied both the Riverine Herbaceous/Shrub functional assessment and Riverine Forested functional assessment (USACE 2010a). The FCI quantify temporary storage of surface water (TSSW), maintenance of plant and animal communities (MPAC), and removal and sequestration of elements and compounds (RSEC) for each wetland to determine physical, biological, and chemical functions, respectively.

The Riverine Herbaceous/Shrub iHGM functional assessment uses 10 variables to evaluate non-forested (herbaceous or scrub-shrub) riverine wetlands. The three indices are expressed as:

$$TSSW = \sqrt{\left[\sqrt{\left(V_{dur} * V_{freq}\right)} * \left(\frac{(V_{topo} + \frac{V_{herb} + V_{mid}}{2})}{3}\right)\right]}$$

$$MPAC = \frac{\left[V_{mid} + V_{herb} + V_{connect}\right]}{3}$$

$$RSEC = \frac{\left[V_{wood} + V_{freq} + V_{dur} + \left(\frac{V_{topo} + V_{herb} + V_{wood}}{3}\right) + \left(\frac{V_{detritus} + V_{redox} + V_{sorpt}}{3}\right)\right]}{5}$$

with the variables

V_{dur} - Duration of flooding and ponding in an average year
V_{freq} - Frequency of flooding and ponding
V_{topo} - Percent containing topographic features
V_{herb} - Percent of herbaceous cover
V_{mid} - Percent of relative cover between the herbaceous and tree strata
V_{wood} - Percent covered by woody vegetation
$V_{detritus}$ - Percent of area with detritus at the soil surface
V_{redox} - Abundance of redox features within the top 12 inches of soil
V_{sorpt} - Absorptive properties of the soil
$V_{connect}$ - Number of habitat types found within 600 feet

ranging from 0 to 1 based on site conditions at the time of the assessment.

The Riverine Forested iHGM model includes the variables found in the Riverine Herbaceous/Shrub iHGM functional assessment with five additional variables that account for the ecological effects of the tree stratum and associated detritus. Comparable to the herbaceous/shrub model, forest indices are expressed as:

$$TSSW = \sqrt{\left[\sqrt{\left(V_{dur} * V_{freq}\right)} * \left(\frac{(V_{topo} + V_{cwd} + V_{wood})}{3}\right)\right]}$$

$$MPAC = \frac{\left[V_{tree} + V_{cwd} + V_{rich} + \frac{\left(V_{basal} + V_{density}\right)}{2} + \frac{(V_{mid} + V_{herb})}{2} + V_{connect}\right]}{6}$$

$$RSEC = \frac{\left[V_{wood} + V_{freq} + V_{dur} + \left(\frac{V_{topo} + V_{cwd} + V_{wood}}{3}\right) + \left(\frac{V_{detritus} + V_{redox} + V_{sorpt}}{3}\right)\right]}{5}$$

with the additional variables

V_{cwd} - Number of pieces of woody debris 3 inches in diameter or greater found along a 100-foot transect

V_{tree} - Percent tree canopy cover

V_{rich} - Number of species representing greater than 5 percent of the tree stand

V_{basal} - Basal area of trees in square feet per acre

$V_{density}$ - Number of trees per acre

also ranging from 0 to 1 based on site conditions at the time of the assessment.

Thus, a wetland scoring closer to 1 for each variable will generate a higher FCI score for each ecological function (TSSW, MPAC, and RSEC) than one in which variable values are near 0. Once an FCI has been calculated for each wetland, the corresponding functional capacity units (FCU) can be determined based on the product of the total acreage of a wetland and its corresponding FCI values.

2.2 Field Survey

SWCA completed the on-site iHGM functional assessment following the guidelines provided in the USACE 2010 Riverine Herbaceous/Shrub iHGM and Forested iHGM guidance documents. Wetlands as identified by the wetland delineation were divided into WAAs, or physically continuous and hydrogeomorphically homogeneous wetlands (USACE 1995). Vegetation communities were classified following the Cowardin et al. (1979) system. Most wetlands within the project area were defined as separate WAAs based on differences in physical, biological, and chemical functions. However, the similarities of some wetlands were deemed homogeneous and were combined and assessed as a single WAA. See Appendix A for maps depicting the location of WAAs within the project area.

A circular 37.2-foot-radius plot (i.e., 0.1 acre) was established for each wetland to assess field variables of the appropriate iHGM functional assessment model. For wetlands less than 0.1 acre, the entire wetland was assessed. Variables that are not amenable to field survey (e.g., $V_{connect}$, V_{dur}, and V_{freq}) were assessed using recent aerial images and United Stated Geological Survey (USGS) topographic and hydrographic data (USGS Quads 2019). Federal Emergency Management Agency (FEMA) floodplain maps and the USGS 7.5-minute digital orthophoto quadrangle where not available for the project site (FEMA 2019).

2.2.1 Herbaceous Wetlands

SWCA assessed 16 palustrine emergent (PEM) wetlands (Table 1) that have a minimal tree stratum and are typified by a thick herbaceous layer with scattered shrubs. Commonly observed herbaceous species included jungle-rice (*Echinochloa colona*), sand spike-rush (*Eleocharis montevidensis*), tall scouring-rush (*Equisetum hyemale*), common rush (*Juncus effusus*), golden crown grass (*Paspalum dilatatum*), mild water-pepper (*Persicaria hydropiper*), and swamp smartweed (*P. hydropiperoides*).

2.2.2 Scrub-shrub Wetlands

SWCA assessed 3 palustrine scrub-shrub (PSS) wetland areas (Table 1) identified during the wetland delineation. These PSS wetlands consist of vegetation communities with at least 30 percent sapling and shrub cover. Dominant shrubs and saplings in the community are black willow (*Salix nigra*), poison-bean (*Sesbania drummondii*), and Chinese tallowtree (*Triadica sebifera*). Golden crown grass was the prevalent herbaceous species within these wetland communities.

2.2.3 Forested Wetlands

SWCA assessed 4 palustrine forested (PFO) wetlands (Table 2) typified by a prevalence of hydrophytic woody species 20 feet or greater in height and 3 inches or greater in diameter at breast height. These areas were largely dominated by pecan (*Carya illinoinensis*), sugarberry (*Celtis laevigata*), green ash (*Fraxinus pennsylvanica*), cedar elm (*Ulmus crassifolia*) and American elm (*Ulmus americana*).

3 RESULTS

SWCA's delineation identified 21.380 acres of wetlands (i.e., 9.624 acres of PEM, 4.933 acres of PSS, and 6.823 acres of PFO) within the proposed location of the project (Figure 3, Appendix A). These acreages were verified by USACE as part of the permitting process. Based on field data, wetlands with similar functional values were parsimoniously grouped into the minimum number of WAAs for each vegetation class using the iHGM analyses. Table 1 and 2 shows the sub-index values assigned for each WAA within the project area. Although specific measured values for the assessed WAA are provided in Appendix B, the following paragraphs provide general descriptions.

Duration of flooding (V_{dur}) is estimated using hydrology indicators listed in the *Corps of Engineers Wetlands Delineation Manual* (Manual; USACE 1987) and the *Regional Supplement to the Corps of Engineers Wetlands Delineation Manual: Atlantic and Gulf Coastal Region* (Version 2.0) (Regional Supplement; USACE 2010b). In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days, resulting in sub-index values of 1.0.

Frequency of flooding (V_{freq}) uses indicators listed in the Manual (USACE 1987), the Regional Supplement (USACE 2010b), and FEMA floodplain maps. FEMA Federal Insurance Rate Map (FIRM) Numbers 48039C0240H and 48039C0245H depict the project area to be within an area of Brazoria County where flood hazards are undetermined (FEMA 2019). However, during the field survey, much of these areas were observed to be inundated by periodic flooding. Based on field observation, SWCA believes that all WAAs generally flood or pond annually 2 out of 5 years. Therefore, each WAA warrants a sub-index score of 0.50.

Topography (V_{topo}) relies on visual estimates conducted in the field to determine what percent of the project area is composed of heterogeneous topographic features (e.g., dips, hummocks, channel sloughs). The WAAs mostly consist of less than 15% distinguishing topographic features within the terrain. Some topographic features observed within the project area include channel sloughs and dips. Therefore, these wetlands were assigned a sub-index values of 0.40.

Woody vegetation (V_{wood}) can be assessed using aerial imagery, field data, and visual observations. Woody vegetation in the forested wetlands had sub-index values ranging from 0.50 to 0.75. This indicates that woody cover ranged from 34 to 90 percent. The PEM wetlands were marked by a paucity of tree stratum cover and therefore warranted an index value ranging from of 0.10 to 0.25, indicating that woody vegetation cover ranges between 0 to 33 percent. The PSS wetland had a sub-index value ranging from 0.25 to 0.75 , that indicates the PSS WAAs mostly had woody coverage from 11 to 90 percent.

Midstory (V_{mid}) describes the shrub and sapling vegetation layer found between ground level and an upper forest canopy. The midstory stratum covered ranged from 1% to 50% of the forested WAAs, warranting sub-index values between 0.25 and 0.50 with the most common sub-index value being 0.50. The midstory stratum covered between 0 to greater than 75 percent in most herbaceous WAAs, warranting sub-index values of 0.10 to 0.75. The PEM wetlands were primarily less than 25 percent midstory cover, warranting a sub-index score of 0.10 to 0.25. However, the midstory stratum within the PSS wetlands generally contained 25 to 75 percent shrub and sapling coverage with, warranting sub-index values of 0.50 to 0.75.

Herbaceous (V_{herb}) describes the average herbaceous vegetation cover in each WAA. The sub-index value was 0.50 within all the PFO WAAs, while ranging from 0.10 to 1.00 for the PEM and PSS WAAs. These values indicate that the herbaceous stratum ranged from 25 to 50 percent in all PFO WAAs and from less than 1 to greater than 75 percent in the PEM and PSS wetlands.

Connectivity to other habitat types ($V_{connect}$) was assessed using aerial imagery extending 600 feet from the project area. The project area included one to four habitat types (including wetland), resulting in sub-index values ranging from 0.25 to 0.75.

Detritus ($V_{detritus}$) refers to the presence of either an O or A horizon associated with the WAAs. Frequent flooding within the project area saturates soils, decreasing the rate at which organic carbon is naturally utilized thereby allowing for the accumulation of organic matter. Due to flooding events being frequent (at least 14 consecutive days), the accumulation of organic matter is high warranting a sub-index value of 1.00 for the majority of WAAs within the project area, in which more than 85 percent of these areas possess an O or A horizon. Other sub-index scores observed indicated some WAAs comprised of less than 11 percent of an O or A horizon, warranting a sub-index value of 0.10 to 0.30.

Redoximorphic process (V_{redox}) is based on the extent to which pedons within the WAA exhibit redoximorphic features as an indication of alternating oxidizing and reducing conditions. Periodic flooding within saturates soils, causing vacillation between anaerobic and aerobic conditions which allows the reduction and translocation of iron and manganese within the upper portions of the soil. Spoils within all WAAs scored 0.10 having less than 20 percent redoximorphic concentrations within the pedon.

Sorptive soil properties (V_{sorpt}) are determined using the Natural Resources Conservation Service (NRCS) Soil Survey (U.S. Department of Agriculture [USDA] 2018) and data recorded in the field. According to the USDA Soil Survey, Brazoria clay, 0 to 1 percent slopes, rarely flooded (10); Brazoria clay, 1 to 3 percent slopes, rarely flooded (11); Clemville silty clay loam, 0 to 1 percent slopes, occasionally flooded (12); Norwood loam, 0 to 1 percent slopes, rarely flooded (33); and Pledger, 0 to 1 percent slopes, rarely flooded (36) are present in the project area. Field surveys confirmed that clay soils dominated the majority of WAAs warranting a sub-index score of 1.00.

Coarse woody debris (V_{cwd}) is measured by a point-intercept method involving a tally of woody debris greater than 3 inches in diameter along a 100-foot-long transect in forested WAAs. SWCA personnel found greater than seven pieces of coarse woody debris greater than 3 inches in diameter in the project area, warranting a sub-index value of 1.00.

The percentage of trees that are mast producers (V_{tree}) was assessed via summation of the percent cover of mast producing species (e.g., oak, hickory, cypress, maple, and elm) in the WAA. The sub index score for the forested WAAs was 0.50, indicating that up to 66 percent of forested wetlands are composed of mast producing tree species with limited undesirable species (e.g., black willow, cottonwood, tallow, and sycamore).

Tree richness (V_{rich}) is a measure of the diversity of species within the WAAs. Common tree species found within the forested WAAs include American elm, cedar elm, green ash, pecan, and sugarberry. The presence of these and other tree species varied within the forested WAAs. WAA WA003_PFO contained five or more species, warranting sub-index scores of 1.0, while WA004_PFO, WC003_PFO, and WC005_PFO diversity varying from three to four species, warranting a sub-index score from 0.60 to 0.80.

Tree basal area (V_{basal}) is the mean basal area per acre of trees in the WAA. The basal area within the forested WAAs was greater than 100 square feet per acre, warranting a sub-index value of 1.00.

Tree density ($V_{density}$) is based on the number of trees per acre that are at least 3 inches in diameter at breast height. Within the forested wetlands, tree density was 100 trees per acre to 200 trees per acre, resulting in sub-index value of 1.0.

The sub-index values in Tables 1 and 2 were used to calculate the FCIs and, by extension, the FCUs of all WAAs (Tables 3 and 4). WAA functional assessment worksheets are provided in Appendix B.

Table 1. Assigned sub-index values for palustrine emergent/palustrine scrub-shrub wetlands within the proposed project area

WAA ID	Acreage	V_{dur}	V_{freq}	V_{topo}	V_{wood}	V_{mid}	V_{herb}	$V_{connect}$	$V_{detritus}$	V_{redox}	V_{sorpt}
WA002_PEM	0.186	1.00	0.50	0.40	0.10	0.10	1.00	0.75	1.00	0.10	1.00
WA004_PEM	2.437	1.00	0.50	0.40	0.10	0.25	1.00	0.75	1.00	0.10	1.00
WA004_PSS	4.547	1.00	0.50	0.40	0.25	0.50	1.00	0.75	1.00	0.10	1.00
WA005_PEM	0.046	1.00	0.50	0.40	0.10	0.10	1.00	0.75	0.30	0.10	1.00
WB001_PEM	0.174	1.00	0.50	0.40	0.10	0.10	0.50	0.75	0.10	0.10	1.00
WB002_ PEM	1.105	1.00	0.50	0.40	0.10	0.25	1.00	0.75	1.00	0.10	1.00
WB003_ PEM	0.054	1.00	0.50	0.40	0.10	0.10	1.00	0.25	1.00	0.10	1.00
WB004_ PEM	0.640	1.00	0.50	0.40	0.10	0.10	1.00	0.75	1.00	0.10	1.00
WB005_ PEM	1.129	1.00	0.50	0.40	0.10	0.25	0.75	0.75	1.00	0.10	1.00
WB005_ PSS	0.105	1.00	0.50	0.40	0.75	0.75	0.10	0.75	1.00	0.10	1.00
WC001_PEM	0.097	1.00	0.50	0.40	0.10	0.25	0.75	0.75	1.00	0.10	1.00
WC002_PEM	0.217	1.00	0.50	0.40	0.25	0.25	0.75	0.75	1.00	0.10	1.00
WC004_PEM	0.031	1.00	0.50	0.40	0.10	0.10	0.75	0.75	1.00	0.10	1.00
WC005_PEM	0.347	1.00	0.50	0.40	0.10	0.10	1.00	0.75	1.00	0.10	1.00
WC006_PEM	0.457	1.00	0.50	0.40	0.25	0.10	0.75	0.75	1.00	0.10	1.00
WC007_PSS	0.281	1.00	0.50	0.40	0.50	0.50	0.50	0.75	1.00	0.10	1.00
WD001_PEM	0.464	1.00	0.50	0.40	0.10	0.10	1.00	0.75	1.00	0.10	1.00
WD002_PEM	0.144	1.00	0.50	0.40	0.10	0.10	1.00	0.75	1.00	0.10	1.00
WD003_PEM	2.096	1.00	0.50	0.40	0.10	0.10	0.75	0.75	1.00	0.10	1.00

Table 2. Assigned sub-index values for palustrine forested wetlands within the proposed project area

WAA ID	Acreage	V_{dur}	V_{freq}	V_{topo}	V_{cwd}	V_{wood}	V_{tree}	V_{rich}	V_{basal}	$V_{density}$	V_{mid}	V_{herb}	$V_{connect}$	$V_{detritus}$	V_{redox}	V_{sorpt}
WA003_PFO	2.100	1.00	0.50	0.40	1.00	0.75	0.50	1.00	1.00	1.00	0.50	0.50	0.50	1.00	0.10	1.00
WA004_PFO	3.120	1.00	0.50	0.40	1.00	0.75	0.50	0.80	1.00	1.00	0.50	0.50	0.50	1.00	0.10	1.00
WC003_PFO	1.570	1.00	0.50	0.40	1.00	0.50	0.50	0.60	1.00	1.00	0.50	0.50	0.50	1.00	0.10	1.00
WC005_PFO	0.033	1.00	0.50	0.40	1.00	0.50	0.50	0.60	1.00	1.00	0.25	0.50	0.50	1.00	0.10	1.00

Table 3. Functional capacity units associated with existing palustrine emergent/palustrine scrub-shrub wetlands in the proposed project

WAA ID	Acreage	TSSW (physical)		MPAC (biological)		RSEC (chemical)	
		FCI	FCU	FCI	FCU	FCI	FCU
WA002_PEM	0.186	0.580	0.108	0.617	0.115	0.560	0.104
WA004_PEM	2.437	0.602	1.467	0.667	1.625	0.570	1.389
WA004_PSS	4.547	0.638	2.901	0.750	3.410	0.617	2.805
WA005_PEM	0.046	0.580	0.027	0.617	0.028	0.513	0.024
WB001_PEM	0.174	0.497	0.086	0.450	0.078	0.467	0.081
WB002_ PEM	1.105	0.602	0.665	0.667	0.737	0.570	0.630
WB003_ PEM	0.054	0.580	0.031	0.450	0.024	0.560	0.030
WB004_ PEM	0.640	0.580	0.371	0.617	0.395	0.560	0.358
WB005_ PEM	1.129	0.564	0.637	0.583	0.658	0.553	0.624
WB005_ PSS	0.105	0.540	0.057	0.533	0.056	0.673	0.071
WC001_PEM	0.097	0.564	0.055	0.583	0.057	0.553	0.054
WC002_PEM	0.217	0.564	0.122	0.583	0.127	0.583	0.127
WC004_PEM	0.031	0.540	0.017	0.533	0.017	0.543	0.017
WC005_PEM	0.347	0.580	0.201	0.617	0.214	0.560	0.194
WC006_PEM	0.457	0.540	0.247	0.533	0.244	0.573	0.262
WC007_PSS	0.281	0.564	0.158	0.583	0.164	0.633	0.178
WD001_PEM	0.464	0.580	0.269	0.617	0.286	0.560	0.260
WD002_PEM	0.144	0.580	0.084	0.617	0.089	0.560	0.081
WD003_PEM	2.096	0.540	1.132	0.533	1.117	0.543	1.138
Total	**14.557**		**8.635**		**9.441**		**8.427**

Table 4. Functional capacity units associated with existing palustrine forested wetlands in the proposed project

WAA ID	Acreage	TSSW (physical)		MPAC (biological)		RSEC (chemical)	
		FCI	FCU	FCI	FCU	FCI	FCU
WA003_PFO	2.100	0.712	1.495	0.750	1.575	0.733	1.539
WA004_PFO	3.120	0.712	2.221	0.717	2.237	0.733	2.287
WC003_PFO	1.570	0.669	1.050	0.683	1.072	0.667	1.047
WC005_PFO	0.033	0.669	0.022	0.663	0.022	0.667	0.022
Total	**6.823**		**4.789**		**4.906**		**4.895**

4 SUMMARY AND CONCLUSIONS

A total of 23 riverine wetlands—consisting of 9.624 acres of PEM wetlands, 4.933 acre of PSS wetlands, and 6.823 acres of PFO wetlands—were identified during the field assessment. Based on variables evaluated for the wetlands, SWCA determined that the site supports 8.365 physical, 9.441 biological, and 8.427 physical functional capacity units for the 14.557 acres of non-forested wetlands and 4.789 physical, 4.906 biological, and 4.895 chemical functional capacity units for the 6.823 acres of forested wetlands. Mitigation requirements for these wetlands would be based on the final design plans and what acreage of these wetlands would be impacted through construction activities.

The findings presented in this report are restricted to and are based upon SWCA's professional opinion. These values are subject to alterations in project plans, verification of the wetland delineation, and verification of the iHGM. Only the USACE and the U.S. Environmental Protection Agency have final legal authority to determine the location, extent, and functional value of waters of the U.S.

5 REFERENCES

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. *Classification of Wetlands and Deepwater Habitats of the United States.* FWS/OBS-79/31. Washington, D.C.: U.S. Fish and Wildlife Service.

Federal Emergency Management Agency (FEMA). 2019. Digital Flood Insurance Map Database, Harris County, Texas. U.S. Department of Homeland Security, FEMA. Oakton, VA. Available at: https://msc.fema.gov. Accessed November 2019.

U.S. Army Corps of Engineers (USACE) 1987. *Corps of Engineers Wetlands Delineation Manual.* Technical Report Y-87-1. Vicksburg, Mississippi: U.S. Army Engineer Research and Development Center.

———. 1995. *An Approach for Assessing Wetland Functions Using Hydrogeomorphic Classification, Reference Wetlands, and Functional Indices.* Technical Report WRP-DE-9. October, 1995.

———. 2010a. USACE: Southwest Galveston District. Galveston's Wetland Functional Assessments. Available at: http://www.swg.usace.army.mil/BusinessWithUs/Regulatory/Wetlands/FunctionalAssessment.aspx. Accessed February 2019.

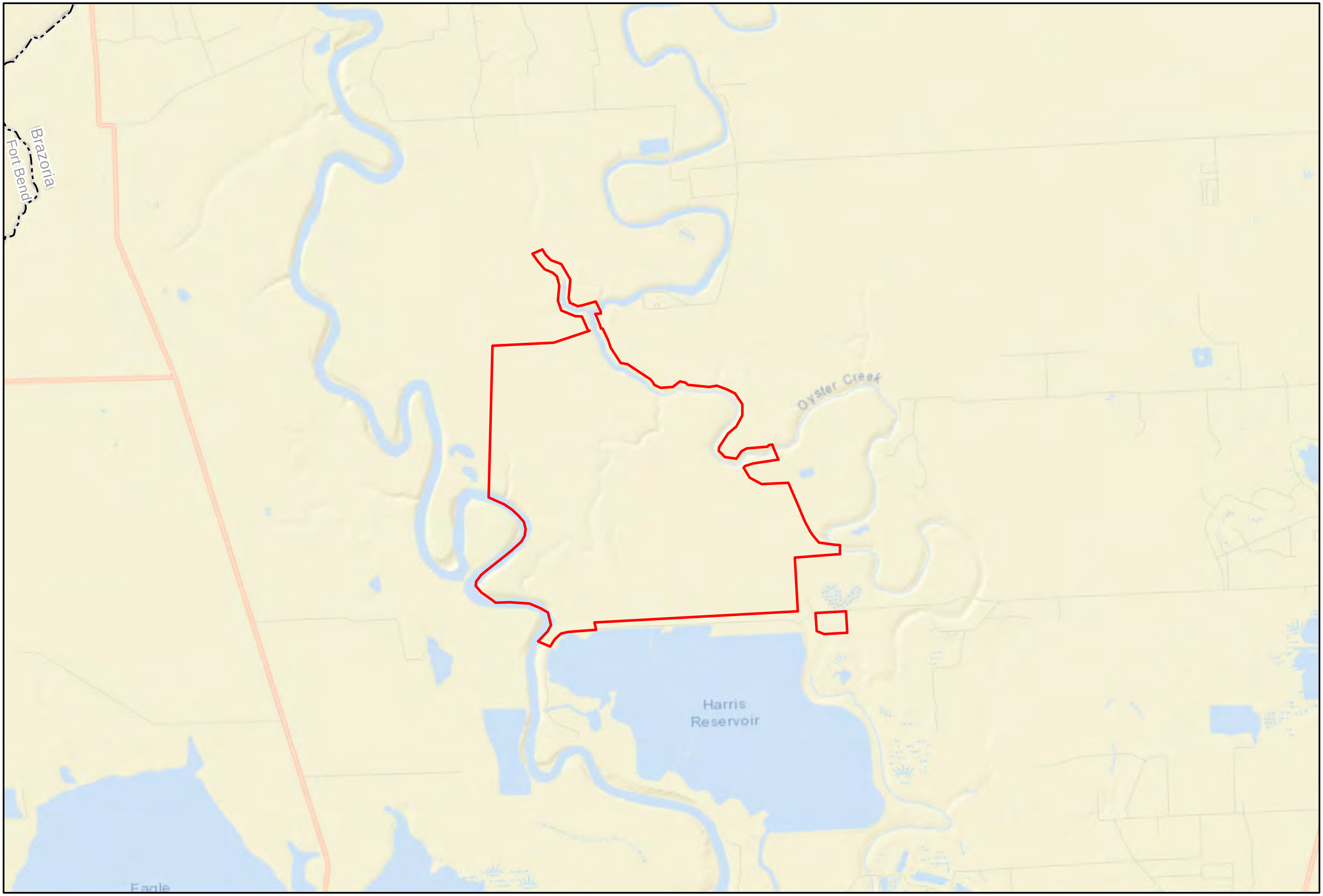
———. 2010b. *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coastal Plain Region (Version 2.0).* ERDC/EL TR-10-20. Vicksburg, Mississippi: U.S. Army Engineer Research and Development Center.

U.S. Department of Agriculture (USDA). 2018. Web Soil Survey. U.S. Department of Agriculture, Natural Resources Conservation Service. Available at: http://websoilsurvey.nrcs.usda.gov. Accessed November 2019.

USGS Quads. 2019. United States Geological Survey, historical topographic and hydrography dataset available online at http://www.metzgerwillard.us/quads/quads.html (Accessed November 2019)

APPENDIX A

Vicinity and Wetland Assessment Maps

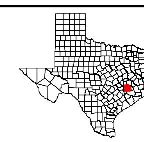


SWCA ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

VICINITY MAP
BRAZORIA COUNTY, TEXAS
FIGURE 1

Project Boundary
County Boundary



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Created By: K. Shields
Project Number: 52872
Date: 11/25/2019
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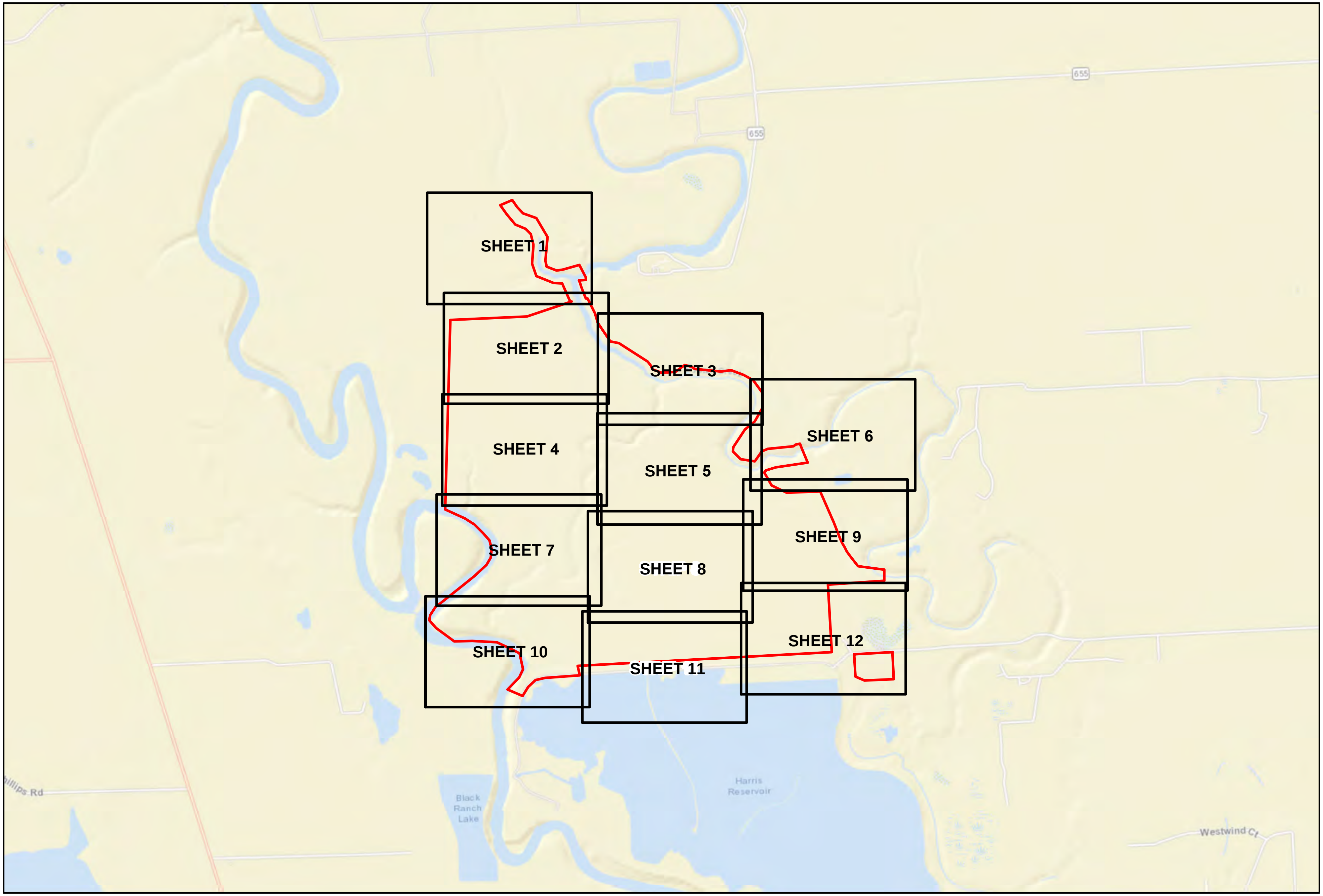
0 300 600 900 1,200 Meters



SWCA ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

INDEX MAP
BRAZORIA COUNTY, TEXAS
FIGURE 2

Project Boundary
Mapbook Index

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Created By: K. Shields
Project Number: 52872
Date: 11/25/2019
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0 1,000 2,000 3,000 4,000 Feet
0 300 600 900 1,200 Meters

DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

WETLAND ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 1 OF 12

FIGURE 3

- Project Boundary
- Datapoint
- Ephemeral Waterbody
- Intermittent Waterbody
- Perennial Waterbody
- Emergent Wetland
- Scrub-Shrub Wetland
- Forested Wetland
- NRCS Soil Map Unit Boundary
- County Boundary

1:6,000

Created By: K. Shields
Project Number: 52872
Date: 11/25/2019
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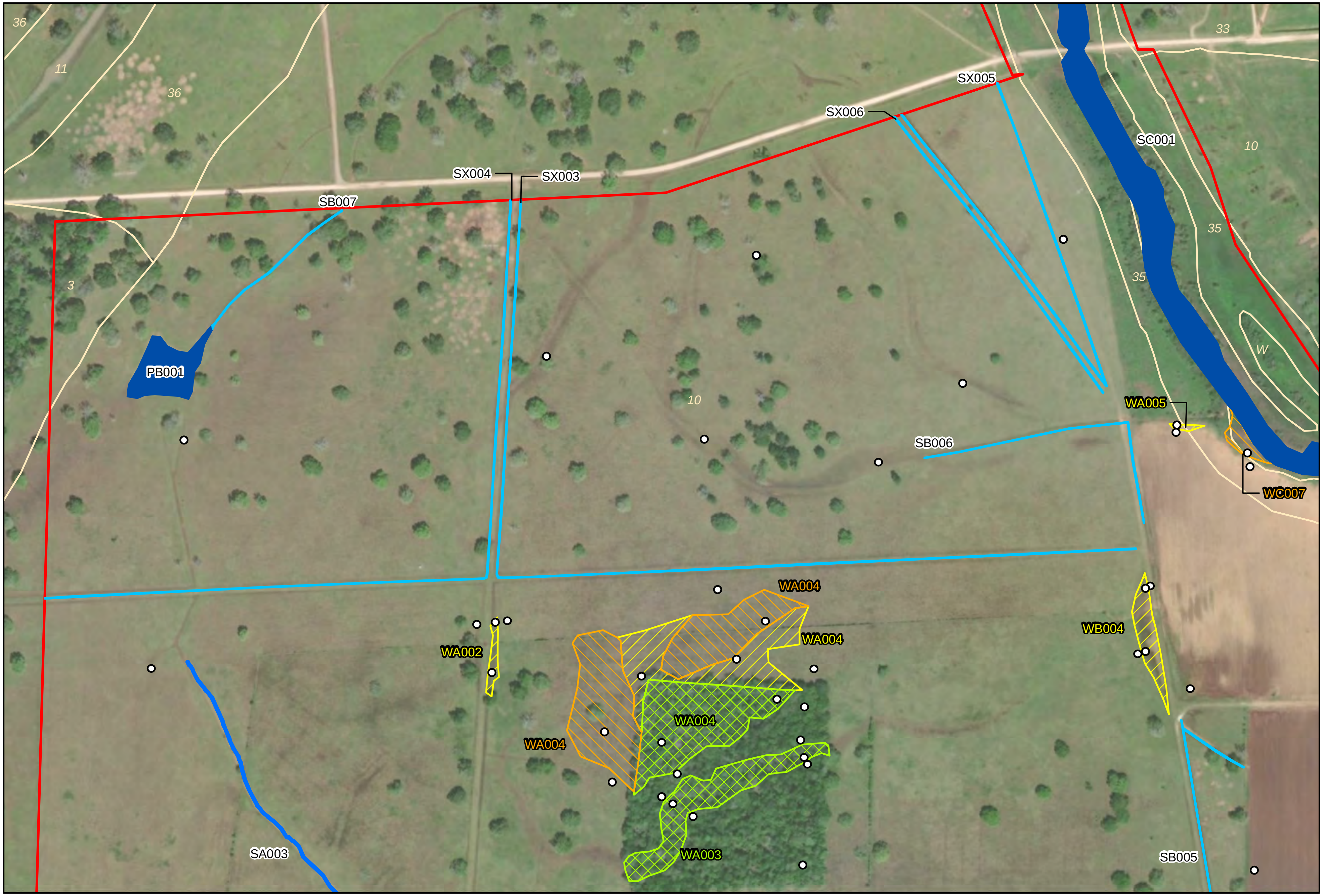


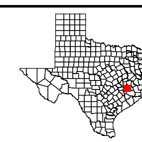
SWCA ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

WETLAND ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 2 OF 12 FIGURE 3

- Project Boundary
- Datapoint
- Ephemeral Waterbody
- Intermittent Waterbody
- Perennial Waterbody
- Emergent Wetland
- Scrub-Shrub Wetland
- Forested Wetland
- NRCS Soil Map Unit Boundary
- County Boundary



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Created By: K. Shields
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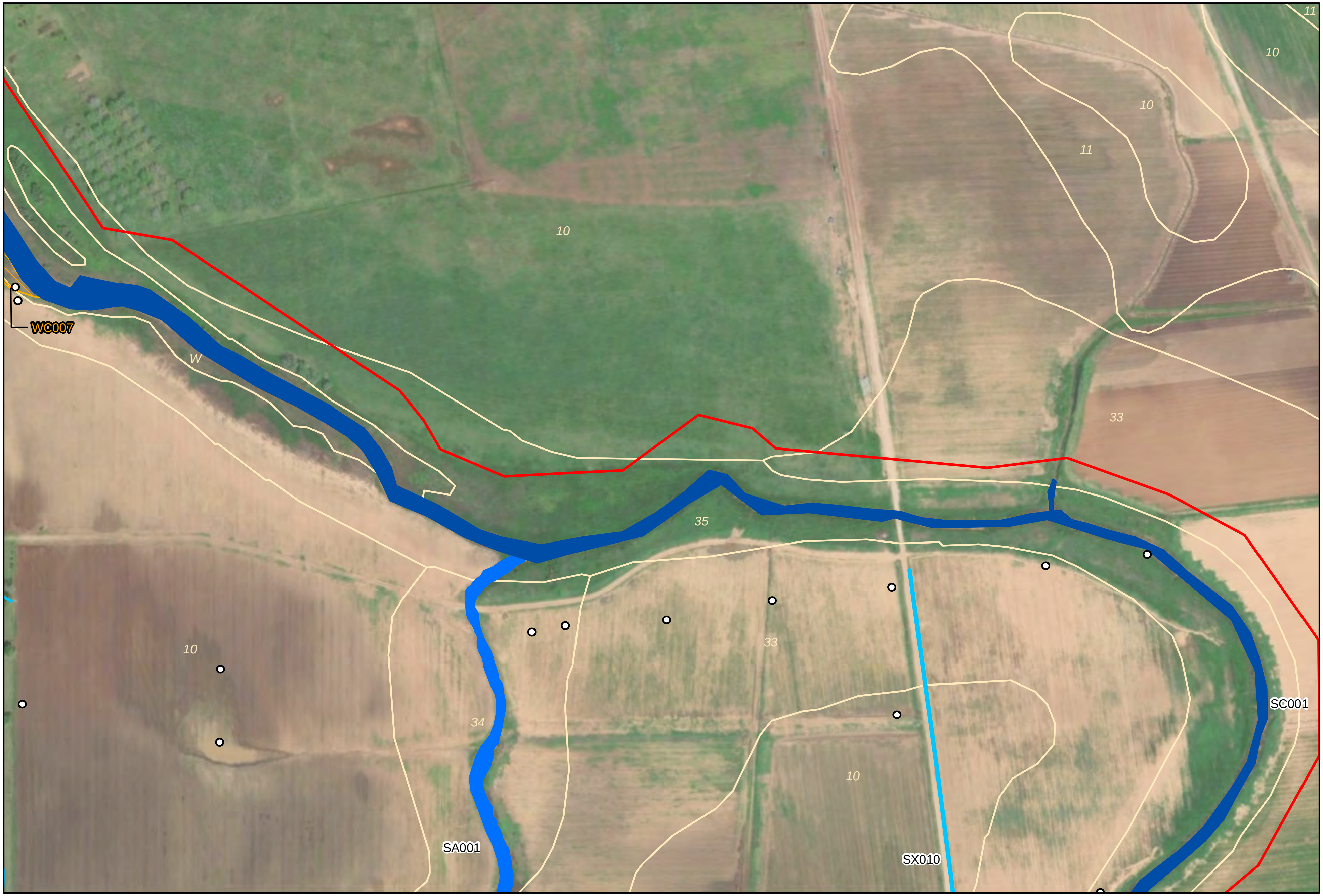


SWCA ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

WETLAND ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 3 OF 12 FIGURE 3

- Project Boundary
- Datapoint
- Ephemeral Waterbody
- Intermittent Waterbody
- Perennial Waterbody
- Emergent Wetland
- Scrub-Shrub Wetland
- Forested Wetland
- NRCS Soil Map Unit Boundary
- County Boundary

1:6,000

Created By: K. Shields
Project Number: 52872
Date: 11/25/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

0 100 200 300 400 500 Feet
0 30 60 90 120 150 Meters

SWCA ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

WETLAND ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 4 OF 12

FIGURE 3

- Project Boundary
- Datapoint
- Ephemeral Waterbody
- Intermittent Waterbody
- Perennial Waterbody
- Emergent Wetland
- Scrub-Shrub Wetland
- Forested Wetland
- NRCS Soil Map Unit Boundary
- County Boundary

1:6,000

Created By: K. Shields
Project Number: 52872
Date: 11/25/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

0 100 200 300 400 500 Feet

0 30 60 90 120 150 Meters

SWCA ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

WETLAND ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 5 OF 12 FIGURE 3

Project Boundary
Datapoint
Ephemeral Waterbody
Intermittent Waterbody
Perennial Waterbody
Emergent Wetland
Scrub-Shrub Wetland
Forested Wetland
NRCS Soil Map Unit Boundary
County Boundary

1:6,000

Created By: K. Shields
Project Number: 52872
Date: 11/25/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

0 100 200 300 400 500 Feet
0 30 60 90 120 150 Meters

SWCA ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

WETLAND ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 6 OF 12

FIGURE 3

Project Boundary
Datapoint
Ephemeral Waterbody
Intermittent Waterbody
Perennial Waterbody
Emergent Wetland
Scrub-Shrub Wetland
Forested Wetland
NRCS Soil Map Unit Boundary
County Boundary

1:6,000

Created By: K. Shields
Project Number: 52872
Date: 11/25/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

0 100 200 300 400 500 Feet
0 30 60 90 120 150 Meters

DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

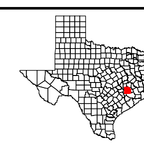
WETLAND ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 7 OF 12

FIGURE 3

SWCA® ENVIRONMENTAL CONSULTANTS

Project Boundary
Datapoint
Ephemeral Waterbody
Intermittent Waterbody
Perennial Waterbody
Emergent Wetland
Scrub-Shrub Wetland
Forested Wetland
NRCS Soil Map Unit Boundary
County Boundary



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Created By: K. Shields
Project Number: 52872
Date: 11/25/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

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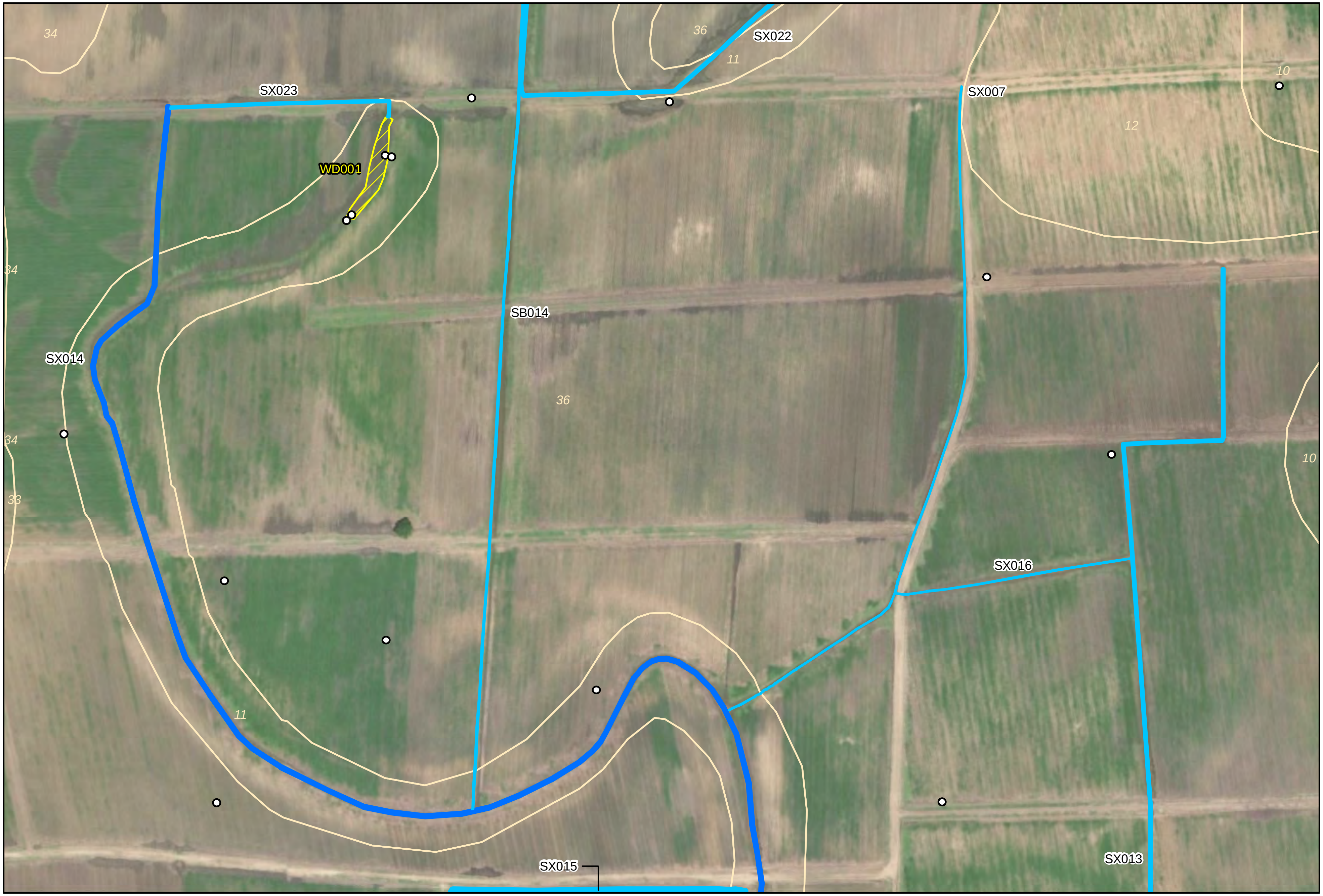
0 30 60 90 120 150 Meters



SWCA ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

WETLAND ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

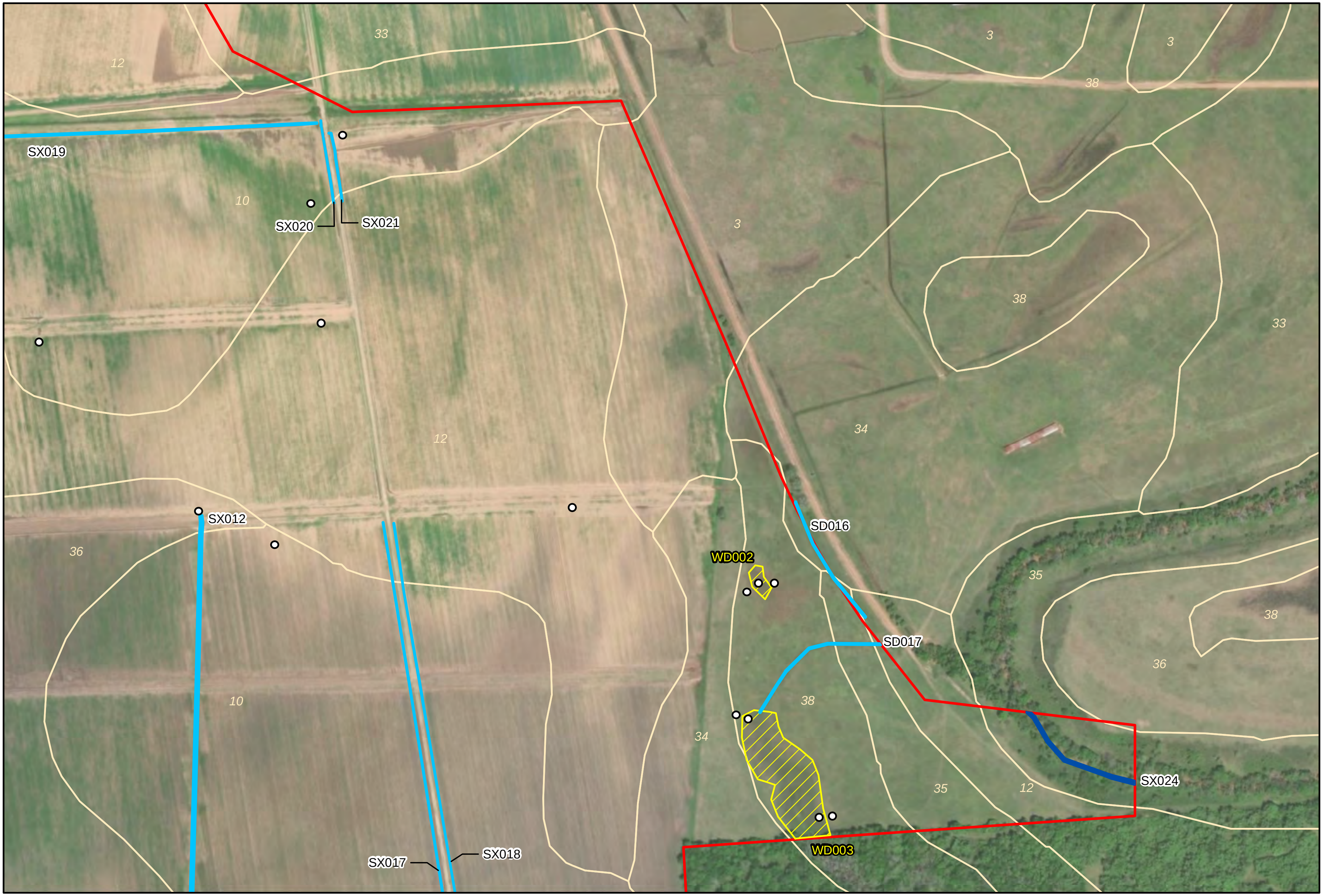
SHEET 8 OF 12 FIGURE 3

Project Boundary
Datapoint
Ephemeral Waterbody
Intermittent Waterbody
Perennial Waterbody
Emergent Wetland
Scrub-Shrub Wetland
Forested Wetland
NRCS Soil Map Unit Boundary
County Boundary

1:6,000

Created By: K. Shields
Project Number: 52872
Date: 11/25/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

0 100 200 300 400 500 Feet
0 30 60 90 120 150 Meters



SWCA ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

WETLAND ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 9 OF 12

FIGURE 3

Project Boundary
Datapoint
Ephemeral Waterbody
Intermittent Waterbody
Perennial Waterbody
Emergent Wetland
Scrub-Shrub Wetland
Forested Wetland
NRCS Soil Map Unit Boundary
County Boundary

1:6,000

Created By: K. Shields
Project Number: 52872
Date: 11/25/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

0 100 200 300 400 500 Feet
0 30 60 90 120 150 Meters

DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

WETLAND ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 10 OF 12

FIGURE 3

SWCA ENVIRONMENTAL CONSULTANTS

- Project Boundary
- Datapoint
- Ephemeral Waterbody
- Intermittent Waterbody
- Perennial Waterbody
- Emergent Wetland
- Scrub-Shrub Wetland
- Forested Wetland
- NRCS Soil Map Unit Boundary
- County Boundary

1:6,000

Created By: K. Shields
Project Number: 52872
Date: 11/25/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

0 100 200 300 400 500 Feet
0 30 60 90 120 150 Meters

SWCA ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

WETLAND ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 11 OF 12

FIGURE 3

Project Boundary
Datapoint
Ephemeral Waterbody
Intermittent Waterbody
Perennial Waterbody
Emergent Wetland
Scrub-Shrub Wetland
Forested Wetland
NRCS Soil Map Unit Boundary
County Boundary

1:6,000

Created By: K. Shields
Project Number: 52872
Date: 11/25/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

0 100 200 300 400 500 Feet

0 30 60 90 120 150 Meters

SWCA ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

WETLAND ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 12 OF 12

FIGURE 3

Project Boundary
Datapoint
Ephemeral Waterbody
Intermittent Waterbody
Perennial Waterbody
Emergent Wetland
Scrub-Shrub Wetland
Forested Wetland
NRCS Soil Map Unit Boundary
County Boundary

1:6,000

Created By: K. Shields
Project Number: 52872
Date: 11/25/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

0 100 200 300 400 500 Feet
0 30 60 90 120 150 Meters

APPENDIX B

iHGM Worksheets

Riverine Herbaceous/Shrub HGM (Interim) Functional Assessment Data Form

Project/Site:	Dow Harris Reservoir Expansion Project	County:	Brazoria	Assessment Date:	June 27, 2019
Applicant/Owner:	Dow Chemical Company	State:	Texas	WAA ID:	WA002
Investigator(s):	E. Munscher/M. Cothren			WAA Acreage:	0.186
Associated Wetland ID:	WA002				

VARIABLE	CATEGORICAL DECISION	COMMENTS	SUBINDEX
Vdur: Percent of the WAA that is flooded and/or ponded due to the hydrology (i.e. flooding overbank flow) of the nearby waterway	*In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.*	In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days	1.000
Vfreq: Frequency that the WAA is flooded and/or ponded by the nearby waterway	*Floods or ponds 2 out of 5 years (100-year floodplain).*	Floods or ponds 2 out of 5 years (100-year floodplain).	0.500
Vtop: Roughness associated with the WAA	*Less than 15% of the WAA is represented by dips, hummocks, channel sloughs, and/or other topographic features.*	The WAA is indicative of a coastal prairie with mostly flat terrain, depressional wetlands, and channel sloughs.	0.400
Vwood: Percentage of the WAA that is covered by woody vegetation	*0-10% of the WAA is covered with woody vegetation.*	Woody vegetation is absent from the WAA.	0.100
Vmid: The average/mean coverage of the midstory (shrub/sapling) layer in the WAA	*Midstory coverage of the WAA is equal to or less than 1%.*	Midstory cover is absent from the WAA.	0.100
Vherb: The average/mean coverage of the herbaceous layer in the WAA	*Herbaceous cover in the WAA averages greater than 75%.*	Herbaceous cover averages 90%.	1.000
Vconnect: Number of habitat types within 600 feet of the perimeter of the WAA (must be ≥5% of the size of the WAA)	*Wetland plus two or more habitat types (other than forested) OR three or more habitat types.*	Wetland plus herbaceous and open water.	0.750
Vdetritus: The amount of detritus on the WAA (The A-horizon has to have a Munsell value of 4 or less)	*Greater than 85% of the area possesses an O or A horizon.*	Soils in the WAA were of 4/2 value and chroma.	1.000
Vredox: The amount of the WAA that exhibits redox features as an indication of the chemical exchange	*Redox features less than 20%.*	Redox concentrations represent 2% of the pedon within the top 20 inches of the soil surface.	0.100
Vsorpt: The absorptive properties of the soils in the WAA	*The WAA is dominated by montmorillonitic clayey soils (clay, clay loams, silty clay loams) or soils with high organic (2/1, 2/2, or 3/1).*	The WAA is dominated by clay.	1.000

Functional Capacity Indices (FCI) and Units (FCU=FCI*WAA Acreage)	FCI	FCU
Temporary Storage & Detention of Storage Water (Physical Function) [{Vdur * Vfreq} 1/2 * {Vtopo + {Vherb + Vmid/2}/2] 1/2	0.580	0.108
Maintain Plant & Animal Community (Biological Function) {Vmid + Vherb + Vconnect}/3	0.617	0.115
Removal & Sequestrian of Elements & Compounds (Chemical Function) [[Vwood + Vfreq + Vdur + [{Vtopo + Vherb + Vmid}/3] + [{Vdetritus + Vredox + Vsorpt}/3]]/5	0.560	0.104

Riverine Forested HGM (Interim) Functional Assessment Data Form

Project/Site: Dow Harris Reservoir Expansion Project County: Brazoria Assessment Date: June 27, 2019
Applicant/Owner: Dow Chemical Company State: Texas WAA ID: WA003
Investigator(s): E. Munscher/M. Cothren WAA Acreage: 2.100
Associated Wetland ID: WA003

VARIABLE	CATEGORICAL DECISION	COMMENTS	SUBINDEX
Vdur: Percent of the WAA that is flooded and/or ponded due to the hydrology (i.e. flooding overbank flow) of the nearby waterway.	*In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.*	In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.	1.000
Vfreq: Frequency that the WAA is flooded and/or ponded by the nearby waterway.	*Floods or ponds 2 out of 5 years (100-year floodplain).*	Floods or ponds 2 out of 5 years (100-year floodplain).	0.500
Vtopo: Roughness associated with the WAA.	*Less than 15% of the WAA is represented by dips, hummocks, channel sloughs, and/or other topographic features.*	The WAA is indicative of a coastal prairie with mostly flat terrain, depressional wetlands, and channel sloughs.	0.400
Vcwd: Coarse Woody Debris within the WAA.	*More than 7 pieces of CWD greater than 3" diameter along 100' transect.*	More than 7 pieces of CWD greater than 3" diameter along 100' transect.	1.000
Vwood: Percentage of the WAA that is covered by woody vegetation.	*67-90% of the WAA is covered with woody vegetation.*	Approximately 73.5% of the WAA is covered in woody vegetation.	0.750
Vtree: The percentage of the trees in the WAA that are mast producers.	*More than 20% of the stand is oak, hickory, cypress, maple, and/or elm. Black willow, cottonwood, tallow, and sycamore do not represent more than 15% of the stand.*	The stand within the WAA is comprised of approximately 25% mast producers, while the remainder is comprised of non-mast producing trees (9% *T. sebifera*).	0.500
Vrich: The diversity of the species within the WAA. (species must comprise at least 5% of the stand.)	*Five or more tree species present.*	*Ulmus americana*, *U. crassifolia*, *Celtis laevigata*, *Triadica sebifera*, and *Fraxinus pennsylvanica* are the five tree species present in the WAA.	1.000
Vbasal: The average/mean basal area of the trees in the WAA per acre.	*The average basal area of the WAA is greater than 100 square feet per acre.*	The average basal area of the WAA is greater than 100 square feet per acre.	1.000
Vdensity: The average density of the WAA stand. (Tree is woody with over 3" Diameter at Breast Height [DBH]).	*The WAA averages a tree density of 100-250 trees per acre.*	The WAA averages a tree density of 100-250 trees per acre.	1.000
Vmid: The average/mean coverage of the midstory (shrub/sapling) layer in the WAA.	*Midstory coverage of the WAA is between 11-30%.*	Midstory cover averages 12.5% in the WAA.	0.500
Vherb: The average/mean coverage of the herbaceous layer in the WAA.	*Herbaceous cover in the WAA averages between 31-50%.*	Herbaceous cover averages 40% in the WAA.	0.500
Vdetritus: The amount of detritus on the WAA (The A-horizon has to have a Munsell value of 4 or less).	*Greater than 85% of the area possesses an O or A horizon.*	Soils in the WAA were of 4/2 value and chroma.	1.000
Vredox: The amount of the WAA that exhibits redox features as an indication of the chemical exchange.	*Redox features less than 20%.*	Redox concentrations represent 3.5% of the pedon within the top 20 inches of the soil surface.	0.100
Vsorpt: The absorptive properties of the soils in the WAA.	*The WAA is dominated by montmorillonitic clayey soils (clay, clay loams, silty clay loams) or soils with high organic (2/1, 2/2, or 3/1).*	The WAA is dominated by clay.	1.000
Vconnect: Number of habitat types within 600 feet of the perimeter of the WAA. (must be ≥5% of the size of the WAA).	*Wetland plus one other habitat type or two other habitat types.*	Wetland plus herbaceous.	0.500

FUNCTIONAL CAPACITY INDICES (FCI) and UNITS (FCU=FCI*WAA Acreage)

	FCI	FCU
Temporary Storage & Detention of Storage Water (Physical Function) [(Vdur * Vfreq) ^ 0.5 * ((Vtopo + Vcwd + Vwood) / 3)] ^ 0.5	0.712	1.495
Maintain Plant & Animal Community (Biological Function) (Vtree + Vcwd + Vrich + [(Vbasal + Vdensity) / 2] + [(Vmid + Vherb) / 2] + Vconnect) / 6	0.750	1.575
Removal & Sequestrian of Elements & Compounds (Chemical Function) (Vwood + Vfreq + Vdur + [(Vtopo + Vcwd + Vwood) / 3] + [(Vdetritus + Vredox +Vsorpt) / 3]) / 5	0.733	1.540

Riverine Herbaceous/Shrub HGM (Interim) Functional Assessment Data Form

Project/Site:	Dow Harris Reservoir Expansion Project	County:	Brazoria	Assessment Date:	June 28, 2019
Applicant/Owner:	Dow Chemical Company	State:	Texas	WAA ID:	WA004
Investigator(s):	E. Munscher/M. Cothren			WAA Acreage:	2.437
Associated Wetland ID:	WA004				

VARIABLE	CATEGORICAL DECISION	COMMENTS	SUBINDEX
Vdur: Percent of the WAA that is flooded and/or ponded due to the hydrology (i.e. flooding overbank flow) of the nearby waterway	*In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.*	In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.	1.000
Vfreq: Frequency that the WAA is flooded and/or ponded by the nearby waterway	*Floods or ponds 2 out of 5 years (100-year floodplain).*	Floods or ponds 2 out of 5 years (100-year floodplain).	0.500
Vtop: Roughness associated with the WAA	*Less than 15% of the WAA is represented by dips, hummocks, channel sloughs, and/or other topographic features.*	The WAA is indicative of a coastal prairie with mostly flat terrain, depressional wetlands, and channel sloughs.	0.400
Vwood: Percentage of the WAA that is covered by woody vegetation	*0-10% of the WAA is covered with woody vegetation.*	Woody vegetation cover averages 5%.	0.100
Vmid: The average/mean coverage of the midstory (shrub/sapling) layer in the WAA	*Midstory coverage of the WAA is between 1-25%.*	Midstory cover averages 5%.	0.250
Vherb: The average/mean coverage of the herbaceous layer in the WAA	*Herbaceous cover in the WAA averages greater than 75%.*	Herbaceous cover averages 100%.	1.000
Vconnect: Number of habitat types within 600 feet of the perimeter of the WAA (must be ≥5% of the size of the WAA)	*Wetland plus two or more habitat types (other than forested) OR three or more habitat types.*	Wetland plus forested, herbaceous, and open water.	0.750
Vdetritus: The amount of detritus on the WAA (The A-horizon has to have a Munsell value of 4 or less)	*Greater than 85% of the area possesses an O or A horizon.*	Soils in the WAA were of 4/2 value and chroma.	1.000
Vredox: The amount of the WAA that exhibits redox features as an indication of the chemical exchange	*Redox features less than 20%.*	Redox concentrations represent 3% of the pedon within the top 20 inches of the soil surface.	0.100
Vsorpt: The absorptive properties of the soils in the WAA	*The WAA is dominated by montmorillonitic clayey soils (clay, clay loams, silty clay loams) or soils with high organic (2/1, 2/2, or 3/1).*	The WAA is dominated by clay.	1.000

Functional Capacity Indices (FCI) and Units (FCU=FCI*WAA Acreage)

	FCI	FCU
Temporary Storage & Detention of Storage Water (Physical Function) [{Vdur * Vfreq} 1/2 * {Vtopo + {Vherb + Vmid/2}/2] 1/2	0.602	1.467
Maintain Plant & Animal Community (Biological Function) {Vmid + Vherb + Vconnect}/3	0.667	1.625
Removal & Sequestrian of Elements & Compounds (Chemical Function) [[Vwood + Vfreq + Vdur + [{Vtopo + Vherb + Vmid}/3] + [{Vdetritus + Vredox + Vsorpt}/3]]/5	0.570	1.389

Riverine Forested HGM (Interim) Functional Assessment Data Form

Project/Site: Dow Harris Reservoir Expansion Project County: Brazoria Assessment Date: June 27, 2019
Applicant/Owner: Dow Chemical Company State: Texas WAA ID: WA004
Investigator(s): E. Munscher/M. Cothren WAA Acreage: 3.120
Associated Wetland ID: WA004

VARIABLE	CATEGORICAL DECISION	COMMENTS	SUBINDEX
Vdur: Percent of the WAA that is flooded and/or ponded due to the hydrology (i.e. flooding overbank flow) of the nearby waterway.	*In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.*	In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.	1.000
Vfreq: Frequency that the WAA is flooded and/or ponded by the nearby waterway.	*Floods or ponds 2 out of 5 years (100-year floodplain).*	Floods or ponds 2 out of 5 years (100-year floodplain).	0.500
Vtopo: Roughness associated with the WAA.	*Less than 15% of the WAA is represented by dips, hummocks, channel sloughs, and/or other topographic features.*	The WAA is indicative of a coastal prairie with mostly flat terrain, depressional wetlands, and channel sloughs.	0.400
Vcwd: Coarse Woody Debris within the WAA.	*More than 7 pieces of CWD greater than 3" diameter along 100' transect.*	More than 7 pieces of CWD greater than 3" diameter along 100' transect.	1.000
Vwood: Percentage of the WAA that is covered by woody vegetation.	*67-90% of the WAA is covered with woody vegetation.*	Approximately 73.5% of the WAA is covered in woody vegetation.	0.750
Vtree: The percentage of the trees in the WAA that are mast producers.	*More than 20% of the stand is oak, hickory, cypress, maple, and/or elm. Black willow, cottonwood, tallow, and sycamore do not represent more than 15% of the stand.*	The stand within the WAA is comprised of approximately 25% mast producers, while the remainder is comprised of non-mast producing trees (0% *T. sebifera*).	0.500
Vrich: The diversity of the species within the WAA. (species must comprise at least 5% of the stand.)	*Four tree species present.*	*Ulmus americana*, *U. crassifolia*, *Celtis laevigata*, and *Fraxinus pennsylvanica* are the four tree species present in the WAA.	0.800
Vbasal: The average/mean basal area of the trees in the WAA per acre.	*The average basal area of the WAA is greater than 100 square feet per acre.*	The average basal area of the WAA is greater than 100 square feet per acre.	1.000
Vdensity: The average density of the WAA stand. (Tree is woody with over 3" Diameter at Breast Height [DBH]).	*The WAA averages a tree density of 100-250 trees per acre.*	The WAA averages a tree density of 100-250 trees per acre.	1.000
Vmid: The average/mean coverage of the midstory (shrub/sapling) layer in the WAA.	*Midstory coverage of the WAA is between 11-30%.*	Midstory cover averages 15% in the WAA.	0.500
Vherb: The average/mean coverage of the herbaceous layer in the WAA.	*Herbaceous cover in the WAA averages between 31-50%.*	Herbaceous cover averages 37.5% in the WAA.	0.500
Vdetritus: The amount of detritus on the WAA (The A-horizon has to have a Munsell value of 4 or less).	*Greater than 85% of the area possesses an O or A horizon.*	Soils in the WAA were of 4/2 value and chroma.	1.000
Vredox: The amount of the WAA that exhibits redox features as an indication of the chemical exchange.	*Redox features less than 20%.*	Redox concentrations represent 2% of the pedon within the top 20 inches of the soil surface.	0.100
Vsorpt: The absorptive properties of the soils in the WAA.	*The WAA is dominated by montmorillonitic clayey soils (clay, clay loams, silty clay loams) or soils with high organic (2/1, 2/2, or 3/1).*	The WAA is dominated by clay.	1.000
Vconnect: Number of habitat types within 600 feet of the perimeter of the WAA. (must be ≥5% of the size of the WAA).	*Wetland plus one other habitat type or two other habitat types.*	Wetland plus forested, herbaceous, and open water.	0.500

FUNCTIONAL CAPACITY INDICES (FCI) and UNITS (FCU=FCI*WAA Acreage)

	FCI	FCU
Temporary Storage & Detention of Storage Water (Physical Function) [(Vdur * Vfreq) ^ 0.5 * ((Vtopo + Vcwd + Vwood) / 3)] ^ 0.5	0.712	2.221
Maintain Plant & Animal Community (Biological Function) (Vtree + Vcwd + Vrich + [(Vbasal + Vdensity) / 2] + [(Vmid + Vherb) / 2] + Vconnect) / 6	0.717	2.236
Removal & Sequestrian of Elements & Compounds (Chemical Function) (Vwood + Vfreq + Vdur + [(Vtopo + Vcwd + Vwood) / 3] + [(Vdetritus + Vredox +Vsorpt) / 3]) / 5	0.733	2.288

Riverine Herbaceous/Shrub HGM (Interim) Functional Assessment Data Form

Project/Site: Dow Harris Reservoir Expansion Project County: Brazoria Assessment Date: June 28, 2019
Applicant/Owner: Dow Chemical Company State: Texas WAA ID: WA004
Investigator(s): E. Munscher/M. Cothren WAA Acreage: 4.547
Associated Wetland ID: WA004

VARIABLE	CATEGORICAL DECISION	COMMENTS	SUBINDEX
Vdur: Percent of the WAA that is flooded and/or ponded due to the hydrology (i.e. flooding overbank flow) of the nearby waterway	*In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.*	In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.	1.000
Vfreq: Frequency that the WAA is flooded and/or ponded by the nearby waterway	*Floods or ponds 2 out of 5 years (100-year floodplain).*	Floods or ponds 2 out of 5 years (100-year floodplain).	0.500
Vtop: Roughness associated with the WAA	*Less than 15% of the WAA is represented by dips, hummocks, channel sloughs, and/or other topographic features.*	The WAA is indicative of a coastal prairie with mostly flat terrain, depressional wetlands, and channel sloughs.	0.400
Vwood: Percentage of the WAA that is covered by woody vegetation	*11-33% of the WAA is covered with woody vegetation.*	Woody vegetation cover averages 32.5%.	0.250
Vmid: The average/mean coverage of the midstory (shrub/sapling) layer in the WAA	*Midstory coverage of the WAA is between 25-50%.*	Midstory cover averages 32.5%.	0.500
Vherb: The average/mean coverage of the herbaceous layer in the WAA	*Herbaceous cover in the WAA averages greater than 75%.*	Herbaceous cover averages 100%.	1.000
Vconnect: Number of habitat types within 600 feet of the perimeter of the WAA (must be ≥5% of the size of the WAA)	*Wetland plus two or more habitat types (other than forested) OR three or more habitat types.*	Wetland plus forested, herbaceous, and open water.	0.750
Vdetritus: The amount of detritus on the WAA (The A-horizon has to have a Munsell value of 4 or less)	*Greater than 85% of the area possesses an O or A horizon.*	Soils in the WAA were of 4/2 value and chroma.	1.000
Vredox: The amount of the WAA that exhibits redox features as an indication of the chemical exchange	*Redox features less than 20%.*	Redox concentrations represent 2% of the pedon within the top 20 inches of the soil surface.	0.100
Vsorpt: The absorptive properties of the soils in the WAA	*The WAA is dominated by montmorillonitic clayey soils (clay, clay loams, silty clay loams) or soils with high organic (2/1, 2/2, or 3/1).*	The WAA is dominated by clay.	1.000

Functional Capacity Indices (FCI) and Units (FCU=FCI*WAA Acreage)

	FCI	FCU
Temporary Storage & Detention of Storage Water (Physical Function) [{Vdur * Vfreq} 1/2 * {Vtopo + {Vherb + Vmid/2}/2] 1/2	0.638	2.899
Maintain Plant & Animal Community (Biological Function) {Vmid + Vherb + Vconnect}/3	0.750	3.410
Removal & Sequestrian of Elements & Compounds (Chemical Function) [[Vwood + Vfreq + Vdur + [{Vtopo + Vherb + Vmid}/3] + [{Vdetritus + Vredox + Vsorpt}/3]]/5	0.617	2.804

Riverine Herbaceous/Shrub HGM (Interim) Functional Assessment Data Form

Project/Site: Dow Harris Reservoir Expansion Project County: Brazoria Assessment Date: June 28, 2019
Applicant/Owner: Dow Chemical Company State: Texas WAA ID: WA005
Investigator(s): E. Munscher/M. Cothren WAA Acreage: 0.046
Associated Wetland ID: WA005

VARIABLE	CATEGORICAL DECISION	COMMENTS	SUBINDEX
Vdur: Percent of the WAA that is flooded and/or ponded due to the hydrology (i.e. flooding overbank flow) of the nearby waterway	*In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.*	In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.	1.000
Vfreq: Frequency that the WAA is flooded and/or ponded by the nearby waterway	*Floods or ponds 2 out of 5 years (100-year floodplain).*	Floods or ponds 2 out of 5 years (100-year floodplain).	0.500
Vtop: Roughness associated with the WAA	*Less than 15% of the WAA is represented by dips, hummocks, channel sloughs, and/or other topographic features.*	The WAA is indicative of a coastal prairie with mostly flat terrain, depressional wetlands, and channel sloughs.	0.400
Vwood: Percentage of the WAA that is covered by woody vegetation	*0-10% of the WAA is covered with woody vegetation.*	Woody vegetation is absent from the WAA.	0.100
Vmid: The average/mean coverage of the midstory (shrub/sapling) layer in the WAA	*Midstory coverage of the WAA is equal to or less than 1%.*	Midstory cover is absent from the WAA.	0.100
Vherb: The average/mean coverage of the herbaceous layer in the WAA	*Herbaceous cover in the WAA averages greater than 75%.*	Herbaceous cover averages 85%.	1.000
Vconnect: Number of habitat types within 600 feet of the perimeter of the WAA (must be ≥5% of the size of the WAA)	*Wetland plus two or more habitat types (other than forested) OR three or more habitat types.*	Wetland plus herbaceous and open water.	0.750
Vdetritus: The amount of detritus on the WAA (The A-horizon has to have a Munsell value of 4 or less)	*Less than 10% of the area possesses an O or A horizon.*	Soils in the WAA were determined to be problematic hydric soils with red parent material with a 4/4 value and chroma.	0.300
Vredox: The amount of the WAA that exhibits redox features as an indication of the chemical exchange	*Redox features less than 20%.*	Redox features were not distinguishable from red parent material.	0.100
Vsorpt: The absorptive properties of the soils in the WAA	*The WAA is dominated by montmorillonitic clayey soils (clay, clay loams, silty clay loams) or soils with high organic (2/1, 2/2, or 3/1).*	The WAA is dominated by clay.	1.000

Functional Capacity Indices (FCI) and Units (FCU=FCI*WAA Acreage)	FCI	FCU
Temporary Storage & Detention of Storage Water (Physical Function) [{Vdur * Vfreq} 1/2 * {Vtopo + {Vherb + Vmid/2}/2] 1/2	0.580	0.027
Maintain Plant & Animal Community (Biological Function) {Vmid + Vherb + Vconnect}/3	0.617	0.028
Removal & Sequestrian of Elements & Compounds (Chemical Function) [[Vwood + Vfreq + Vdur + [{Vtopo + Vherb + Vmid}/3] + [{Vdetritus + Vredox + Vsorpt}/3]]/5	0.513	0.024

Riverine Herbaceous/Shrub HGM (Interim) Functional Assessment Data Form

Project/Site: Dow Harris Reservoir Expansion Project County: Brazoria Assessment Date: June 29, 2019
Applicant/Owner: Dow Chemical Company State: Texas WAA ID: WB001
Investigator(s): I. Mock/J. Mitchell WAA Acreage: 0.174
Associated Wetland ID: WB001

VARIABLE	CATEGORICAL DECISION	COMMENTS	SUBINDEX
Vdur: Percent of the WAA that is flooded and/or ponded due to the hydrology (i.e. flooding overbank flow) of the nearby waterway	*In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.*	In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.	1.000
Vfreq: Frequency that the WAA is flooded and/or ponded by the nearby waterway	*Floods or ponds 2 out of 5 years (100-year floodplain).*	Floods or ponds 2 out of 5 years (100-year floodplain).	0.500
Vtop: Roughness associated with the WAA	*Less than 15% of the WAA is represented by dips, hummocks, channel sloughs, and/or other topographic features.*	The WAA is indicative of a coastal prairie with mostly flat terrain, depressional wetlands, and channel sloughs.	0.400
Vwood: Percentage of the WAA that is covered by woody vegetation	*0-10% of the WAA is covered with woody vegetation.*	Woody vegetation is absent from the WAA.	0.100
Vmid: The average/mean coverage of the midstory (shrub/sapling) layer in the WAA	*Midstory coverage of the WAA is equal to or less than 1%.*	Midstory cover is absent from the WAA.	0.100
Vherb: The average/mean coverage of the herbaceous layer in the WAA	*Herbaceous cover in the WAA averages between 25-50%.*	Herbaceous cover averages 25%.	0.500
Vconnect: Number of habitat types within 600 feet of the perimeter of the WAA (must be ≥5% of the size of the WAA)	*Wetland plus two or more habitat types (other than forested) OR three or more habitat types.*	Wetland plus forested, herbaceous, and open water.	0.750
Vdetritus: The amount of detritus on the WAA (The A-horizon has to have a Munsell value of 4 or less)	*Site is plowed.*	Soils in the WAA were determined to be disturbed.	0.100
Vredox: The amount of the WAA that exhibits redox features as an indication of the chemical exchange	*Redox features less than 20%.*	Redox features were not distinguishable due to disturbance.	0.100
Vsorpt: The absorptive properties of the soils in the WAA	*The WAA is dominated by montmorillonitic clayey soils (clay, clay loams, silty clay loams) or soils with high organic (2/1, 2/2, or 3/1).*	The WAA is dominated by clay.	1.000

Functional Capacity Indices (FCI) and Units (FCU=FCI*WAA Acreage)

	FCI	FCU
Temporary Storage & Detention of Storage Water (Physical Function) [{Vdur * Vfreq} 1/2 * {Vtopo + {Vherb + Vmid/2}/2] 1/2	0.497	0.087
Maintain Plant & Animal Community (Biological Function) {Vmid + Vherb + Vconnect}/3	0.450	0.078
Removal & Sequestrian of Elements & Compounds (Chemical Function) [[Vwood + Vfreq + Vdur + [{Vtopo + Vherb + Vmid}/3] + [{Vdetritus + Vredox + Vsorpt}/3]]/5	0.467	0.081

Riverine Herbaceous/Shrub HGM (Interim) Functional Assessment Data Form

Project/Site: Dow Harris Reservoir Expansion Project County: Brazoria Assessment Date: June 26, 2019
Applicant/Owner: Dow Chemical Company State: Texas WAA ID: WB002
Investigator(s): I. Mock/J. Mitchell WAA Acreage: 1.105
Associated Wetland ID: WB002

VARIABLE	CATEGORICAL DECISION	COMMENTS	SUBINDEX
Vdur: Percent of the WAA that is flooded and/or ponded due to the hydrology (i.e. flooding overbank flow) of the nearby waterway	*In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.*	In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.	1.000
Vfreq: Frequency that the WAA is flooded and/or ponded by the nearby waterway	*Floods or ponds 2 out of 5 years (100-year floodplain).*	Floods or ponds 2 out of 5 years (100-year floodplain).	0.500
Vtop: Roughness associated with the WAA	*Less than 15% of the WAA is represented by dips, hummocks, channel sloughs, and/or other topographic features.*	The WAA is indicative of a coastal prairie with mostly flat terrain, depressional wetlands, and channel sloughs.	0.400
Vwood: Percentage of the WAA that is covered by woody vegetation	*0-10% of the WAA is covered with woody vegetation.*	Woody vegetation cover averages 10%.	0.100
Vmid: The average/mean coverage of the midstory (shrub/sapling) layer in the WAA	*Midstory coverage of the WAA is between 1-25%.*	Midstory cover averages 10%.	0.250
Vherb: The average/mean coverage of the herbaceous layer in the WAA	*Herbaceous cover in the WAA averages greater than 75%.*	Herbaceous cover averages 100%.	1.000
Vconnect: Number of habitat types within 600 feet of the perimeter of the WAA (must be ≥5% of the size of the WAA)	*Wetland plus two or more habitat types (other than forested) OR three or more habitat types.*	Wetland plus forested, herbaceous, and open water.	0.750
Vdetritus: The amount of detritus on the WAA (The A-horizon has to have a Munsell value of 4 or less)	*Greater than 85% of the area possesses an O or A horizon.*	Soils in the WAA were of 4/2 value and chroma.	1.000
Vredox: The amount of the WAA that exhibits redox features as an indication of the chemical exchange	*Redox features less than 20%.*	Redox concentrations represent 2% of the pedon within the top 20 inches of the soil surface.	0.100
Vsorpt: The absorptive properties of the soils in the WAA	*The WAA is dominated by montmorillonitic clayey soils (clay, clay loams, silty clay loams) or soils with high organic (2/1, 2/2, or 3/1).*	The WAA is dominated by clay loam.	1.000

Functional Capacity Indices (FCI) and Units (FCU=FCI*WAA Acreage)

Function	FCI	FCU
Temporary Storage & Detention of Storage Water (Physical Function) [{Vdur * Vfreq} 1/2 * {Vtopo + {Vherb + Vmid/2}/2] 1/2	0.602	0.665
Maintain Plant & Animal Community (Biological Function) {Vmid + Vherb + Vconnect}/3	0.667	0.737
Removal & Sequestrian of Elements & Compounds (Chemical Function) [[Vwood + Vfreq + Vdur + [{Vtopo + Vherb + Vmid}/3] + [{Vdetritus + Vredox + Vsorpt}/3]]/5	0.570	0.630

Riverine Herbaceous/Shrub HGM (Interim) Functional Assessment Data Form

Project/Site:	Dow Harris Reservoir Expansion Project	County:	Brazoria	Assessment Date:	June 27, 2019
Applicant/Owner:	Dow Chemical Company	State:	Texas	WAA ID:	WB003
Investigator(s):	I. Mock/J. Mitchell			WAA Acreage:	0.054
Associated Wetland ID:	WB003				

VARIABLE	CATEGORICAL DECISION	COMMENTS	SUBINDEX
Vdur: Percent of the WAA that is flooded and/or ponded due to the hydrology (i.e. flooding overbank flow) of the nearby waterway	*In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.*	In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.	1.000
Vfreq: Frequency that the WAA is flooded and/or ponded by the nearby waterway	*Floods or ponds 2 out of 5 years (100-year floodplain).*	Floods or ponds 2 out of 5 years (100-year floodplain).	0.500
Vtop: Roughness associated with the WAA	*Less than 15% of the WAA is represented by dips, hummocks, channel sloughs, and/or other topographic features.*	The WAA is indicative of a coastal prairie with mostly flat terrain, depressional wetlands, and channel sloughs.	0.400
Vwood: Percentage of the WAA that is covered by woody vegetation	*0-10% of the WAA is covered with woody vegetation.*	Woody vegetation cover is absent.	0.100
Vmid: The average/mean coverage of the midstory (shrub/sapling) layer in the WAA	*Midstory coverage of the WAA is equal to or less than 1%.*	Midstory cover is absent.	0.100
Vherb: The average/mean coverage of the herbaceous layer in the WAA	*Herbaceous cover in the WAA averages greater than 75%.*	Herbaceous cover averages 80%.	1.000
Vconnect: Number of habitat types within 600 feet of the perimeter of the WAA (must be ≥5% of the size of the WAA)	*One other habitat types other than urban habitat.*	Forested, herbaceous, and open water.	0.250
Vdetritus: The amount of detritus on the WAA (The A-horizon has to have a Munsell value of 4 or less)	*Greater than 85% of the area possesses an O or A horizon.*	Soils in the WAA were of 4/2 value and chroma.	1.000
Vredox: The amount of the WAA that exhibits redox features as an indication of the chemical exchange	*Redox features less than 20%.*	Redox concentrations represent 2% of the pedon within the top 20 inches of the soil surface.	0.100
Vsorpt: The absorptive properties of the soils in the WAA	*The WAA is dominated by montmorillonitic clayey soils (clay, clay loams, silty clay loams) or soils with high organic (2/1, 2/2, or 3/1).*	The WAA is dominated by clay.	1.000

Functional Capacity Indices (FCI) and Units (FCU=FCI*WAA Acreage)	FCI	FCU
Temporary Storage & Detention of Storage Water (Physical Function) [{Vdur * Vfreq} 1/2 * {Vtopo + {Vherb + Vmid/2}/2] 1/2	0.580	0.031
Maintain Plant & Animal Community (Biological Function) {Vmid + Vherb + Vconnect}/3	0.450	0.024
Removal & Sequestrian of Elements & Compounds (Chemical Function) [[Vwood + Vfreq + Vdur + [{Vtopo + Vherb + Vmid}/3] + [{Vdetritus + Vredox + Vsorpt}/3]]/5	0.560	0.030

Riverine Herbaceous/Shrub HGM (Interim) Functional Assessment Data Form

Project/Site: Dow Harris Reservoir Expansion Project County: Brazoria Assessment Date: June 28, 2019
Applicant/Owner: Dow Chemical Company State: Texas WAA ID: WB004
Investigator(s): I. Mock/J. Mitchell WAA Acreage: 0.640
Associated Wetland ID: WB004

VARIABLE	CATEGORICAL DECISION	COMMENTS	SUBINDEX
Vdur: Percent of the WAA that is flooded and/or ponded due to the hydrology (i.e. flooding overbank flow) of the nearby waterway	*In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.*	In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.	1.000
Vfreq: Frequency that the WAA is flooded and/or ponded by the nearby waterway	*Floods or ponds 2 out of 5 years (100-year floodplain).*	Floods or ponds 2 out of 5 years (100-year floodplain).	0.500
Vtop: Roughness associated with the WAA	*Less than 15% of the WAA is represented by dips, hummocks, channel sloughs, and/or other topographic features.*	The WAA is indicative of a coastal prairie with mostly flat terrain, depressional wetlands, and channel sloughs.	0.400
Vwood: Percentage of the WAA that is covered by woody vegetation	*0-10% of the WAA is covered with woody vegetation.*	Woody vegetation is absent from the WAA.	0.100
Vmid: The average/mean coverage of the midstory (shrub/sapling) layer in the WAA	*Midstory coverage of the WAA is equal to or less than 1%.*	Midstory cover is absent from the WAA.	0.100
Vherb: The average/mean coverage of the herbaceous layer in the WAA	*Herbaceous cover in the WAA averages greater than 75%.*	Herbaceous cover averages 85%.	1.000
Vconnect: Number of habitat types within 600 feet of the perimeter of the WAA (must be ≥5% of the size of the WAA)	*Wetland plus two or more habitat types (other than forested) OR three or more habitat types.*	Wetland plus herbaceous and open water.	0.750
Vdetritus: The amount of detritus on the WAA (The A-horizon has to have a Munsell value of 4 or less)	*Greater than 85% of the area possesses an O or A horizon.*	Soils in the WAA were of 3/2 value and chroma.	1.000
Vredox: The amount of the WAA that exhibits redox features as an indication of the chemical exchange	*Redox features less than 20%.*	Redox concentrations represent 5% of the pedon within the top 20 inches of the soil surface.	0.100
Vsorpt: The absorptive properties of the soils in the WAA	*The WAA is dominated by montmorillonitic clayey soils (clay, clay loams, silty clay loams) or soils with high organic (2/1, 2/2, or 3/1).*	The WAA is dominated by clay.	1.000

Functional Capacity Indices (FCI) and Units (FCU=FCI*WAA Acreage)

	FCI	FCU
Temporary Storage & Detention of Storage Water (Physical Function) [{Vdur * Vfreq} 1/2 * {Vtopo + {Vherb + Vmid/2}/2] 1/2	0.580	0.371
Maintain Plant & Animal Community (Biological Function) {Vmid + Vherb + Vconnect}/3	0.617	0.395
Removal & Sequestrian of Elements & Compounds (Chemical Function) [[Vwood + Vfreq + Vdur + [{Vtopo + Vherb + Vmid}/3] + [{Vdetritus + Vredox + Vsorpt}/3]]/5	0.560	0.358

Riverine Herbaceous/Shrub HGM (Interim) Functional Assessment Data Form

Project/Site:	Dow Harris Reservoir Expansion Project	County:	Brazoria	Assessment Date:	June 29, 2019
Applicant/Owner:	Dow Chemical Company	State:	Texas	WAA ID:	WB005
Investigator(s):	I. Mock/J. Mitchell			WAA Acreage:	1.129
Associated Wetland ID:	WB005				

VARIABLE	CATEGORICAL DECISION	COMMENTS	SUBINDEX
Vdur: Percent of the WAA that is flooded and/or ponded due to the hydrology (i.e. flooding overbank flow) of the nearby waterway	*In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.*	In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.	1.000
Vfreq: Frequency that the WAA is flooded and/or ponded by the nearby waterway	*Floods or ponds 2 out of 5 years (100-year floodplain).*	Floods or ponds 2 out of 5 years (100-year floodplain).	0.500
Vtop: Roughness associated with the WAA	*Less than 15% of the WAA is represented by dips, hummocks, channel sloughs, and/or other topographic features.*	The WAA is indicative of a coastal prairie with mostly flat terrain, depressional wetlands, and channel sloughs.	0.400
Vwood: Percentage of the WAA that is covered by woody vegetation	*0-10% of the WAA is covered with woody vegetation.*	Woody vegetation cover averages 2.5%.	0.100
Vmid: The average/mean coverage of the midstory (shrub/sapling) layer in the WAA	*Midstory coverage of the WAA is between 1-25%.*	Midstory cover averages 2.5%.	0.250
Vherb: The average/mean coverage of the herbaceous layer in the WAA	*Herbaceous cover in the WAA averages between 50-75%.*	Herbaceous cover averages 55%.	0.750
Vconnect: Number of habitat types within 600 feet of the perimeter of the WAA (must be ≥5% of the size of the WAA)	*Wetland plus two or more habitat types (other than forested) OR three or more habitat types.*	Wetland plus forested, herbaceous, and open water.	0.750
Vdetritus: The amount of detritus on the WAA (The A-horizon has to have a Munsell value of 4 or less)	*Greater than 85% of the area possesses an O or A horizon.*	Soils in the WAA were determined to be problematic hydric soils with red parent material. Soils in the WAA were of 4/6 and 3/4 in value and chroma.	1.000
Vredox: The amount of the WAA that exhibits redox features as an indication of the chemical exchange	*Redox features less than 20%.*	Redox features were not distinguishable from red parent material.	0.100
Vsorpt: The absorptive properties of the soils in the WAA	*The WAA is dominated by montmorillonitic clayey soils (clay, clay loams, silty clay loams) or soils with high organic (2/1, 2/2, or 3/1).*	The WAA is dominated by clay.	1.000

Functional Capacity Indices (FCI) and Units (FCU=FCI*WAA Acreage)

	FCI	FCU
Temporary Storage & Detention of Storage Water (Physical Function) [{Vdur * Vfreq} 1/2 * {Vtopo + {Vherb + Vmid/2}/2] 1/2	0.564	0.637
Maintain Plant & Animal Community (Biological Function) {Vmid + Vherb + Vconnect}/3	0.583	0.659
Removal & Sequestrian of Elements & Compounds (Chemical Function) [[Vwood + Vfreq + Vdur + [{Vtopo + Vherb + Vmid}/3] + [{Vdetritus + Vredox + Vsorpt}/3]]/5	0.553	0.625

Riverine Herbaceous/Shrub HGM (Interim) Functional Assessment Data Form

Project/Site:	Dow Harris Reservoir Expansion Project	County:	Brazoria	Assessment Date:	June 29, 2019
Applicant/Owner:	Dow Chemical Company	State:	Texas	WAA ID:	WB005
Investigator(s):	I. Mock/J. Mitchell			WAA Acreage:	0.105
Associated Wetland ID:	WB005				

VARIABLE	CATEGORICAL DECISION	COMMENTS	SUBINDEX
Vdur: Percent of the WAA that is flooded and/or ponded due to the hydrology (i.e. flooding overbank flow) of the nearby waterway	*In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.*	In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.	1.000
Vfreq: Frequency that the WAA is flooded and/or ponded by the nearby waterway	*Floods or ponds 2 out of 5 years (100-year floodplain).*	Floods or ponds 2 out of 5 years (100-year floodplain).	0.500
Vtop: Roughness associated with the WAA	*Less than 15% of the WAA is represented by dips, hummocks, channel sloughs, and/or other topographic features.*	The WAA is indicative of a coastal prairie with mostly flat terrain, depressional wetlands, and channel sloughs.	0.400
Vwood: Percentage of the WAA that is covered by woody vegetation	*67-90% of the WAA is covered with woody vegetation.*	Woody vegetation cover averages 70%.	0.750
Vmid: The average/mean coverage of the midstory (shrub/sapling) layer in the WAA	*Midstory coverage of the WAA is between 50-75%.*	Midstory cover averages 60%.	0.750
Vherb: The average/mean coverage of the herbaceous layer in the WAA	*Herbaceous cover in the WAA is equal to or less than 1% (barren soil or all shrub).*	Herbaceous cover is absent from the WAA.	0.100
Vconnect: Number of habitat types within 600 feet of the perimeter of the WAA (must be ≥5% of the size of the WAA)	*Wetland plus two or more habitat types (other than forested) OR three or more habitat types.*	Wetland plus forested, herbaceous, and open water.	0.750
Vdetritus: The amount of detritus on the WAA (The A-horizon has to have a Munsell value of 4 or less)	*Greater than 85% of the area possesses an O or A horizon.*	Soils in the WAA were determined to be problematic hydric soils with red parent material. Soils in the WAA were of 4/6 and 3/4 in value and chroma.	1.000
Vredox: The amount of the WAA that exhibits redox features as an indication of the chemical exchange	*Redox features less than 20%.*	Redox features were not distinguishable from red parent material.	0.100
Vsorpt: The absorptive properties of the soils in the WAA	*The WAA is dominated by montmorillonitic clayey soils (clay, clay loams, silty clay loams) or soils with high organic (2/1, 2/2, or 3/1).*	The WAA is dominated by clay.	1.000

Functional Capacity Indices (FCI) and Units (FCU=FCI*WAA Acreage)	FCI	FCU
Temporary Storage & Detention of Storage Water (Physical Function) [{Vdur * Vfreq} 1/2 * {Vtopo + {Vherb + Vmid/2}/2] 1/2	0.540	0.057
Maintain Plant & Animal Community (Biological Function) {Vmid + Vherb + Vconnect}/3	0.533	0.056
Removal & Sequestrian of Elements & Compounds (Chemical Function) [[Vwood + Vfreq + Vdur + [{Vtopo + Vherb + Vmid}/3] + [{Vdetritus + Vredox + Vsorpt}/3]]/5	0.673	0.071

Riverine Herbaceous/Shrub HGM (Interim) Functional Assessment Data Form

Project/Site: Dow Harris Reservoir Expansion Project County: Brazoria Assessment Date: July 1, 2019
Applicant/Owner: Dow Chemical Company State: Texas WAA ID: WC001
Investigator(s): M. Criswell/K. Gartner WAA Acreage: 0.097
Associated Wetland ID: WC001

VARIABLE	CATEGORICAL DECISION	COMMENTS	SUBINDEX
Vdur: Percent of the WAA that is flooded and/or ponded due to the hydrology (i.e. flooding overbank flow) of the nearby waterway	*In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.*	In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.	1.000
Vfreq: Frequency that the WAA is flooded and/or ponded by the nearby waterway	*Floods or ponds 2 out of 5 years (100-year floodplain).*	Floods or ponds 2 out of 5 years (100-year floodplain).	0.500
Vtop: Roughness associated with the WAA	*Less than 15% of the WAA is represented by dips, hummocks, channel sloughs, and/or other topographic features.*	The WAA is indicative of a coastal prairie with mostly flat terrain, depressional wetlands, and channel sloughs.	0.400
Vwood: Percentage of the WAA that is covered by woody vegetation	*0-10% of the WAA is covered with woody vegetation.*	Woody vegetation cover averages 2.5%.	0.100
Vmid: The average/mean coverage of the midstory (shrub/sapling) layer in the WAA	*Midstory coverage of the WAA is between 1-25%.*	Midstory cover averages 2.5%.	0.250
Vherb: The average/mean coverage of the herbaceous layer in the WAA	*Herbaceous cover in the WAA averages between 50-75%.*	Herbaceous cover averages 67.6%.	0.750
Vconnect: Number of habitat types within 600 feet of the perimeter of the WAA (must be ≥5% of the size of the WAA)	*Wetland plus two or more habitat types (other than forested) OR three or more habitat types.*	Wetland plus herbaceous and open water.	0.750
Vdetritus: The amount of detritus on the WAA (The A-horizon has to have a Munsell value of 4 or less)	*Greater than 85% of the area possesses an O or A horizon.*	Soils in the WAA were of 4/2 value and chroma.	1.000
Vredox: The amount of the WAA that exhibits redox features as an indication of the chemical exchange	*Redox features less than 20%.*	Redox concentrations represent 10% of the pedon within the top 20 inches of the soil surface.	0.100
Vsorpt: The absorptive properties of the soils in the WAA	*The WAA is dominated by montmorillonitic clayey soils (clay, clay loams, silty clay loams) or soils with high organic (2/1, 2/2, or 3/1).*	The WAA is dominated by clay loam.	1.000

Functional Capacity Indices (FCI) and Units (FCU=FCI*WAA Acreage)	FCI	FCU
Temporary Storage & Detention of Storage Water (Physical Function) [{Vdur * Vfreq} 1/2 * {Vtopo + {Vherb + Vmid/2}/2] 1/2	0.564	0.055
Maintain Plant & Animal Community (Biological Function) {Vmid + Vherb + Vconnect}/3	0.583	0.057
Removal & Sequestrian of Elements & Compounds (Chemical Function) [[Vwood + Vfreq + Vdur + [{Vtopo + Vherb + Vmid}/3] + [{Vdetritus + Vredox + Vsorpt}/3]]/5	0.553	0.054

Riverine Herbaceous/Shrub HGM (Interim) Functional Assessment Data Form

Project/Site: Dow Harris Reservoir Expansion Project County: Brazoria Assessment Date: July 1, 2019
Applicant/Owner: Dow Chemical Company State: Texas WAA ID: WC002
Investigator(s): M Criswell/K. Gartner WAA Acreage: 0.217
Associated Wetland ID: WC002

VARIABLE	CATEGORICAL DECISION	COMMENTS	SUBINDEX
Vdur: Percent of the WAA that is flooded and/or ponded due to the hydrology (i.e. flooding overbank flow) of the nearby waterway	*In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.*	In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.	1.000
Vfreq: Frequency that the WAA is flooded and/or ponded by the nearby waterway	*Floods or ponds 2 out of 5 years (100-year floodplain).*	Floods or ponds 2 out of 5 years (100-year floodplain).	0.500
Vtop: Roughness associated with the WAA	*Less than 15% of the WAA is represented by dips, hummocks, channel sloughs, and/or other topographic features.*	The WAA is indicative of a coastal prairie with mostly flat terrain, depressional wetlands, and channel sloughs.	0.400
Vwood: Percentage of the WAA that is covered by woody vegetation	*11-33% of the WAA is covered with woody vegetation.*	Woody vegetation cover averages 15%.	0.250
Vmid: The average/mean coverage of the midstory (shrub/sapling) layer in the WAA	*Midstory coverage of the WAA is between 1-25%.*	Midstory cover averages 15%.	0.250
Vherb: The average/mean coverage of the herbaceous layer in the WAA	*Herbaceous cover in the WAA averages between 50-75%.*	Herbaceous cover averages 55%.	0.750
Vconnect: Number of habitat types within 600 feet of the perimeter of the WAA (must be ≥5% of the size of the WAA)	*Wetland plus two or more habitat types (other than forested) OR three or more habitat types.*	Wetland plus herbaceous and open water.	0.750
Vdetritus: The amount of detritus on the WAA (The A-horizon has to have a Munsell value of 4 or less)	*Greater than 85% of the area possesses an O or A horizon.*	Soils in the WAA were of 4/2 value and chroma.	1.000
Vredox: The amount of the WAA that exhibits redox features as an indication of the chemical exchange	*Redox features less than 20%.*	Redox concentrations represent 10% of the pedon within the top 20 inches of the soil surface.	0.100
Vsorpt: The absorptive properties of the soils in the WAA	*The WAA is dominated by montmorillonitic clayey soils (clay, clay loams, silty clay loams) or soils with high organic (2/1, 2/2, or 3/1).*	The WAA is dominated by clay loam.	1.000

Functional Capacity Indices (FCI) and Units (FCU=FCI*WAA Acreage)

	FCI	FCU
Temporary Storage & Detention of Storage Water (Physical Function) [{Vdur * Vfreq} 1/2 * {Vtopo + {Vherb + Vmid/2}/2] 1/2	0.564	0.122
Maintain Plant & Animal Community (Biological Function) {Vmid + Vherb + Vconnect}/3	0.583	0.127
Removal & Sequestrian of Elements & Compounds (Chemical Function) [[Vwood + Vfreq + Vdur + [{Vtopo + Vherb + Vmid}/3] + [{Vdetritus + Vredox + Vsorpt}/3]]/5	0.583	0.127

Riverine Forested HGM (Interim) Functional Assessment Data Form

Project/Site:	Dow Harris Reservoir Expansion Project	County:	Brazoria	Assessment Date:	June 27, 2019
Applicant/Owner:	Dow Chemical Company	State:	Texas	WAA ID:	WC003
Investigator(s):	M. Criswell/C. Chambers			WAA Acreage:	1.570
Associated Wetland ID:	WC003				

VARIABLE	CATEGORICAL DECISION	COMMENTS	SUBINDEX
Vdur: Percent of the WAA that is flooded and/or ponded due to the hydrology (i.e. flooding overbank flow) of the nearby waterway.	*In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.*	In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.	1.000
Vfreq: Frequency that the WAA is flooded and/or ponded by the nearby waterway.	*Floods or ponds 2 out of 5 years (100-year floodplain).*	Floods or ponds 2 out of 5 years (100-year floodplain).	0.500
Vtopo: Roughness associated with the WAA.	*Less than 15% of the WAA is represented by dips, hummocks, channel sloughs, and/or other topographic features.*	The WAA is indicative of a coastal prairie with mostly flat terrain, depressional wetlands, and channel sloughs.	0.400
Vcwd: Coarse Woody Debris within the WAA.	*More than 7 pieces of CWD greater than 3" diameter along 100' transect.*	More than 7 pieces of CWD greater than 3" diameter along 100' transect.	1.000
Vwood: Percentage of the WAA that is covered by woody vegetation.	*34-66% of the WAA is covered with woody vegetation.*	Approximately 65% of the WAA is covered in woody vegetation.	0.500
Vtree: The percentage of the trees in the WAA that are mast producers.	*More than 20% of the stand is oak, hickory, cypress, maple, and/or elm. Black willow, cottonwood, tallow, and sycamore do not represent more than 15% of the stand.*	The stand within the WAA is comprised of approximately 30% mast producers, while the remainder is comprised of non-mast producing trees (0% *T. sebifera*).	0.500
Vrich: The diversity of the species within the WAA. (species must comprise at least 5% of the stand.)	*Three tree species present.*	*Ulmus americana*, *Celtis laevigata*, and *Carya illinoinensis* are the three tree species present in the WAA.	0.600
Vbasal: The average/mean basal area of the trees in the WAA per acre.	*The average basal area of the WAA is greater than 100 square feet per acre.*	The average basal area of the WAA is greater than 100 square feet per acre.	1.000
Vdensity: The average density of the WAA stand. (Tree is woody with over 3" Diameter at Breast Height [DBH]).	*The WAA averages a tree density of 100-250 trees per acre.*	The WAA averages a tree density of 100-250 trees per acre.	1.000
Vmid: The average/mean coverage of the midstory (shrub/sapling) layer in the WAA.	*Midstory coverage of the WAA is between 11-30%.*	Midstory cover averages 20% in the WAA.	0.500
Vherb: The average/mean coverage of the herbaceous layer in the WAA.	*Herbaceous cover in the WAA averages between 31-50%.*	Herbaceous cover averages 30% in the WAA.	0.500
Vdetritus: The amount of detritus on the WAA (The A-horizon has to have a Munsell value of 4 or less).	*Greater than 85% of the area possesses an O or A horizon.*	Soils in the WAA were of 3/2 value and chroma.	1.000
Vredox: The amount of the WAA that exhibits redox features as an indication of the chemical exchange.	*Redox features less than 20%.*	Redox concentrations represent 5% of the pedon within the top 20 inches of the soil surface.	0.100
Vsorpt: The absorptive properties of the soils in the WAA.	*The WAA is dominated by montmorillonitic clayey soils (clay, clay loams, silty clay loams) or soils with high organic (2/1, 2/2, or 3/1).*	The WAA is dominated by clay loam.	1.000
Vconnect: Number of habitat types within 600 feet of the perimeter of the WAA. (must be ≥5% of the size of the WAA).	*Wetland plus one other habitat type or two other habitat types.*	Wetland plus forested, herbaceous, and open water.	0.500

FUNCTIONAL CAPACITY INDICES (FCI) and UNITS (FCU=FCI*WAA Acreage)

	FCI	FCU
Temporary Storage & Detention of Storage Water (Physical Function) [(Vdur * Vfreq) ^ 0.5 * ((Vtopo + Vcwd + Vwood) / 3)] ^ 0.5	0.669	1.051
Maintain Plant & Animal Community (Biological Function) (Vtree + Vcwd + Vrich + [(Vbasal + Vdensity) / 2] + [(Vmid + Vherb) / 2] + Vconnect) / 6	0.683	1.073
Removal & Sequestrian of Elements & Compounds (Chemical Function) (Vwood + Vfreq + Vdur + [(Vtopo + Vcwd + Vwood) / 3] + [(Vdetritus + Vredox +Vsorpt) / 3]) / 5	0.667	1.047

Riverine Herbaceous/Shrub HGM (Interim) Functional Assessment Data Form

Project/Site:	Dow Harris Reservoir Expansion Project	County:	Brazoria	Assessment Date:	July 3, 2019
Applicant/Owner:	Dow Chemical Company	State:	Texas	WAA ID:	WC004
Investigator(s):	M. Criswell/C. Chambers			WAA Acreage:	0.031
Associated Wetland ID:	WC004				

VARIABLE	CATEGORICAL DECISION	COMMENTS	SUBINDEX
Vdur: Percent of the WAA that is flooded and/or ponded due to the hydrology (i.e. flooding overbank flow) of the nearby waterway	*In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.*	In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.	1.000
Vfreq: Frequency that the WAA is flooded and/or ponded by the nearby waterway	*Floods or ponds 2 out of 5 years (100-year floodplain).*	Floods or ponds 2 out of 5 years (100-year floodplain).	0.500
Vtop: Roughness associated with the WAA	*Less than 15% of the WAA is represented by dips, hummocks, channel sloughs, and/or other topographic features.*	The WAA is indicative of a coastal prairie with mostly flat terrain, depressional wetlands, and channel sloughs.	0.400
Vwood: Percentage of the WAA that is covered by woody vegetation	*0-10% of the WAA is covered with woody vegetation.*	Woody vegetation is absent from the WAA.	0.100
Vmid: The average/mean coverage of the midstory (shrub/sapling) layer in the WAA	*Midstory coverage of the WAA is equal to or less than 1%.*	Midstory cover is absent from the WAA.	0.100
Vherb: The average/mean coverage of the herbaceous layer in the WAA	*Herbaceous cover in the WAA averages between 50-75%.*	Herbaceous cover averages 70%.	0.750
Vconnect: Number of habitat types within 600 feet of the perimeter of the WAA (must be ≥5% of the size of the WAA)	*Wetland plus two or more habitat types (other than forested) OR three or more habitat types.*	Wetland plus forested, herbaceous, and open water.	0.750
Vdetritus: The amount of detritus on the WAA (The A-horizon has to have a Munsell value of 4 or less)	*Greater than 85% of the area possesses an O or A horizon.*	Soils in the WAA were of 3/2 value and chroma.	1.000
Vredox: The amount of the WAA that exhibits redox features as an indication of the chemical exchange	*Redox features less than 20%.*	Redox concentrations represent 5% of the pedon within the top 20 inches of the soil surface.	0.100
Vsorpt: The absorptive properties of the soils in the WAA	*The WAA is dominated by montmorillonitic clayey soils (clay, clay loams, silty clay loams) or soils with high organic (2/1, 2/2, or 3/1).*	The WAA is dominated by clay loam.	1.000

Functional Capacity Indices (FCI) and Units (FCU=FCI*WAA Acreage)	FCI	FCU
Temporary Storage & Detention of Storage Water (Physical Function) [{Vdur * Vfreq} 1/2 * {Vtopo + {Vherb + Vmid/2}/2] 1/2	0.540	0.017
Maintain Plant & Animal Community (Biological Function) {Vmid + Vherb + Vconnect}/3	0.533	0.017
Removal & Sequestrian of Elements & Compounds (Chemical Function) [[Vwood + Vfreq + Vdur + [{Vtopo + Vherb + Vmid}/3] + [{Vdetritus + Vredox + Vsorpt}/3]]/5	0.543	0.017

Riverine Herbaceous/Shrub HGM (Interim) Functional Assessment Data Form

Project/Site: Dow Harris Reservoir Expansion Project County: Brazoria Assessment Date: July 3, 2019
Applicant/Owner: Dow Chemical Company State: Texas WAA ID: WC005
Investigator(s): M. Criswell/C. Chambers WAA Acreage: 0.347
Associated Wetland ID: WC005

VARIABLE	CATEGORICAL DECISION	COMMENTS	SUBINDEX
Vdur: Percent of the WAA that is flooded and/or ponded due to the hydrology (i.e. flooding overbank flow) of the nearby waterway	*In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.*	In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.	1.000
Vfreq: Frequency that the WAA is flooded and/or ponded by the nearby waterway	*Floods or ponds 2 out of 5 years (100-year floodplain).*	Floods or ponds 2 out of 5 years (100-year floodplain).	0.500
Vtop: Roughness associated with the WAA	*Less than 15% of the WAA is represented by dips, hummocks, channel sloughs, and/or other topographic features.*	The WAA is indicative of a coastal prairie with mostly flat terrain, depressional wetlands, and channel sloughs.	0.400
Vwood: Percentage of the WAA that is covered by woody vegetation	*0-10% of the WAA is covered with woody vegetation.*	Woody vegetation is absent from the WAA.	0.100
Vmid: The average/mean coverage of the midstory (shrub/sapling) layer in the WAA	*Midstory coverage of the WAA is equal to or less than 1%.*	Midstory cover is absent from the WAA.	0.100
Vherb: The average/mean coverage of the herbaceous layer in the WAA	*Herbaceous cover in the WAA averages greater than 75%.*	Herbaceous cover averages 82.5%.	1.000
Vconnect: Number of habitat types within 600 feet of the perimeter of the WAA (must be ≥5% of the size of the WAA)	*Wetland plus two or more habitat types (other than forested) OR three or more habitat types.*	Wetland plus forested, herbaceous, and open water.	0.750
Vdetritus: The amount of detritus on the WAA (The A-horizon has to have a Munsell value of 4 or less)	*Greater than 85% of the area possesses an O or A horizon.*	Soils in the WAA were of 3/2 and 4/2 value and chroma.	1.000
Vredox: The amount of the WAA that exhibits redox features as an indication of the chemical exchange	*Redox features less than 20%.*	Redox concentrations represent 5% of the pedon within the top 20 inches of the soil surface.	0.100
Vsorpt: The absorptive properties of the soils in the WAA	*The WAA is dominated by montmorillonitic clayey soils (clay, clay loams, silty clay loams) or soils with high organic (2/1, 2/2, or 3/1).*	The WAA is dominated by clay loam.	1.000

Functional Capacity Indices (FCI) and Units (FCU=FCI*WAA Acreage)

	FCI	FCU
Temporary Storage & Detention of Storage Water (Physical Function) [{Vdur * Vfreq} 1/2 * {Vtopo + {Vherb + Vmid/2}/2] 1/2	0.580	0.201
Maintain Plant & Animal Community (Biological Function) {Vmid + Vherb + Vconnect}/3	0.617	0.214
Removal & Sequestrian of Elements & Compounds (Chemical Function) [[Vwood + Vfreq + Vdur + [{Vtopo + Vherb + Vmid}/3] + [{Vdetritus + Vredox + Vsorpt}/3]]/5	0.560	0.194

Riverine Forested HGM (Interim) Functional Assessment Data Form

Project/Site: Dow Harris Reservoir Expansion Project County: Brazoria Assessment Date: July 3, 2019
Applicant/Owner: Dow Chemical Company State: Texas WAA ID: WC005
Investigator(s): M. Criswell/C. Chambers WAA Acreage: 0.033
Associated Wetland ID: WC005

VARIABLE	CATEGORICAL DECISION	COMMENTS	SUBINDEX
Vdur: Percent of the WAA that is flooded and/or ponded due to the hydrology (i.e. flooding overbank flow) of the nearby waterway.	*In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.*	In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.	1.000
Vfreq: Frequency that the WAA is flooded and/or ponded by the nearby waterway.	*Floods or ponds 2 out of 5 years (100-year floodplain).*	Floods or ponds 2 out of 5 years (100-year floodplain).	0.500
Vtopo: Roughness associated with the WAA.	*Less than 15% of the WAA is represented by dips, hummocks, channel sloughs, and/or other topographic features.*	The WAA is indicative of a coastal prairie with mostly flat terrain, depressional wetlands, and channel sloughs.	0.400
Vcwd: Coarse Woody Debris within the WAA.	*More than 7 pieces of CWD greater than 3" diameter along 100' transect.*	More than 7 pieces of CWD greater than 3" diameter along 100' transect.	1.000
Vwood: Percentage of the WAA that is covered by woody vegetation.	*34-66% of the WAA is covered with woody vegetation.*	Approximately 60% of the WAA is covered in woody vegetation.	0.500
Vtree: The percentage of the trees in the WAA that are mast producers.	*More than 20% of the stand is oak, hickory, cypress, maple, and/or elm. Black willow, cottonwood, tallow, and sycamore do not represent more than 15% of the stand.*	The stand within the WAA is comprised of approximately 25% mast producers, while the remainder is comprised of non-mast producing trees (0% *Triadica sebifera*).	0.500
Vrich: The diversity of the species within the WAA. (species must comprise at least 5% of the stand.)	*Three tree species present.*	*Ulmus americana* , *Celtis laevigata* , and *Fraxinus pennsylvanica* are the three tree species present in the WAA.	0.600
Vbasal: The average/mean basal area of the trees in the WAA per acre.	*The average basal area of the WAA is greater than 100 square feet per acre.*	The average basal area of the WAA is greater than 100 square feet per acre.	1.000
Vdensity: The average density of the WAA stand. (Tree is woody with over 3" Diameter at Breast Height [DBH]).	*The WAA averages a tree density of 100-250 trees per acre.*	The WAA averages a tree density of 100-250 trees per acre.	1.000
Vmid: The average/mean coverage of the midstory (shrub/sapling) layer in the WAA.	*Midstory coverage of the WAA is less than 10%.*	Midstory cover averages 5% in the WAA.	0.250
Vherb: The average/mean coverage of the herbaceous layer in the WAA.	*Herbaceous cover in the WAA averages between 31-50%.*	Herbaceous cover averages 40% in the WAA.	0.500
Vdetritus: The amount of detritus on the WAA (The A-horizon has to have a Munsell value of 4 or less).	*Greater than 85% of the area possesses an O or A horizon.*	Soils in the WAA were of 4/2 value and chroma.	1.000
Vredox: The amount of the WAA that exhibits redox features as an indication of the chemical exchange.	*Redox features less than 20%.*	Redox concentrations represent 5% of the pedon within the top 20 inches of the soil surface.	0.100
Vsorpt: The absorptive properties of the soils in the WAA.	*The WAA is dominated by montmorillonitic clayey soils (clay, clay loams, silty clay loams) or soils with high organic (2/1, 2/2, or 3/1).*	The WAA is dominated by silty clay loam.	1.000
Vconnect: Number of habitat types within 600 feet of the perimeter of the WAA. (must be ≥5% of the size of the WAA).	*Wetland plus one other habitat type or two other habitat types.*	Wetland plus forested, herbaceous, and open water.	0.500

FUNCTIONAL CAPACITY INDICES (FCI) and UNITS (FCU=FCI*WAA Acreage)

	FCI	FCU
Temporary Storage & Detention of Storage Water (Physical Function) [(Vdur * Vfreq) ^ 0.5 * ((Vtopo + Vcwd + Vwood) / 3)] ^ 0.5	0.669	0.022
Maintain Plant & Animal Community (Biological Function) (Vtree + Vcwd + Vrich + [(Vbasal + Vdensity) / 2] + [(Vmid + Vherb) / 2] + Vconnect) / 6	0.663	0.022
Removal & Sequestrian of Elements & Compounds (Chemical Function) (Vwood + Vfreq + Vdur + [(Vtopo + Vcwd + Vwood) / 3] + [(Vdetritus + Vredox +Vsorpt) / 3]) / 5	0.667	0.022

Riverine Herbaceous/Shrub HGM (Interim) Functional Assessment Data Form

Project/Site: Dow Harris Reservoir Expansion Project County: Brazoria Assessment Date: July 5, 2019
Applicant/Owner: Dow Chemical Company State: Texas WAA ID: WC006
Investigator(s): M. Criswell/C. Chambers WAA Acreage: 0.457
Associated Wetland ID: WC006

VARIABLE	CATEGORICAL DECISION	COMMENTS	SUBINDEX
Vdur: Percent of the WAA that is flooded and/or ponded due to the hydrology (i.e. flooding overbank flow) of the nearby waterway	*In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.*	In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.	1.000
Vfreq: Frequency that the WAA is flooded and/or ponded by the nearby waterway	*Floods or ponds 2 out of 5 years (100-year floodplain).*	Floods or ponds 2 out of 5 years (100-year floodplain).	0.500
Vtop: Roughness associated with the WAA	*Less than 15% of the WAA is represented by dips, hummocks, channel sloughs, and/or other topographic features.*	The WAA is indicative of a coastal prairie with mostly flat terrain, depressional wetlands, and channel sloughs.	0.400
Vwood: Percentage of the WAA that is covered by woody vegetation	*11-33% of the WAA is covered with woody vegetation.*	Woody vegetation cover averages 17.5%.	0.250
Vmid: The average/mean coverage of the midstory (shrub/sapling) layer in the WAA	*Midstory coverage of the WAA is equal to or less than 1%.*	Midstory cover is absent from the WAA.	0.100
Vherb: The average/mean coverage of the herbaceous layer in the WAA	*Herbaceous cover in the WAA averages between 50-75%.*	Herbaceous cover averages 55%.	0.750
Vconnect: Number of habitat types within 600 feet of the perimeter of the WAA (must be ≥5% of the size of the WAA)	*Wetland plus two or more habitat types (other than forested) OR three or more habitat types.*	Wetland plus herbaceous and open water.	0.750
Vdetritus: The amount of detritus on the WAA (The A-horizon has to have a Munsell value of 4 or less)	*Greater than 85% of the area possesses an O or A horizon.*	Soils in the WAA were of 4/2 value and chroma.	1.000
Vredox: The amount of the WAA that exhibits redox features as an indication of the chemical exchange	*Redox features less than 20%.*	Redox concentrations represent 10% of the pedon within the top 20 inches of the soil surface.	0.100
Vsorpt: The absorptive properties of the soils in the WAA	*The WAA is dominated by montmorillonitic clayey soils (clay, clay loams, silty clay loams) or soils with high organic (2/1, 2/2, or 3/1).*	The WAA is dominated by clay.	1.000

Functional Capacity Indices (FCI) and Units (FCU=FCI*WAA Acreage)	FCI	FCU
Temporary Storage & Detention of Storage Water (Physical Function) [{Vdur * Vfreq} 1/2 * {Vtopo + {Vherb + Vmid/2}/2] 1/2	0.540	0.247
Maintain Plant & Animal Community (Biological Function) {Vmid + Vherb + Vconnect}/3	0.533	0.244
Removal & Sequestrian of Elements & Compounds (Chemical Function) [[Vwood + Vfreq + Vdur + [{Vtopo + Vherb + Vmid}/3] + [{Vdetritus + Vredox + Vsorpt}/3]]/5	0.573	0.262

Riverine Herbaceous/Shrub HGM (Interim) Functional Assessment Data Form

Project/Site: Dow Harris Reservoir Expansion Project County: Brazoria Assessment Date: June 29, 2019
Applicant/Owner: Dow Chemical Company State: Texas WAA ID: WC007
Investigator(s): A. Tuggle/M. Cothren WAA Acreage: 0.281
Associated Wetland ID: WC007

VARIABLE	CATEGORICAL DECISION	COMMENTS	SUBINDEX
Vdur: Percent of the WAA that is flooded and/or ponded due to the hydrology (i.e. flooding overbank flow) of the nearby waterway	*In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.*	In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.	1.000
Vfreq: Frequency that the WAA is flooded and/or ponded by the nearby waterway	*Floods or ponds 2 out of 5 years (100-year floodplain).*	Floods or ponds 2 out of 5 years (100-year floodplain).	0.500
Vtop: Roughness associated with the WAA	*Less than 15% of the WAA is represented by dips, hummocks, channel sloughs, and/or other topographic features.*	The WAA is indicative of a coastal prairie with mostly flat terrain, depressional wetlands, and channel sloughs.	0.400
Vwood: Percentage of the WAA that is covered by woody vegetation	*34-66% of the WAA is covered with woody vegetation.*	Woody vegetation cover averages 45%.	0.500
Vmid: The average/mean coverage of the midstory (shrub/sapling) layer in the WAA	*Midstory coverage of the WAA is between 25-50%.*	Midstory cover averages 45%.	0.500
Vherb: The average/mean coverage of the herbaceous layer in the WAA	*Herbaceous cover in the WAA averages between 25-50%.*	Herbaceous cover averages 30%.	0.500
Vconnect: Number of habitat types within 600 feet of the perimeter of the WAA (must be ≥5% of the size of the WAA)	*Wetland plus two or more habitat types (other than forested) OR three or more habitat types.*	Wetland plus herbaceous and open water.	0.750
Vdetritus: The amount of detritus on the WAA (The A-horizon has to have a Munsell value of 4 or less)	*Greater than 85% of the area possesses an O or A horizon.*	Soils in the WAA were of 3/2 value and chroma.	1.000
Vredox: The amount of the WAA that exhibits redox features as an indication of the chemical exchange	*Redox features less than 20%.*	Redox concentrations represent 5% of the pedon within the top 20 inches of the soil surface.	0.100
Vsorpt: The absorptive properties of the soils in the WAA	*The WAA is dominated by montmorillonitic clayey soils (clay, clay loams, silty clay loams) or soils with high organic (2/1, 2/2, or 3/1).*	The WAA is dominated by clay.	1.000

Functional Capacity Indices (FCI) and Units (FCU=FCI*WAA Acreage)

	FCI	FCU
Temporary Storage & Detention of Storage Water (Physical Function) [{Vdur * Vfreq} 1/2 * {Vtopo + {Vherb + Vmid/2}/2] 1/2	0.564	0.159
Maintain Plant & Animal Community (Biological Function) {Vmid + Vherb + Vconnect}/3	0.583	0.164
Removal & Sequestrian of Elements & Compounds (Chemical Function) [[Vwood + Vfreq + Vdur + [{Vtopo + Vherb + Vmid}/3] + [{Vdetritus + Vredox + Vsorpt}/3]]/5	0.633	0.178

Riverine Herbaceous/Shrub HGM (Interim) Functional Assessment Data Form

Project/Site: Dow Harris Reservoir Expansion Project County: Brazoria Assessment Date: July 1, 2019
Applicant/Owner: Dow Chemical Company State: Texas WAA ID: WD001
Investigator(s): I. Mock/C. Chambers WAA Acreage: 0.464
Associated Wetland ID: WD001

VARIABLE	CATEGORICAL DECISION	COMMENTS	SUBINDEX
Vdur: Percent of the WAA that is flooded and/or ponded due to the hydrology (i.e. flooding overbank flow) of the nearby waterway	*In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.*	In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.	1.000
Vfreq: Frequency that the WAA is flooded and/or ponded by the nearby waterway	*Floods or ponds 2 out of 5 years (100-year floodplain).*	Floods or ponds 2 out of 5 years (100-year floodplain).	0.500
Vtop: Roughness associated with the WAA	*Less than 15% of the WAA is represented by dips, hummocks, channel sloughs, and/or other topographic features.*	The WAA is indicative of a coastal prairie with mostly flat terrain, depressional wetlands, and channel sloughs.	0.400
Vwood: Percentage of the WAA that is covered by woody vegetation	*0-10% of the WAA is covered with woody vegetation.*	Woody vegetation is absent from the WAA.	0.100
Vmid: The average/mean coverage of the midstory (shrub/sapling) layer in the WAA	*Midstory coverage of the WAA is equal to or less than 1%.*	Midstory cover is absent from the WAA.	0.100
Vherb: The average/mean coverage of the herbaceous layer in the WAA	*Herbaceous cover in the WAA averages greater than 75%.*	Herbaceous cover averages 80%.	1.000
Vconnect: Number of habitat types within 600 feet of the perimeter of the WAA (must be ≥5% of the size of the WAA)	*Wetland plus two or more habitat types (other than forested) OR three or more habitat types.*	Wetland plus herbaceous and open water.	0.750
Vdetritus: The amount of detritus on the WAA (The A-horizon has to have a Munsell value of 4 or less)	*Greater than 85% of the area possesses an O or A horizon.*	Soils in the WAA were of 3/1 value and chroma.	1.000
Vredox: The amount of the WAA that exhibits redox features as an indication of the chemical exchange	*Redox features less than 20%.*	Redox concentrations represent 5% of the pedon within the top 20 inches of the soil surface.	0.100
Vsorpt: The absorptive properties of the soils in the WAA	*The WAA is dominated by montmorillonitic clayey soils (clay, clay loams, silty clay loams) or soils with high organic (2/1, 2/2, or 3/1).*	The WAA is dominated by clay.	1.000

Functional Capacity Indices (FCI) and Units (FCU=FCI*WAA Acreage)

	FCI	FCU
Temporary Storage & Detention of Storage Water (Physical Function) [{Vdur * Vfreq} 1/2 * {Vtopo + {Vherb + Vmid/2}/2] 1/2	0.580	0.269
Maintain Plant & Animal Community (Biological Function) {Vmid + Vherb + Vconnect}/3	0.617	0.286
Removal & Sequestrian of Elements & Compounds (Chemical Function) [[Vwood + Vfreq + Vdur + [{Vtopo + Vherb + Vmid}/3] + [{Vdetritus + Vredox + Vsorpt}/3]]/5	0.560	0.260

Riverine Herbaceous/Shrub HGM (Interim) Functional Assessment Data Form

Project/Site: Dow Harris Reservoir Expansion Project County: Brazoria Assessment Date: July 2, 2019
Applicant/Owner: Dow Chemical Company State: Texas WAA ID: WD002
Investigator(s): I. Mock/C. Chambers WAA Acreage: 0.144
Associated Wetland ID: WD002

VARIABLE	CATEGORICAL DECISION	COMMENTS	SUBINDEX
Vdur: Percent of the WAA that is flooded and/or ponded due to the hydrology (i.e. flooding overbank flow) of the nearby waterway	*In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.*	In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.	1.000
Vfreq: Frequency that the WAA is flooded and/or ponded by the nearby waterway	*Floods or ponds 2 out of 5 years (100-year floodplain).*	Floods or ponds 2 out of 5 years (100-year floodplain).	0.500
Vtop: Roughness associated with the WAA	*Less than 15% of the WAA is represented by dips, hummocks, channel sloughs, and/or other topographic features.*	The WAA is indicative of a coastal prairie with mostly flat terrain, depressional wetlands, and channel sloughs.	0.400
Vwood: Percentage of the WAA that is covered by woody vegetation	*0-10% of the WAA is covered with woody vegetation.*	Woody vegetation is absent from the WAA.	0.100
Vmid: The average/mean coverage of the midstory (shrub/sapling) layer in the WAA	*Midstory coverage of the WAA is equal to or less than 1%.*	Midstory cover is absent from the WAA.	0.100
Vherb: The average/mean coverage of the herbaceous layer in the WAA	*Herbaceous cover in the WAA averages greater than 75%.*	Herbaceous cover averages 85%.	1.000
Vconnect: Number of habitat types within 600 feet of the perimeter of the WAA (must be ≥5% of the size of the WAA)	*Wetland plus two or more habitat types (other than forested) OR three or more habitat types.*	Wetland plus herbaceous and open water.	0.750
Vdetritus: The amount of detritus on the WAA (The A-horizon has to have a Munsell value of 4 or less)	*Greater than 85% of the area possesses an O or A horizon.*	Soils in the WAA were of 3/1 value and chroma.	1.000
Vredox: The amount of the WAA that exhibits redox features as an indication of the chemical exchange	*Redox features less than 20%.*	Redox concentrations represent 5% of the pedon within the top 20 inches of the soil surface.	0.100
Vsorpt: The absorptive properties of the soils in the WAA	*The WAA is dominated by montmorillonitic clayey soils (clay, clay loams, silty clay loams) or soils with high organic (2/1, 2/2, or 3/1).*	The WAA is dominated by clay.	1.000

Functional Capacity Indices (FCI) and Units (FCU=FCI*WAA Acreage)

	FCI	FCU
Temporary Storage & Detention of Storage Water (Physical Function) [{Vdur * Vfreq} 1/2 * {Vtopo + {Vherb + Vmid/2}/2] 1/2	0.580	0.083
Maintain Plant & Animal Community (Biological Function) {Vmid + Vherb + Vconnect}/3	0.617	0.089
Removal & Sequestrian of Elements & Compounds (Chemical Function) [[Vwood + Vfreq + Vdur + [{Vtopo + Vherb + Vmid}/3] + [{Vdetritus + Vredox + Vsorpt}/3]]/5	0.560	0.081

Riverine Herbaceous/Shrub HGM (Interim) Functional Assessment Data Form

Project/Site: Dow Harris Reservoir Expansion Project County: Brazoria Assessment Date: July 2, 2019
Applicant/Owner: Dow Chemical Company State: Texas WAA ID: WD003
Investigator(s): I. Mock/C. Chambers WAA Acreage: 2.096
Associated Wetland ID: WD003

VARIABLE	CATEGORICAL DECISION	COMMENTS	SUBINDEX
Vdur: Percent of the WAA that is flooded and/or ponded due to the hydrology (i.e. flooding overbank flow) of the nearby waterway	*In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.*	In an average year, at least 80% of the WAA either floods and/or ponds for at least 14 consecutive days.	1.000
Vfreq: Frequency that the WAA is flooded and/or ponded by the nearby waterway	*Floods or ponds 2 out of 5 years (100-year floodplain).*	Floods or ponds 2 out of 5 years (100-year floodplain).	0.500
Vtop: Roughness associated with the WAA	*Less than 15% of the WAA is represented by dips, hummocks, channel sloughs, and/or other topographic features.*	The WAA is indicative of a coastal prairie with mostly flat terrain, depressional wetlands, and channel sloughs.	0.400
Vwood: Percentage of the WAA that is covered by woody vegetation	*0-10% of the WAA is covered with woody vegetation.*	Woody vegetation is absent from the WAA.	0.100
Vmid: The average/mean coverage of the midstory (shrub/sapling) layer in the WAA	*Midstory coverage of the WAA is equal to or less than 1%.*	Midstory cover is absent from the WAA.	0.100
Vherb: The average/mean coverage of the herbaceous layer in the WAA	*Herbaceous cover in the WAA averages between 50-75%.*	Herbaceous cover averages 55%.	0.750
Vconnect: Number of habitat types within 600 feet of the perimeter of the WAA (must be ≥5% of the size of the WAA)	*Wetland plus two or more habitat types (other than forested) OR three or more habitat types.*	Wetland plus forested, herbaceous, and open water.	0.750
Vdetritus: The amount of detritus on the WAA (The A-horizon has to have a Munsell value of 4 or less)	*Greater than 85% of the area possesses an O or A horizon.*	Soils in the WAA were of 3/2 value and chroma.	1.000
Vredox: The amount of the WAA that exhibits redox features as an indication of the chemical exchange	*Redox features less than 20%.*	Redox concentrations represent 5% of the pedon within the top 20 inches of the soil surface.	0.100
Vsorpt: The absorptive properties of the soils in the WAA	*The WAA is dominated by montmorillonitic clayey soils (clay, clay loams, silty clay loams) or soils with high organic (2/1, 2/2, or 3/1).*	The WAA is dominated by clay.	1.000

Functional Capacity Indices (FCI) and Units (FCU=FCI*WAA Acreage)

	FCI	FCU
Temporary Storage & Detention of Storage Water (Physical Function) [{Vdur * Vfreq} 1/2 * {Vtopo + {Vherb + Vmid/2}/2] 1/2	0.540	1.132
Maintain Plant & Animal Community (Biological Function) {Vmid + Vherb + Vconnect}/3	0.533	1.118
Removal & Sequestrian of Elements & Compounds (Chemical Function) [[Vwood + Vfreq + Vdur + [{Vtopo + Vherb + Vmid}/3] + [{Vdetritus + Vredox + Vsorpt}/3]]/5	0.543	1.139

APPENDIX F

Wetland Delineation Report

Wetland Delineation Report for the Dow Harris Reservoir Expansion Project in Brazoria County, Texas

USACE File No. SWG-2016-01027

SEPTEMBER 2019

PREPARED FOR

Dow Chemical Company

PREPARED BY

SWCA Environmental Consultants

WETLAND DELINEATION REPORT FOR THE DOW HARRIS RESERVOIR EXPANSION PROJECT IN BRAZORIA COUNTY, TEXAS

Prepared for

Dow Chemical Company
Texas Innovation Center
332 SH 332 E
Lake Jackson, Texas 77566

Prepared by

SWCA Environmental Consultants
10245 West Little York Road, Suite 600
Houston, Texas 77040
(281) 617-3217
www.swca.com

SWCA Project No. 52872
USACE File No. SWG-2016-01027

September 2019

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1 INTRODUCTION

In response to Dow Chemical Company's required Environmental Impact Statement, Dow Chemical Company retained SWCA Environmental Consultants (SWCA) to conduct an evaluation of waters of the U.S. (WOTUS) (otherwise known as a wetland delineation) on a parcel totaling approximately 2,529 acres associated with the proposed Dow Harris Reservoir Expansion Project (Project) located in Brazoria County, Texas. The location of the proposed Project is illustrated in Figure 1 in Appendix A. To facilitate the increasing water demands of their Texas Operations facilities in Freeport, Texas, Dow Chemical Company plans to expand their existing reservoir impoundment complex that currently lies immediately south of the project area. The project area is adjacent to both the Brazos River and Oyster Creek and would be used for surface water diversion. Additional reservoir facilities, including intake and pump stations, inlets, outlets, and spillways would be constructed for the proposed Project. Previous WOTUS delineations covering portions of the project area were performed by Cardno PPI (Cardno) in 2012, 2017, and 2019, the results of which were provided to SWCA by U.S. Army Corps of Engineers (USACE) to inform our delineation efforts (Appendix B).

The purpose of the wetland delineation was to determine the presence, location, and extent of WOTUS within the project area to achieve compliance with permit requirements. To achieve its intended purpose, the wetland delineation boundary was determined by a combination of desktop resource reviews and field surveys of the proposed project area. According to the USACE, WOTUS include territorial seas, tidal waters, traditional navigable waters, interstate waters, and the adjacent waters, contributing waters, or impoundments of these waters (e.g., rivers, creeks, streams, lakes, reservoirs). Special aquatic resources associated with these waters are also considered WOTUS and include sanctuaries and refuges, wetlands, mud flats, vegetated shallows, coral reefs, and riffle and pool complexes.

Wetlands are typically the most common special aquatic resources present and are defined by the USACE as "areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (40 Code of Federal Regulations [CFR] 230.3[t]). Based on this definition, for an area to be considered a wetland it must possess the following parameters under normal circumstances: 1) a predominance of vegetation adapted to live in water or saturated soils (i.e., hydrophytic vegetation), 2) soil characteristics of frequent saturation (i.e., hydric soils), and 3) the presence of hydrology showing evidence of regular flooding or ponding (i.e., wetland hydrology).

2 METHODS

2.1 Desktop Resource Review

Prior to performing the delineation, SWCA conducted a resource review of available background information to help identify the portions of the project area most likely to contain wetlands and/or waterbodies. Resources reviewed included historic aerial photography, U.S. Fish and Wildlife Service National Wetlands Inventory (NWI) data, U.S. Geological Survey (USGS) National Hydrography Dataset (NHD) data, historic USGS topographic quadrangles, and the most recently available Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map data. Additionally, SWCA reviewed the previous WOTUS delineations which were performed by Cardno in 2012, 2017, and 2019.

2.2 Field Survey of Wetlands

SWCA conducted field surveys of the project area from June through July 2019, following the wetland delineation guidelines provided in both the *Corps of Engineers Wetlands Delineation Manual* (Manual) (USACE 1987) and the subsequent *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coastal Plain Region (Version 2.0)* (Regional Supplement) (USACE 2010). Field surveys were focused along nine transects traversing the project area to access the presence or absence of the three wetland parameters (i.e., hydrophytic vegetation, hydric soils, and wetland hydrology) and areas bearing aerial image signatures typical of wetlands.

Data sheets, which document representative areas of uniformity (i.e., similar vegetation, soils, and hydrology), were completed at select locations (i.e., data points) within the project area to differentiate wetland and non-wetland areas based on the presence or absence of the wetland parameters (Appendix B. Data point locations included wetland/non-wetland boundaries, NWI/NHD feature locations and areas suggestive of inundation or saturation in aerial imagery evaluated during the desktop reviews, and the various non-wetland vegetation community types encountered within the project area. At each data point, SWCA took photographs to support the information recorded on the data sheets and document the general conditions observed in the field. A subset of the photographs is provided in the photographic log in Appendix C.

2.2.1 Vegetation Community Types and Hydrophytic Vegetation

Vegetation community types within the project area were categorized based on the uppermost layer of vegetation that comprised at least 20% areal cover into one of three categories: emergent, scrub-shrub, or forested. Wetland communities were further described using the USFWS *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al. 1979; Federal Geographic Data Committee 2013). Wetland and non-wetland vegetation communities were differentiated by the presence or absence of hydrophytic vegetation, respectively.

Hydrophytic vegetation refers to plant species adapted to survive in saturated or inundated soils for at least 5% of the growing season. A given area is said to have hydrophytic vegetation when the prevalence of hydrophytes (water-adapted plants) exceeds that of non-hydrophytes based on species wetland indicator status ratings assigned by the USACE. To assess this parameter consistently with the Regional Supplement, SWCA personnel listed all plants by strata within circular sample plots centered at each data point as well as each plant species' areal cover. Then, based on the USACE *National Wetland Plant List: 2016 Wetland Ratings* (Lichvar et al. 2016), SWCA personnel assigned the appropriate wetland indicator status rating to each species and assessed dominance and prevalence values, as appropriate, to determine if the assessed plant community met the hydrophytic vegetation parameter.

2.2.2 Hydric Soils

Hydric soils typically have characteristics indicating that they formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper strata (Soil Conservation Service 1994). Characteristic indicators of hydric soils are described in *Field Indicators of Hydric Soils in the United States, Version 8.1* (U.S. Department of Agriculture Natural Resources Conservation Service [NRCS] 2017). Soils that do not match any of the accepted hydric soil indicators are considered non-hydric. To assess this parameter consistent with the Regional Supplement, SWCA personnel extracted soil pedons to a depth of no more than 20 inches at the data points and recorded soil characteristics (e.g., color, texture, redoximorphic features) necessary for comparison to known indicators. The hydric soil parameter was met when the soil profile matched the description of a regionally accepted hydric soil indicator.

2.2.3 Wetland Hydrology

Wetland hydrology refers to observable characteristics that confirm recent or continuing inundation and/or soil saturation within an assessed area during the growing season. Direct observation of continuous saturation or inundation within 12 inches of the soil surface for a duration of no less than 14 consecutive days will meet the standard for hydrology specified in the *Technical Standard for Water-Table Monitoring of Potential Wetland Sites* (USACE 2005a). Because on-site investigations to accurately determine the presence or absence of this standard are often impractical, the Regional Supplement describes a variety of readily observable primary (more reliable) and secondary (less reliable) hydrologic indicators that serve as sufficient evidence of wetland hydrology, when present. In accordance with the Regional Supplement, all indications of periodic inundation and/or soil saturation within an assessed area were recorded and compared to known wetland hydrology indicators. If the area displayed at least one primary indicator or two secondary indicators, the wetland hydrology parameter was met.

Of the three wetland assessment parameters, wetland hydrology is perhaps the most difficult to accurately assess because it is both transitory and influenced by physical and climatic factors (e.g., precipitation, soil permeability, stratigraphy, topography). In this region, the normality of precipitation (primarily as rainfall) has a substantial temporal influence on wetland hydrology. This is particularly true for the summer months when evapotranspiration rates are highest and typically result in receding water tables. Therefore, it is essential to assess wetland hydrology with respect to rainfall normality within the project area. This was done by following the direct antecedent rainfall evaluation method (DAREM) (Sprecher and Warne 2000). This method assesses an area's wetland hydrologic condition by comparing prior 3-month precipitation values to 30-year norms available from the NRCS in tabular form as Wetlands Evaluation Tables (WETS) (NRCS 1997). Evaluation using DAREM classifies the wetland hydrologic condition of an area into one of three categories: drier than normal, normal, or wetter than normal. This assessment along with rainfall events during or shortly before the delineation were considered to determine if identified wetland hydrology indicators should be considered normal or resultant of wetter than normal hydrologic conditions, or if hydrology indicators were lacking due to abnormal or problematic conditions.

2.3 Field Surveys of Waterbodies

SWCA delineated all waterbodies within the project area that possess an ordinary high-water mark (OHWM). An OHWM is a line on the shore established by the fluctuations of water during ordinary high water flows and indicated by physical characteristics such as "a clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas" (33 CFR 328.3[e]). The OHWM was delineated following the recommendations of the 2005 USACE Regulatory Guidance Letter (RGL) 05-05: Ordinary High Water Mark Identification (USACE 2005b). For each waterbody, SWCA took photographs and documented its general characteristics (e.g., OHWM dimensions, flow, substrate).

2.4 Mapping

SWCA used a Trimble Geo-Explorer 7X series global positioning system (GPS) unit to geographically reference features, such as data point locations and wetland/waterbody boundaries, identified during the delineation. Geographic information system (GIS) software was used to differentially correct (i.e., post-process) recorded features, calculate areas, and generate the wetland delineation map (see Appendix A). The point, line, and polygon data displayed on the attached wetland delineation map, though recorded with a GPS unit capable of submeter accuracy, are for review purposes only, and do not represent a professional civil survey. Data points and delineated features are identified by a unique identifier. Waterbodies were identified by “P” for ponds and “S” for channels as the first character and followed by the team designation, “A,” and a unique sequential number beginning with 001. For example, SA001 is the first channel that was delineated by team A. Data points are identified by the transect number “T#,” followed by “DP,” the team letter designation, a unique sequential number beginning with 001, and the type of vegetation community in which the data point is located (e.g., “U” for upland). For example, T1DPA003_U represents the third data point, which is in an upland, recorded by team A, along transect 1.

2.5 Aerial Interpretation of Wetlands and Waterbodies

Portions of the project area contained potential WOTUS identified by Cardno PPI in previous delineation efforts. SWCA verified particular features within the project area during the desktop reviews and field surveys and these features were added to the wetland delineation data set using Google Earth and GIS software. The aerially interpreted wetlands and waterbodies include “X” in the feature identification number within report tables and maps.

3 RESULTS

3.1 Resource Review

According to the resource review, the project area consists primarily of undeveloped land primarily used for agricultural purposes with agricultural ditches surrounding tracts at the base of bermed farm roads. The NWI depicts multiple palustrine emergent (PEM) wetlands, palustrine forested (PFO) wetlands, freshwater ponds, and riverine habitats primarily following the main waterbodies which dissect the project area (USFWS 2019). SWCA used FEMA floodplain mapping instruments to evaluate the locations of wetlands relative to the 100-year floodplain, which typically defines the USACE Galveston District’s limit of jurisdiction. The FEMA FIRM Maps 48039C0245H and 48039C0240H indicate that approximately 98% of the project area is within the 100-year floodplain (FEMA 2019) (see Figure 1, Appendix A). Please refer to the vicinity and wetland delineation maps in Appendix A for more detailed information.

According to Houston Wilderness (2019), the project area is outside the current limits of the Columbia Bottomlands ecological area; however, the region is not well defined. As a result, the field observations were evaluated to determine if any of the forested communities in the project area are consistent with the descriptions of historical Columbia Bottomlands.

3.2 Wetlands

SWCA delineated 23 wetlands within the project area, consisting of 16 PEM wetlands, three palustrine scrub-shrub (PSS) wetlands, and four PFO wetlands. The type and acreage of each wetland identified within the project area are provided in Table 1. Figure 2 in Appendix A provides an Index Map for Figure 3 which illustrates the location of each wetland and data point recorded within the project area. Photographs of select wetlands are provided in Appendix C.

Table 1. Wetland Characteristics

Map Page Number (Figure 3)	Wetland ID	Latitude	Longitude	Wetland Community Type	Wetland Acreage in Project Area*
1	WA002	29.277314	-95.561142	PEM	0.186
1	WA003	29.275841	-95.558368	PFO	2.100
1	WA004	29.277070	-95.558099	PEM	2.437
1	WA004	29.276564	-95.558772	PFO	3.120
1	WA004	29.276772	-95.559722	PSS	4.547
1	WA005	29.279598	-95.552662	PEM	0.046
3	WB001	29.256580	-95.565756	PEM	0.174
3	WB002	29.257160	-95.565025	PEM	1.105
3	WB003	29.259335	-95.562436	PEM	0.054
1	WB004	29.277343	-95.553189	PEM	0.640
3	WB005	29.257187	-95.566643	PEM	1.129
3	WB005	29.256935	-95.566913	PSS	0.105
1, 2	WC001	29.271008	-95.549308	PEM	0.097
1	WC002	29.271366	-95.550582	PEM	0.217
3	WC003	29.250921	-95.560021	PFO	1.570
3	WC004	29.251396	-95.559081	PEM	0.031
3	WC005	29.251679	-95.558576	PEM	0.347
3	WC005	29.251491	-95.558690	PFO	0.033
1	WC006	29.284840	-95.554806	PEM	0.457
1	WC007	29.279442	-95.551982	PSS	0.281
2, 3	WD001	29.263545	-95.549025	PEM	0.464
2, 4	WD002	29.261430	-95.529353	PEM	0.144
2, 4	WD003	29.259356	-95.529090	PEM	2.096
Subtotal PEM Wetlands					*9.624*
Subtotal PSS Wetlands					*4.933*
Subtotal PFO Wetlands					*6.823*
Total					**21.380**

* Acreages were rounded to the nearest 0.001 acre.

3.2.1 Vegetation Communities

Overall, the project area consists of a majority of herbaceous upland and tilled cropland with smaller portions of woods and shrublands forming riparian buffers. Six vegetation community types were determined to be within the project area, including three wetland vegetation communities (i.e., PEM, PSS, and PFO) and three non-wetland/upland vegetation communities (i.e., herbaceous, scrub/shrub, and forested). The species identified at each data point along with their areal coverage are recorded on the data sheets in Appendix B. A photographic log, which includes a representative subset of the vegetation communities observed within the project area as viewed from select data points, is provided in Appendix C The dominant species identified within sample points by vegetation community type and their assigned wetland indicator status (i.e., facultative [FAC], facultative upland [FACU], facultative wet [FACW], obligate [OBL], upland [UPL]) are summarized in the following paragraphs.

PEM Wetland. PEM wetland communities consist of a prevalence of hydrophytic non-woody vegetation less than 3 feet in height. Dominant herbaceous species within the project area included jungle-rice

(*Echinochloa colona*; FACW), sand spike-rush (*Eleocharis montevidensis*; FACW), tall scouring-rush (*Equisetum hyemale*; FACW), common rush (*Juncus effusus*; OBL), golden crown grass (*Paspalum dilatatum*; FAC), mild water-pepper (*Persicaria hydropiper*; OBL), and swamp smartweed (*P. hydropiperoides*; OBL).

PSS Wetland. PSS wetland communities consist of a prevalence of hydrophytic woody species less than 20 feet in height and 3 inches or greater in diameter at breast height. PSS wetlands within the project area were dominated by black willow (*Salix nigra*; OBL), poison-bean (*Sesbania drummondii*; FACW), and Chinese tallowtree (*Triadica sebifera*; FAC). Golden crown grass was the prevalent herbaceous species within these wetland communities.

PFO Wetland. PFO wetland communities consist of a prevalence of hydrophytic woody species greater than 20 feet in height and 3 inches in diameter at breast height. PFO wetlands in the project area were dominated by tree and shrub species of pecan (*Carya illinoinensis*, FAC), sugarberry (*Celtis laevigata*; FACW), green ash (*Fraxinus pennsylvanica*; FACW), and American elm (*Ulmus americana*; FAC). The tree species found within these communities are typical of forested areas in the coastal plains; however, they do not appear to be consistent with remnants of the historical Columbia Bottomlands.

Herbaceous Upland. Herbaceous upland communities consist of non-wetland areas dominated by non-woody vegetation. Dominant herbaceous species in the project area included careless weed (*Amaranthus palmeri*; FACU), great ragweed (*Ambrosia trifida*; FAC), tumble windmill grass (*Chloris verticillata*; UPL), Bermuda grass (*Cynodon dactylon*; FACU), jungle-rice, sand spike-rush, petticoat-climber (*Eragrostis spectabilis*; FACU), soybean (*Glycine max*; UPL), upland cotton (*Gossypium hirsutum*; FACU), annual marsh-elder (*Iva annua*; FAC), Santa Maria feverfew (*Parthenium hysterophorus*; FAC), golden crown grass, poison-bean, Johnsongrass (*Sorghum halepense*; FACU), St. Augustine grass (*Stenotaphrum secundatum*; FAC), and corn (*Zea mays*; UPL).

Scrub/Shrub Upland. Scrub/shrub upland communities consist of non-wetland areas dominated by woody vegetation less than 20 feet in height and 3 inches or greater in diameter at breast height. The dominant shrub species in the project area consisted of poison-bean, while the dominant herbaceous species consisted of Bermuda grass and golden crown grass.

Forested Upland. Forested upland communities consist of a prevalence of non-wetland woody species greater than 3 inches in diameter at breast height. The dominant trees in this community type within the project area are pecan, sugarberry, American elm, and Virginia live oak (*Ulmus crassifolia*; FAC). Bermuda grass, long-leaf basket grass (*Oplismenus hirtellus*; FAC), and golden crown grass were the dominant herbaceous species. As with the forested wetlands, forested uplands communities within the project area are consistent with the coastal plains but do not bear the hallmarks of historical Columbia Bottomlands communities.

3.2.2 Soils

According to the NRCS Soil Survey for Brazoria County, Texas (NRCS 2019), nine soil map units are present within the project area and one soil map unit is listed as hydric soils or includes hydric components (Table 2) (NRCS 2017). Brief descriptions of the NRCS soil map units present within the project area are provided in Appendix D

Although an NRCS hydric listing alone is generally insufficient to determine if soils for a site are hydric, it does indicate that suitable soil properties or conditions exist that promote the formation of hydric soil conditions. As a result, the portions of the project area depicted as containing hydric soil map units were subjected to greater scrutiny with respect to the presence of hydric soil indicators. The NRCS mapped soil units are described in Appendix D.

Table 2. NRCS-Mapped Soils and Their Hydric Characteristics

Map Unit Name (Unit Code)	Hydric Map Unit (Yes/No)	Hydric Component Characteristics			Acreage within Project Area†
		Name (Unit Percent)	Landform	Hydric Criteria*	
Brazoria County					
Asa silty clay loam, 0 to 1 percent slopes, rarely flooded (3)	No	N/A	N/A	N/A	15.1
Brazoria clay, 0 to 1 percent slopes, rarely flooded (10)	No	N/A	N/A	N/A	1024.8
Brazoria clay, 1 to 3 percent slopes, rarely flooded (11)	No	N/A	N/A	N/A	70.2
Clemville silty clay loam, 0 to 1 percent slopes, occasionally flooded (12)	No	N/A	N/A	N/A	138.7
Norwood loam, 0 to 1 percent slopes, rarely flooded (33)	No	N/A	N/A	N/A	183.1
Norwood silt loam, 1 to 5 percent slopes, rarely flooded (34)	No	N/A	N/A	N/A	115.4
Norwood-Asa complex, 1 to 8 percent slopes (35)	No	N/A	N/A	N/A	132.3
	No	N/A	N/A	N/A	
Pledger clay, 0 to 1 percent slopes, rarely flooded (36)	No	N/A	N/A	N/A	776.5
Churnabog clay, 0 to 1 percent slopes, frequently flooded (38)	Yes	Churnabog (90%)	Floodplains, oxbows	2, 3	12.8

* 2 = somewhat poorly to very poorly drained soils that have a shallow water table (i.e., at a depth of less than 1 foot) during the growing season; 3 = soils that are frequently ponded for a long or very long duration during the growing season.

† Acreages were calculated using ESRI ArcMap on July 2019 and rounded to the nearest 0.1 acre.

The project area is entirely located within the Gulf Coastal Prairie soil region and the Lake Charles-Bernard-Edna Series (USDA 2008). Direct observations of soil epipedons revealed that the typical soil matrix was 10YR and 7.5YR in hue and 1, 2, 3, 4, 6 in chroma, while typical redox components were 10YR, 7.5YR, and 5YR in hue and 2, 4, 6 in chroma. Soils textures observed were predominantly clays and silty clays, occasionally including loam components and less often sand components. Wetland areas displayed the depleted matrix (F3), redox dark surface (F6), and red parent material (TF2) hydric soil indicators. Non-wetland/upland areas either failed to display hydric soil indicators, or they displayed hydric soils but failed to meet vegetation and/or hydrology parameters. Refer to Appendix B for data point specific soil observations.

3.2.3 Hydrology

The DAREM wetland hydrologic conditions for June 2019 (Table 3a) and July 2019 (Table 3b) were calculated using WETS and monthly precipitation data from the Angleton 2 W weather station (Global Historical Climatology Network [GHCN]: USC00410257) located approximately 7.51 miles southeast of the project area (National Oceanic and Atmospheric Administration 2019; Sprecher and Warne 2000). Monthly precipitation data for June 2019 were provided from the Angleton Lake Jackson Brazoria County AP (GHCN: USC00012976) located approximately 10.41 miles southeast of the project area

(National Oceanic and Atmospheric Administration 2019). The precipitation and 30-year normal range values used to calculate the wetland hydrologic conditions at the times of the surveys are also provided. According to the DAREM, the wetland hydrologic condition transitioned from normal to wetter than normal during the wetland delineation.

Table 3a. DAREM Wetland Hydrologic Conditions during June 2019

Prior Month		WETS Percentile (inches)		Measured Rainfall	Rainfall Condition*	Month Weight†	Score‡
		30th	70th				
1st	May	1.96	5.50	6.81	3	3	9
2nd	April	1.32	4.06	1.81	2	2	4
3rd	March	2.21	4.55	1.02	1	1	1
DAREM Score (i.e., Scores Total)							**14**

DAREM Score	6	7	8	9	10	11	12	13	**14**	15	16	17	18
DAREM Wetland Hydrologic Condition	Drier than normal				**Normal**					Wetter than normal			

Data source: Angleton 2 W weather station (TX08; GHCND No. USC00410257).
* 1 = measured rainfall that was less than the WETS 30th percentile, 2 = measured rainfall that was between the WETS 30th and 70th percentiles, and 3 = measured rainfall that was greater than the WETS 70th percentile.
† 1st prior month = 3, 2nd prior month = 2, and 3rd prior month = 1.
‡ Scores are the product of the Condition × Weight.

Table 3b. DAREM Wetland Hydrologic Conditions during July 2019

Prior Month		WETS Percentile (inches)		Measured Rainfall	Rainfall Condition*	Month Weight†	Score‡
		30th	70th				
1st	June	2.75	6.55	9.26	3	3	9
2nd	May	1.96	5.50	6.81	3	2	6
3rd	April	1.32	4.06	1.81	2	1	2
DAREM Score (i.e., Scores Total)							**17**

DAREM Score	6	7	8	9	10	11	12	13	14	15	16	**17**	18
DAREM Wetland Hydrologic Condition	Drier than normal				Normal					**Wetter than normal**			

Data source: Angleton 2 W weather station (GHCND No. USC00410257) and Angleton Lake Jackson Brazoria County AP (GHCND No. USW00012976)
* 1 = measured rainfall that were less than the WETS 30th percentile, 2 = measured rainfall that were between the WETS 30th and 70th percentiles, and 3 = measured rainfall that were greater than the WETS 70th-percentile.
†1st prior month = 3, 2nd prior month = 2, and 3rd prior month = 1.
‡ Scores are the product of the Condition × Weight.

Wetland hydrology indicators observed in the field included primary wetland hydrology indicators (i.e., surface water, high water table, saturation, sediment deposits, algal mat/crust, water marks, inundation visible on aerial imagery, water-stained leaves, aquatic fauna, and hydrogen sulfide odor) and secondary wetland hydrology indicators (i.e., surface soil cracks, sparsely vegetated concave surface, crayfish burrows, geomorphic position, and positive FAC-neutral test). Refer to the data sheets in Appendix B for the wetland hydrology indicators observed at a specific data point.

3.3 Waterbodies

SWCA delineated 41 waterbodies consisting of 11 streams, 5 ditches, 22 agricultural ditches, and 3 ponds within the project area. The type, OHWM width, length, and acreage of each waterbody within the project area are provided in Table 4. Refer to Figure 3 in Appendix A for the location of each waterbody within the project area. Photographs of a subset of the waterbodies are provided in Appendix C.

Table 4. Waterbody Characteristics

Map Page Number (Figure 3)	Waterbody ID	Latitude	Longitude	Flow	Waterbody Type	Waterbody Sub-Type	USGS Name*	OHWM Width (feet)	Waterbody Length in Project Area (feet)	Waterbody Acreage in Project Area†
3	SA001	29.265231	-95.554668	Intermittent	Modified	Stream	Jennings Bayou	30	13,497	11.343
1, 3	SA003	29.270622	-95.560341	Intermittent	Modified	Ditch	UT of Jennings Bayou	10	6,129	1.409
3	SB002	29.267012	-95.56052	Ephemeral	Modified	Ag Ditch	N/A	3	1,257	0.087
3	SB003	29.269085	-95.564918	Ephemeral	Modified	Stream	UT of Brazos River	3	2,589	0.178
3	SB004	29.268567	-95.562722	Ephemeral	Modified	Ag Ditch	N/A	2	2,807	0.193
1	SB005	29.274512	-95.552484	Ephemeral	Modified	Ag Ditch	N/A	3	1,738	0.133
1	SB006	29.279423	-95.554144	Ephemeral	Modified	Ag Ditch	N/A	4	1,197	0.110
1	SB007	29.281621	-95.563656	Ephemeral	Modified	Stream	N/A	4	678	0.063
3	SB013	29.260737	-95.559104	Ephemeral	Modified	Stream	UT of Jennings Bayou	1	116	0.003
3, 4	SB014	29.261892	-95.547528	Ephemeral	Man-Made	Ag Ditch	N/A	6	3,740	0.516
1, 2	SC001	29.280204	-95.549075	Perennial	Modified	Stream	Oyster Creek	30	16,888	21.335
1, 2	SC005	29.271447	-95.548408	Ephemeral	Natural	Stream	UT of Jennings Bayou	1	73	0.002
1	SC016	29.286476	-95.557825	Ephemeral	Modified	Stream	UT of Oyster Creek	10	201	0.041
2, 4	SD016	29.261634	-95.528514	Ephemeral	Man-Made	Ag Ditch	N/A	8	523	0.097
2, 4	SD017	29.260563	-95.528734	Ephemeral	Man-Made	Ag Ditch	N/A	8	594	0.110
3	SX001	29.262504	-95.564496	Perennial	Modified	River	Brazos River	300	4,309	15.963
3	SX002	29.253758	-95.562461	Perennial	Modified	River	Brazos River	300	4,530	9.008
1	SX003	29.279016	-95.558534	Ephemeral	Man-Made	Ditch	N/A	4	3,946	0.362
1	SX004	29.279147	-95.562531	Ephemeral	Man-Made	Ditch	N/A	4	3,189	0.292
1	SX005	29.281655	-95.554482	Ephemeral	Man-Made	Ditch	N/A	5	2,569	0.294
1	SX006	29.281533	-95.554826	Ephemeral	Man-Made	Ag Ditch	N/A	5	1,341	0.154
4	SX007	29.260645	-95.542613	Ephemeral	Man-Made	Ag Ditch	N/A	4	2,816	0.259
3	SX008	29.254434	-95.558953	Ephemeral	Man-Made	Ag Ditch	N/A	8	1,384	0.255
3	SX009	29.254435	-95.55879	Ephemeral	Man-Made	Ag Ditch	N/A	10	1,326	0.306
2	SX010	29.273381	-95.540811	Ephemeral	Man-Made	Ag Ditch	N/A	10	1,938	0.447

Map Page Number (Figure 3)	Waterbody ID	Latitude	Longitude	Flow	Waterbody Type	Waterbody Sub-Type	USGS Name*	OHWM Width (feet)	Waterbody Length in Project Area (feet)	Waterbody Acreage in Project Area†
1, 3	SX011	29.270579	-95.550388	Ephemeral	Man-Made	Ag Ditch	N/A	12	486	0.135
4	SX012	29.257545	-95.536386	Ephemeral	Man-Made	Ditch	N/A	15	3,474	1.200
2, 4	SX013	29.257775	-95.539679	Ephemeral	Man-Made	Ag Ditch	N/A	12	3,885	1.071
3	SX014	29.257925	-95.548556	Intermittent	Modified	Stream	N/A	16	7,290	2.678
3, 4	SX015	29.254985	-95.547728	Ephemeral	Man-Made	Ag Ditch	N/A	16	2,421	0.891
4	SX016	29.259067	-95.541417	Ephemeral	Man-Made	Ag Ditch	N/A	4	924	0.085
4	SX017	29.259368	-95.533469	Ephemeral	Man-Made	Ag Ditch	N/A	5	2,074	0.239
4	SX018	29.259372	-95.533333	Ephemeral	Man-Made	Ag Ditch	N/A	5	2,061	0.237
2, 4	SX019	29.26643	-95.53796	Ephemeral	Man-Made	Ag Ditch	N/A	8	2,170	0.400
2, 4	SX020	29.266058	-95.534439	Ephemeral	Man-Made	Ag Ditch	N/A	5	322	0.037
2, 4	SX021	29.266011	-95.534325	Ephemeral	Man-Made	Ag Ditch	N/A	5	276	0.032
2, 3	SX022	29.265983	-95.544676	Ephemeral	Modified	Ag Ditch	N/A	12	4,057	1.120
4	SX024	29.259485	-95.52556	Perennial	Modified	Stream	Oyster Creek	15	523	0.179
1, 3	PA001	29.270161	-95.556922	Perennial	Modified	Pond	N/A	N/A	N/A	1.028
1	PB001	29.281622	-95.56364	Perennial	Modified	Pond	N/A	N/A	N/A	1.077
3	PB002	29.260762	-95.559083	Perennial	Modified	Pond	N/A	N/A	N/A	0.731
Subtotal of Ephemeral Waterbodies									26,250	49.321
Subtotal of Intermittent Waterbodies									26,916	15.430
Subtotal of Perennial Waterbodies									56,172	9.349
Total									**109,338**	**74.100**

* UT=unnamed tributary
† Acreages were rounded to the nearest 0.001 acre.

4 SUMMARY AND CONCLUSIONS

SWCA performed a wetland delineation of the Dow Harris Reservoir Expansion Project site between June and July 2019. Collectively, the delineations identified 23 wetlands totaling 21.380 acres within the project area. Additionally, 41 waterbodies were identified within the project area totaling 109,338 linear feet and 74.100 acres.

In comparison to the results of the WOTUS delineations conducted by Cardno, SWCA's wetland delineation observed a greater total of wetland and waterbody acreage. When each of the Cardno reports are combined to cover the majority of the project area, this results in wetlands totaling 19.149 acres and waterbodies totaling 104,435 linear feet and 60.743 acres.

Table 5. Comparison of Cardno and SWCA Wetland Delineation Results

	Cardno Results		SWCA Results	
	Acreage in Project Area†	**Waterbody Length in Project Area (feet)**	**Acreage in Project Area†**	**Waterbody Length in Project Area (feet)**
Wetland Subtotal	19.149	--	21.380	--
Waterbody Subtotal	60.743	104,435	74.100	109,338
Total	**79.892**	**104,435**	**95.480**	**109,338**

† Acreages were rounded to the nearest 0.001 acre.

The delineation findings contained within this report represent the professional opinion of SWCA and are not a verification or jurisdictional determination of WOTUS. No other warranty, expressed or implied, is made.

5 LITERATURE CITED

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. *Classification of Wetlands and Deepwater Habitats of the United States*. FWS/OBS-79/31. Washington, D.C.: U.S. Fish and Wildlife Service.

Federal Emergency Management Agency (FEMA). 2019. FEMA Flood Map Service Center. Available at: https://msc.fema.gov/portal/home. Accessed July 2019.

Federal Geographic Data Committee. 2013. *Classification of Wetlands and Deepwater Habitats of the United States*. FGDC-STD-004-2013. Second Edition. Washington, D.C.: Wetlands Subcommittee, Federal Geographic Data Committee and U.S. Fish and Wildlife Service.

Houston Wilderness. 2019. Columbia Bottomlands. Available at: http://houstonwilderness.org/colombia-bottomlands. Accessed July 2019.

Lichvar, R.W., D.L. Banks, W.N. Kirchner, and N.C. Melvin. 2016. The National Wetland Plant List: 2016 wetland ratings. *Phytoneuron* 2016-30:1–17.

National Oceanic and Atmospheric Administration. 2019. Weather Stations: USDA, Natural Resources Conservation Service. Available at: http://agacis.rcc-acis.org/. Accessed July 2019.

Soil Conservation Service. 1994. Changes in hydric soils of the United States. *Federal Register* 59(133):35680–35681. July 13, 1994.

Sprecher, S.W., and A.G. Warne. 2000. *Accessing and Using Meteorological Data to Evaluate Wetland Hydrology*. Technical Report TR-WRAP-00-1. Vicksburg, Mississippi: U.S. Army Engineer Research and Development Center.

U.S. Army Corps of Engineers (USACE). 1987. *U.S. Army Corps of Engineers Wetlands Delineation Manual*. Technical Report Y-87-1. Vicksburg, Mississippi: U.S. Army Engineers Waterways Experiment Station Environmental Laboratory.

———. 2005a. *Technical Standard for Water-Table Monitoring of Potential Wetland Sites*. WARP Technical Notes Collection (ERDC TN-WRAP-05-2). Vicksburg, Mississippi: U.S. Army Engineer Research and Development Center.

———. 2005b. *Ordinary High Water Mark Identification*. Regulatory Guidance Letter 05-05. December 7, 2005.

———. 2010. *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coastal Plain Region* (Version 2.0). ERDC/EL TR-10-20. Vicksburg, Mississippi: U.S. Army Engineer Research and Development Center.

U.S. Department of Agriculture Natural Resources Conservation Service (NRCS). 1997. National Water and Climate Center: WETS Table Documentation website. Available at: http://www.wcc.nrcs.usda.gov/ climate/wets_doc.html. Accessed July 2019.

———. 2008. *General Soil Map of Texas.* Available at: https://legacy.lib.utexas.edu/maps/texas/texas-general_soil_map-2008.pdf. Accessed August 2019.

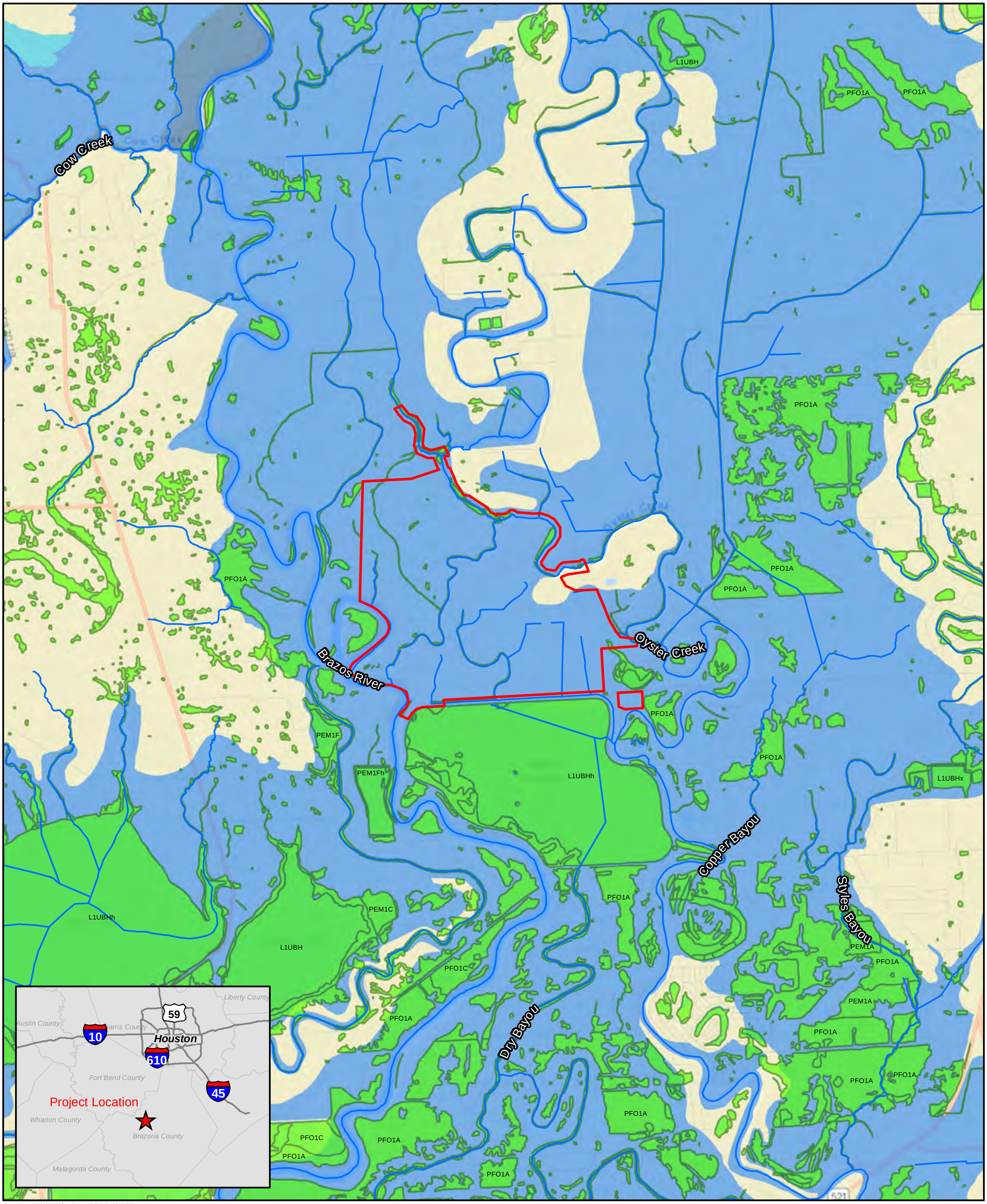
———. 2017. *Field Indicators of Hydric Soils in the United States, Version 8.1* edited by L.M. Vasilas, G.W. Hurt, and J.F. Berkowitz. USDA, NRCS, in cooperation with the National Technical Committee for Hydric Soils.

———. 2019. Web Soil Survey. U.S. Department of Agriculture, Natural Resources Conservation Service. Available at: http://websoilsurvey.nrcs.usda.gov. Accessed July 2019.

U.S. Fish and Wildlife Service (USFWS). 2019. National Wetland Inventory. U.S. Department of the Interior, U.S. Fish and Wildlife Service. Available at: https://www.fws.gov/wetlands/data/Mapper.html. Accessed July 2019.

APPENDIX A

Maps



SWCA ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESEVOIR EXPANSION PROJECT

VICINITY MAP
BRAZORIA COUNTY, TEXAS

FIGURE 1

Project Boundary
Named NHD Stream
NWI Wetlands
100-Year Floodplain (Floodway)
100-Year Floodplain
500-Year Floodplain

1:75,000

Created By: CM
Project Number: 52872
Date: 7/30/2019
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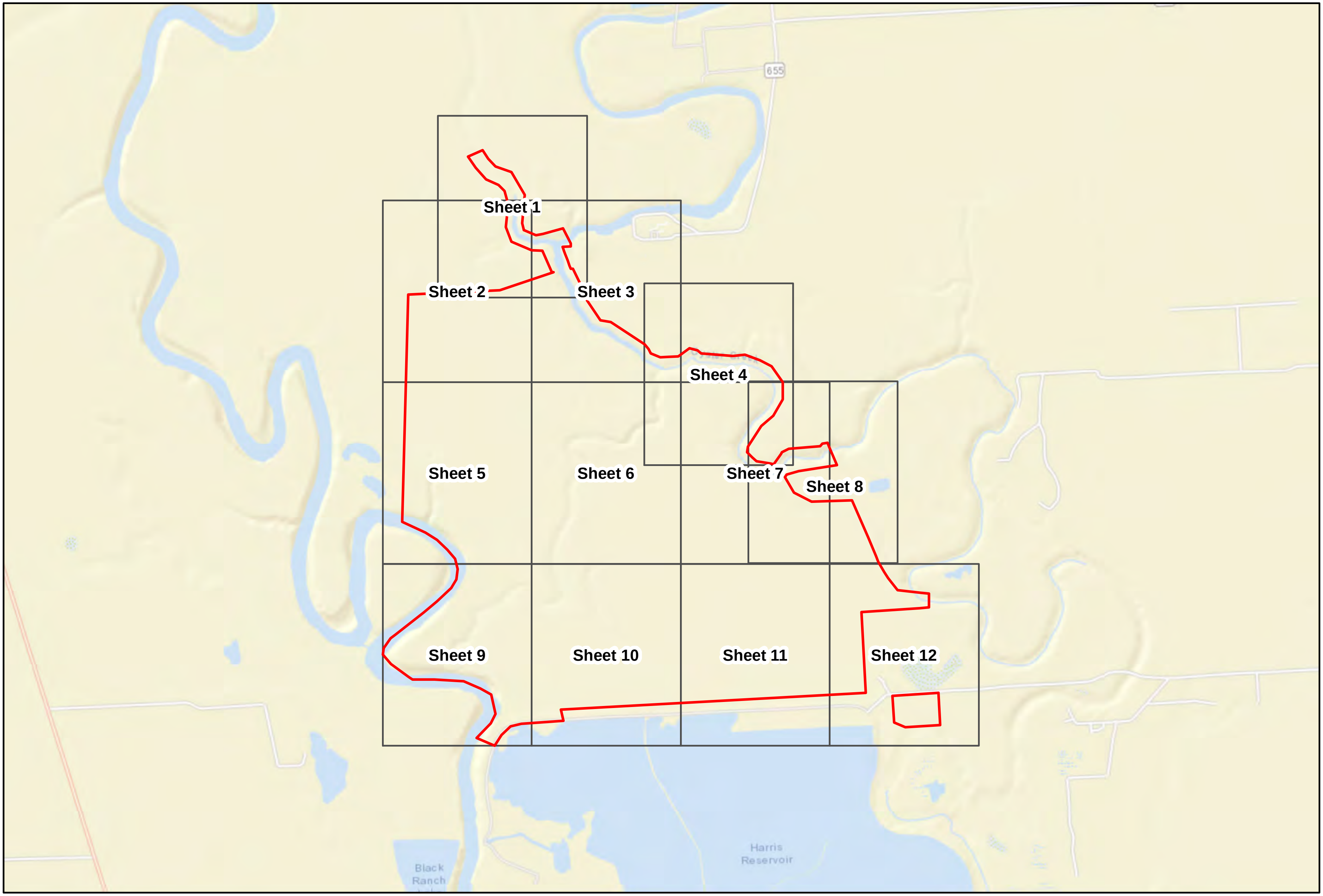
0 1,000 2,000 3,000 4,000 5,000 6,000 Feet
0 200 400 600 800 1,000 1,200 1,400 Meters

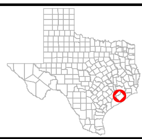


SWCA ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESEVOIR EXPANSION PROJECT
INDEX MAP
USACE GALVESTON DISTRICT

Figure 2

Project Boundary
Mapbook Index



1:40,000
Created By: C. McConnell
Project Number: 52872
Date: 7/30/2019
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0 0.25 0.5 Miles
0 187.5 375 750 1,125 1,500 Miles

SWCA ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESEVOIR EXPANSION PROJECT

WETLAND DELINEATION MAP
BRAZORIA COUNTY, TEXAS

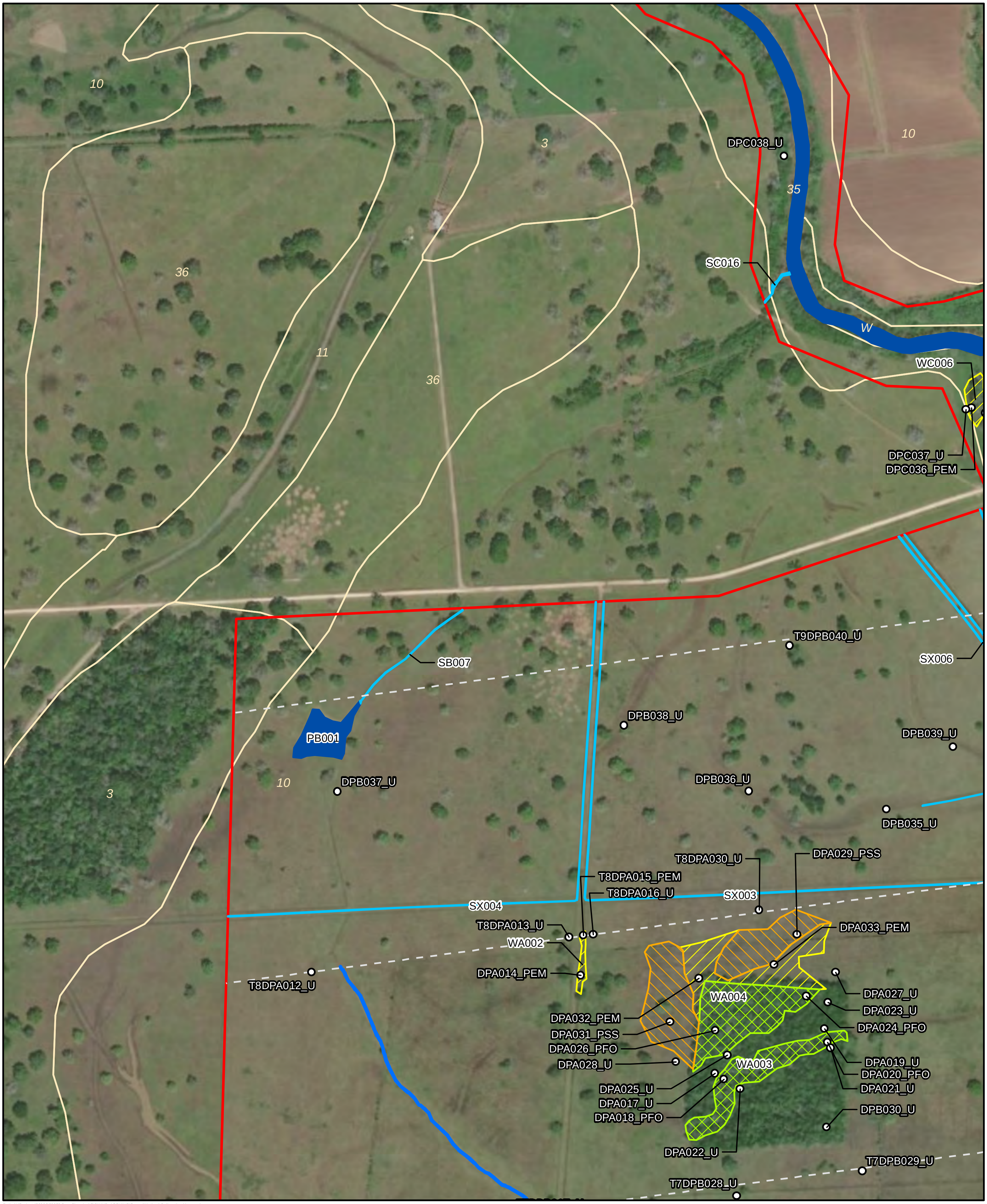
FIGURE 3 - SHEET 1 of 12

Project Boundary
Data Points
Transect
Soil Map Unit Boundary
Ephemeral
Intermittent
Perennial
Emergent Wetland
Forested Wetland
Scrub-Scrub Wetland

1:7,500

Created By: CM
Project Number: 52872
Date: 7/30/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

0 150 300 450 600 Feet
0 30 60 90 120 150 Meters



SWCA ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESEVOIR EXPANSION PROJECT

WETLAND DELINEATION MAP
BRAZORIA COUNTY, TEXAS

FIGURE 3 - SHEET 2 of 12

Project Boundary
Data Points
Transect
Soil Map Unit Boundary
Ephemeral
Intermittent
Perennial
Emergent Wetland
Forested Wetland
Scrub-Scrub Wetland

1:7,500

Created By: CM
Project Number: 52872
Date: 7/30/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

0 150 300 450 600 Feet
0 30 60 90 120 150 Meters

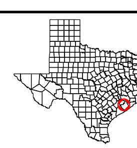
SWCA ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESEVOIR EXPANSION PROJECT

WETLAND DELINEATION MAP
BRAZORIA COUNTY, TEXAS

FIGURE 3 - SHEET 3 of 12

Project Boundary
Data Points
Transect
Soil Map Unit Boundary
Ephemeral
Intermittent
Perennial
Emergent Wetland
Forested Wetland
Scrub-Scrub Wetland



1:7,500

Created By: CM
Project Number: 52872
Date: 7/30/2019
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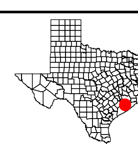
SWCA ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESEVOIR EXPANSION PROJECT

WETLAND DELINEATION MAP
BRAZORIA COUNTY, TEXAS

FIGURE 3 - SHEET 4 of 12

Project Boundary
Data Points
Transect
Soil Map Unit Boundary
Ephemeral
Intermittent
Perennial
Emergent Wetland
Forested Wetland
Scrub-Scrub Wetland



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Project Number: 52872
Date: 7/30/2019
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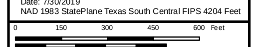
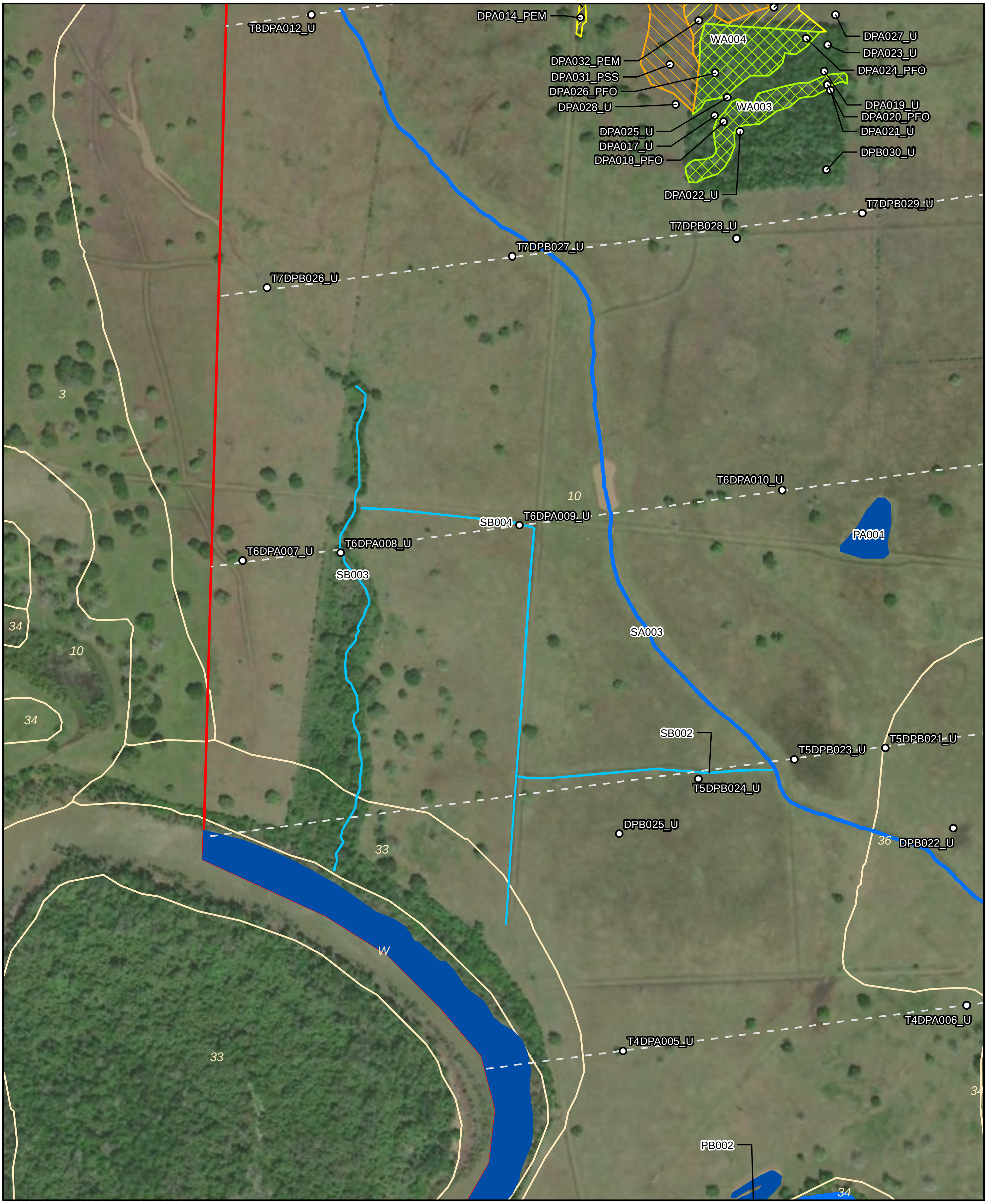




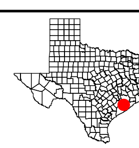
DOW CHEMICAL HARRIS RESEVOIR EXPANSION PROJECT

WETLAND DELINEATION MAP
BRAZORIA COUNTY, TEXAS

FIGURE 3 - SHEET 5 of 12

SWCA ENVIRONMENTAL CONSULTANTS

Project Boundary
Data Points
Transect
Soil Map Unit Boundary
Ephemeral
Intermittent
Perennial
Emergent Wetland
Forested Wetland
Scrub-Scrub Wetland



1:7,500

N
S

Created By: CM
Project Number: 52872
Date: 7/30/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

0 150 300 450 600 Feet

0 30 60 90 120 150 Meters

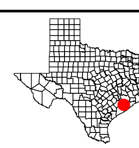
DOW CHEMICAL HARRIS RESEVOIR EXPANSION PROJECT

WETLAND DELINEATION MAP
BRAZORIA COUNTY, TEXAS

FIGURE 3 - SHEET 6 of 12

SWCA ENVIRONMENTAL CONSULTANTS

- Project Boundary
- Data Points
- Transect
- Soil Map Unit Boundary
- Ephemeral
- Intermittent
- Perennial
- Emergent Wetland
- Forested Wetland
- Scrub-Scrub Wetland



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N
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Created By: CM
Project Number: 52872
Date: 7/30/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

0 150 300 450 600 Feet

0 30 60 90 120 150 Meters

SWCA ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESEVOIR EXPANSION PROJECT

WETLAND DELINEATION MAP
BRAZORIA COUNTY, TEXAS

FIGURE 3 - SHEET 7 of 12

Project Boundary	Intermittent
Data Points	Perennial
Transect	Emergent Wetland
Soil Map Unit Boundary	Forested Wetland
Ephemeral	Scrub-Scrub Wetland

1:7,500

Created By: CM
Project Number: 52872
Date: 7/30/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

0 150 300 450 600 Feet

0 30 60 90 120 150 Meters

SWCA ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESEVOIR EXPANSION PROJECT

WETLAND DELINEATION MAP
BRAZORIA COUNTY, TEXAS

FIGURE 3 - SHEET 8 of 12

- Project Boundary
- Data Points
- Transect
- Soil Map Unit Boundary
- Ephemeral
- Intermittent
- Perennial
- Emergent Wetland
- Forested Wetland
- Scrub-Scrub Wetland

1:7,500

Created By: CM
Project Number: 52872
Date: 7/30/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

N S

0 150 300 450 600 Feet
0 30 60 90 120 150 Meters

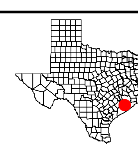
DOW CHEMICAL HARRIS RESEVOIR EXPANSION PROJECT

WETLAND DELINEATION MAP
BRAZORIA COUNTY, TEXAS

FIGURE 3 - SHEET 9 of 12

SWCA ENVIRONMENTAL CONSULTANTS

Project Boundary
Data Points
Transect
Soil Map Unit Boundary
Ephemeral
Intermittent
Perennial
Emergent Wetland
Forested Wetland
Scrub-Scrub Wetland



1:7,500

Created By: CM
Project Number: 52872
Date: 7/30/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

0 150 300 450 600 Feet
0 30 60 90 120 150 Meters

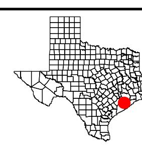
SWCA ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESEVOIR EXPANSION PROJECT

WETLAND DELINEATION MAP
BRAZORIA COUNTY, TEXAS

FIGURE 3 - SHEET 10 of 12

Project Boundary
Data Points
Transect
Soil Map Unit Boundary
Ephemeral
Intermittent
Perennial
Emergent Wetland
Forested Wetland
Scrub-Scrub Wetland



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Created By: CM
Project Number: 52872
Date: 7/30/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

0 150 300 450 600 Feet
0 30 60 90 120 150 Meters

SWCA ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESEVOIR EXPANSION PROJECT

WETLAND DELINEATION MAP
BRAZORIA COUNTY, TEXAS

FIGURE 3 - SHEET 11 of 12

Legend	
Project Boundary	Intermittent
Data Points	Perennial
Transect	Emergent Wetland
Soil Map Unit Boundary	Forested Wetland
Ephemeral	Scrub-Scrub Wetland

1:7,500

N
S

Created By: CM
Project Number: 52872
Date: 7/30/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

0 150 300 450 600 Feet
0 30 60 90 120 150 Meters

SWCA ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESEVOIR EXPANSION PROJECT

WETLAND DELINEATION MAP
BRAZORIA COUNTY, TEXAS

FIGURE 3 - SHEET 12 of 12

Project Boundary
Data Points
Transect
Soil Map Unit Boundary
Ephemeral
Intermittent
Perennial
Emergent Wetland
Forested Wetland
Scrub-Scrub Wetland

1:7,500

Created By: CM
Project Number: 52872
Date: 7/30/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

0 150 300 450 600 Feet
0 30 60 90 120 150 Meters

APPENDIX B

Wetland Delineation Data Sheets

Available upon request

APPENDIX C

Photographic Log

Available upon request

APPENDIX D

NRCS Soil Map Unit Descriptions

Available upon request

APPENDIX H

Oyster Creek Aquatic Assessment

Harris Reservoir Expansion Environmental Impact Statement Oyster Creek Aquatic Assessment, Brazoria County, Texas

OCTOBER 2021

PREPARED FOR

The Dow Chemical Company, Inc.

PREPARED BY

SWCA Environmental Consultants

HARRIS RESERVOIR EXPANSION ENVIRONMENTAL IMPACT STATEMENT AQUATIC ASSESSMENT, BRAZORIA COUNTY, TEXAS

Prepared for

The Dow Chemical Company, Inc.
P.O. Box 4324
Houston, Texas 77210-4324

Prepared by

SWCA Environmental Consultants
10245 W. Little York Road, Suite 600
Houston, Texas 77040
(281) 617-3217
www.swca.com

SWG- SWG–2016–01027

SWCA Project No. 52872

October 2021

CONTENTS

Appendices

Appendix A. Exhibits
Appendix B. Vegetation Cover

Tables

1 BACKGROUND

The Dow Chemical Company, Inc. (Dow) proposes to construct an approximately 50,986 acre-foot (ac-ft) off-channel water supply reservoir (known as the Harris Reservoir Expansion; proposed project) immediately to the north of the existing Harris Reservoir in central Brazoria County, Texas (Exhibit 1 and 2, Appendix A). A full description of the project purpose is provided in the Dow application for a standard permit from the U.S. Army Corps of Engineers (USACE). The project purpose is to expand Dow's current combined water supply of 27,343 ac-ft from Harris Reservoir and Brazoria Reservoir to increase water storage from approximately 63 days to 180 days. The Texas Commission on Environmental Quality (TCEQ) recommends water suppliers have at least 180 days of water storage to allow for continued operations during drought conditions.

The proposed project covers approximately 2,000 acres (ac) of storage, a pumped intake station on the Brazos River, and a gravity outfall to Oyster Creek via a new bypass channel that will be operated independently of the Harris and Brazoria Reservoirs. Dow proposes operating the three reservoirs similarly to current operations, with the proposed project providing the initial water source to Dow's Freeport facilities. During prolonged droughts, the proposed project's water storage would be exhausted first, followed by the Harris Reservoir, and then the Brazoria Reservoir. The decision for emergency releases due to severe weather, such as tropical storms and hurricanes with wind speeds that can overtop the embankments, would remain unchanged.

Watearth performed Better Assessment Science Integration Point and Nonpoint Sources (BASINS) modeling together with Hydrologic Simulation Program Fortran (HSPF) for drought conditions (Watearth, Inc. 2021). The model outputs were used to examine four different constant outflow scenarios from the proposed Harris Reservoir into Oyster Creek during 180 days of drought conditions. These data were used to determine possible effects to the biological resources of Oyster Creek.

2 EXISTING CONDITIONS

2.1 Site Location

The proposed property for the reservoir expansion sits immediately north of Harris Reservoir, in between the Brazos River and Oyster Creek in rural north-central Brazoria County. The combined floodplain of these two streams covers the agricultural fields in this area with elevations ranging from 0 feet to 50 feet above mean sea level (Exhibit 3, Appendix A). The Brazos River is a major river system within the state of Texas that discharges into the Gulf of Mexico, near Freeport, Texas. Oyster Creek, a relict channel of the Brazos River, generally flows parallel to the Brazos River before discharging to the Intracoastal Waterway, north of Surfside Beach, Texas. The general climate for the project area includes high potential rainfall events from tropical storms and hurricanes and long periods of drought.

2.2 Land Use and Vegetation

According to data from the Multi-Resolution Land Characteristics Consortium's National Land Cover Database, the proposed project area includes a variety of land cover types (Exhibit 3, Appendix A). In particular, the proposed project is situated in areas that are identified as hay/pasture, woody wetlands, and herbaceous and emergent herbaceous wetlands. Downstream of the reservoir, Oyster Creek flows through hay/pasture, emergent herbaceous wetlands, developed land of low, medium, and high intensities, and developed open space.

To categorize the current vegetation community adjacent to Oyster Creek, SWCA Environmental Consultants (SWCA) classified the vegetation within the insipient point of flooding during summer 2021. The habitat description and vegetation types were consistent with the NLCD data, with a more detailed description of the vegetation and habitat description provided in Appendix B. The vegetation survey indicates that the channel and near-shore banks of Oyster Creek generally lack vegetation.

2.3 Water Quality Data

To provide better insight into existing stream conditions, physiochemical data were extracted from studies completed in 1987 (Linam and Kleinsasser 1987) and 1993 (Wood et al. 1994) for Oyster Creek and the Brazos River system, respectively. Supplemental data were collected from Oyster Creek by SWCA during the summer of 2021 (Table 1).

Table 1. Physiochemical Properties of Oyster Creek, Allens Creek, and the Brazos River

Stream	Survey Location	Date	Time	DO (mg/L)	pH (SU)	Temp (˚F)	Conductivity (mS/cm)	Turbidity (NTU)	Total Dissolved Solids	Depth (feet)	Velocity (ft/sec)
Oyster Creek	FM 1462	2 Jul 1987	1603	8.590	8.20	78.26	0.614	–	–	–	–
	Walker Road	2 Jul 1987	0835	6.140	7.85	75.74	0.589	–	–	–	–
	Providence Road	2 Jul 1987	1409	6.580	7.88	76.64	0.587	–	–	–	–
	FM 521	3 Jul 1987	0919	7.212	7.89	73.04	0.616	–	–	–	–
Allens Creek	Station 5	7 Sep 1993	1107	5.09	7.90	79.57	755	–	–	–	–
		17 Nov 1993	1134	8.5	8.35	58.14	132	–	–	–	–
Brazos River	Station 6	7 Sep 1993	1430	8.6	8.21	86.05	1160	–	–	–	–
		17 Nov 1993	1301	8.02	8.19	62.98	637	–	–	–	–
Oyster Creek	1	13 May 2021	–	8.590	8.20	78.26	0.614	88.80	399	6.67	0.07
	2	13 May 2021	–	6.140	7.85	75.74	0.589	97.90	383	4.68	0.55
	3	13 May 2021	–	6.580	7.88	76.64	0.587	109.23	382	5.37	0.36
	4	14 May 2021	–	7.212	7.89	73.04	0.616	101.00	400	6.10	0.75
	5	14 May 2021	–	7.050	7.82	73.04	0.615	116.00	400	9.64	0.21
	6	16 Jun 2021	–	4.920	7.63	84.20	0.970	73.72	388	9.34	0.50
	7	15 Jun 2021	–	5.010	7.65	84.56	0.557	64.97	362	6.97	1.17
	8	15 Jun 2021	–	5.140	7.67	86.54	0.565	59.87	367	6.38	0.30
	9	16 Jun 2021	–	3.230	7.54	86.90	0.593	40.18	386	8.40	0.44
	10	16 Jun 2021	–	2.880	7.64	81.68	0.585	44.82	380	5.45	1.10

Note: ˚F = degrees Fahrenheit, ft/sec = feet per second, mg/L = milligrams per liter, mS/cm = milliSiemens per centimeter, NTU = nephelometric turbidity unit

2.4 Stream Sediments

According to the U.S. Department of Agriculture (USDA 2016), the majority of soils in the proposed project area are in Hydrologic Soil Groups B, C, and D. The hydrologic soil groups are based on estimated runoff potential and are defined according to the rate water infiltrates into the soil when not protected by vegetation, the soil is wet, and the soil receives precipitation from long-duration storms. As shown in Exhibit 4 in Appendix A, Group B and C soils dominate in and along Oyster Creek; however, Group D soils are primarily associated with the proposed reservoir location itself. Group B soils have a moderate infiltration rate when thoroughly wet, consist of well drained soils with a moderately fine texture to coarse texture, and have a moderate rate of water transmission. Group C soils have a slower infiltration rate when thoroughly wet, consist of soil layers impeding downward movement of water, and have a slow rate of water transmission. Both soils are usually moderately fine texture to fine texture soils. Group D soils have a very slow infiltration rate with a high runoff potential when wet, are mostly clays, have high water tables, and have a slow rate of water transmission (USDA 2016).

The soil classification for Oyster Creek generally is consistent with the sediment data collected in the 2021 transect locations shown in Exhibit 5 in Appendix A and Table 2.

Table 2. 2021 Sediment Data

Transect	Sampling Date	Texture
1	13 May 2021	Fine silts and clay
2	13 May 2021	Fine silts and clay
3	13 May 2021	Fine silts and clay, granules greater that T1
4	14 May 2021	Fine silts and clay, granules greater that T1
5	14 May 2021	Fine silts and clay, granules greater that T1
6	16 Jun 2021	Fine silts and clay
7	15 Jun 2021	Fine silts and clay
8	15 Jun 2021	Fine silts and clay, granules greater that T1 and T2
9	16 Jun 2021	Fine silts and clay, granules greater that T1 and T2
10	16 Jun 2021	Fine silts and clay, granules greater that T1 and T2

2.5 Biological Data

2.5.1 Benthic Invertebrates

Benthic organisms are important indicators of the health of aquatic ecosystems. The sedentary nature of benthic macroinvertebrates and their generally aquatic life cycles mean that the community structure of these organisms provides insights into water quality. Benthic macroinvertebrates vary widely in their sensitivities to various toxic compounds.

To project the proposed project's impacts on Oyster Creek, benthic data were gathered from studies in Allens Creek (Wood et al. 1994) with supplemental field data for Oyster Creek collected in 2021 (Table 3).

Table 3. Benthic Macroinvertebrate Data for Oyster Creek, Allens Creek, and Brazos River

Survey Area	Date	Class	Order	Family	Species	Common Name	Count
Oyster Creek							
1	13 May 2021	–	–	–	–	–	–
2	13 May 2021	Gastropoda	–	–	–	snail w/operculum	1
3	13 May 2021	Insecta	Diptera	Chironomidea	–	non-biting midge	3
4	14 May 2021	–	–	–	–	–	–
5	14 May 2021	Clitellata	–	–	–	aquatic earthworm	1
6	16 Jun 2021	Bivalvia	Veneroida	Corbiculidae	*Corbicula fluminea*	Asian clam	4
		Bivalvia	Unionida	Unionidae	*Glebula rotundata*	round pearlshell	1
		Clitellata	–	–	–	leech	3
		Insecta	Coleoptera	Elmidae	–	riffle beetle	1
7	15 Jun 2021	Bivalvia	Veneroida	Corbiculidae	*Corbicula fluminea*	Asian clam	1
		Clitellata	–	–	–	leech	2
		Gastropoda	–	–	–	snail w/operculum	1
8	15 Jun 2021	Bivalvia	Unionida	Unionidae	*Glebula rotundata*	round pearlshell	18
		Bivalvia	Unionida	Unionidae	*Utterbackia imbecilllis*	paper pondshell	3
		Gastropoda	–	–	–	snail w/operculum	3
		Insecta	Diptera	Chironomidea	–	non-biting midge	1
9	16 Jun 2021	Bivalvia	Veneroida	Corbiculidae	*Corbicula fluminea*	Asian clam	11
		Bivalvia	Unionida	Unionidae	*Lampsilis teres*	yellow sandshell	8
		Clitellata	–	–	–	leech	2
		Gastropoda	–	–	–	snail w/operculum	4
		Insecta	Diptera	Chironomidea	–	non-biting midge	4
10	16 Jun 2021	Clitellata	–	–	–	leech	1
		Gastropoda	–	–	–	snail w/operculum	1
		Insecta	Coleoptera	Elmidae	–	riffle beetle	1
		Insecta	Diptera	Chironomidea	–	non-biting midge	2
		Insecta	Trichoptera	Polycentropodidae		trumpetnet caddisfly	2

Survey Area	Date	Class	Order	Family	Species	Common Name	Count
		Malacostraca	Amphipoda	–	–	scud	2
Allens Creek							
1	Sep 1993	Oligochaeta	–	–	–	earthworm	9
		Clitellata	Arhychobdellida	Hirudinidae	–	leech	6
		Bivalvia	Unionida	Unionidae	*Popenaias popeii*	Texas hornshell	153
		Insecta	Coleoptera	Elmidae	–	riffle beetle	91
		Insecta	Diptera	Ceratopogonidae	–	biting midge	3
		Insecta	Diptera	Chironomidae	–	non-biting midge	153
		Insecta	Diptera	Stratiomyoidea	–	soldier fly	3
		Insecta	Diptera	Tipulidae	*Rhabdomastix* sp.	crane fly	3
		Insecta	Ephemeroptera	Baetidae	*Baetis* sp.	small minnow mayfly	18
		Insecta	Ephemeroptera	Leptophlebiidae	–	prong-gilled mayfly	6
		Insecta	Ephemeroptera	Leptohyphidae	*Leptohyphes* sp.	mayfly	3
		Gastropoda	–	Planorbidae	*Hebetancylus* sp.	–	3
		Insecta	Odonata	Corduliidae	*Neurocordullia yamaskanensis*	stygian shadowdragon	3
		Insecta	Odonata	Gomphidae	*Erpetogomphus* sp.	ringtail dragonfly	3
		Insecta	Trichoptera	Hydropsychidae	*Hydropsyche* sp.	netspinning caddisfly	91
	Oct 1993	Malacostraca	Amphipoda	Hyalellidae	*Hyalella aztecus*	–	3
		Hirudinea	–	–	–	leech	3
		Bivalvia	Unionida	Unionidae	*Popenaias popeii*	Texas hornshell	74
		Insecta	Coleoptera	Elmidae	–	riffle beetle	270
		Malacostraca	Decapoda	Palaemonidae	*Palaemonetes* sp.	caridean shrimp	3
		Insecta	Diptera	Chironomidae	–	nematoceran fly	94
		Insecta	Ephemeroptera	Baetidae	*Baetis* sp.	mayfly	303
		Insecta	Ephemeroptera	Leptophlebiidae	*Thraulodes* sp.	mayfly	18
		Insecta	Ephemeroptera	Leptohyphidae	*Tricorythodes* sp.	little stout crawler mayfly	9
		Gastropoda	–	–	–	snail	3
		Insecta	Hemiptera	Corixidae	–	water boatman	3

Survey Area	Date	Class	Order	Family	Species	Common Name	Count
		Insecta	Trichoptera	Hydropsychidae	*Hydropsyche* sp.	net-spinning caddisfly	373
	Nov 1993	Oligochaeta-	–	–	–	earthworm	32
		Hirudinea	–	–	–	leech	9
		Bivalvia	Unionida	Unionidae	*Popenaias popeii*	Texas hornshell	79
		Insecta	Coleoptera	Elmidae		riffle beetle	38
		Malacostraca	Decapoda	Palaemonidae	*Palamonetes* sp.	Caridean Shrimp	3
		Insecta	Diptera	Ceratopogonidae	–	biting midges	12
		Insecta	Diptera	Chironomidae	–	chironomids	194
		Insecta	Diptera	Simuliidae	–	blackfly	6
		Insecta	Ephemeroptera	Baetidae	*Baetis* sp.	mayfly	129
		Insecta	Ephemeroptera	Leptophlebiidae	*Thraulodes* sp.	mayfly	3
		Insecta	Ephemeroptera	Tricorythidae	*Leptohyphes* sp.	mayfly	50
		Insecta	Odonata	Gomphidae	*Erpetogomphus* sp.	dragonfly	3
		Insecta	Trichoptera	Hydropsychoidea	*Hydropsyche* sp.	net-spinning caddisfly	71
2	Sep 1993	Oligochaeta-	–	–	–	earthworm	38
		Bivalvia	Unionida	Unionidae	–	Texas hornshell	9
		Insecta	Coleoptera	Elmidae	–	riffle beetle	3
		Insecta	Diptera	Chironomidae	–	non-biting midge	44
		Insecta	Ephemeroptera	Leptohyphidae	*Leptohyphes* sp.	mayfly	9
		Insecta	Hemiptera	Gerridae	–	water strider	3
	Oct 1993	Insecta	Odonata	Gomphidae	*Erpetogomphus* sp.	ringtail dragonfly	6
		Oligochaeta–	–	–	–	earthworm	38
		Bivalvia	Unionida	Unionidae	*Popenaias popeii*	Texas hornshell	3
		Insecta	Coleoptera	Elmidae	–	riffle beetle	3
		Insecta	Diptera	Chironomidae	–	nematoceran fly	35
		Insecta	Ephemeroptera	Leptohyphidae	*Tricorythodes* sp.	little stout crawler mayfly	6
		Insecta	Hemiptera	Gerridae	*Rheumatobates* sp.	water strider	3
		Insecta	Odonata	Gomphidae	*Erpetogomphus* sp.	dragonfly	3

Survey Area	Date	Class	Order	Family	Species	Common Name	Count
3	Sep 1993	Oligochaeta-	–	–	–	earthworm	21
		Bivalvia	Unionida	Unionidae	–	Texas hornshell	21
		Insecta	Diptera	Ceratopogonidae	–	biting midges	6
		Insecta	Diptera	Chironomidae	–	non-biting midge	106
		Insecta	Diptera	Stratiomyoidea	–	soldier flies	144
		Insecta	Diptera	Tipulidae	*Rhabdomastix* sp.	crane fly	6
		Gastropoda	–	–	–	snail	3
	Oct 1993	Bivalvia	Unionida	Unionidae	*Popenaias popeii*	Texas hornshell	12
		Insecta	Coleoptera	Elmidae	–	riffle beetle	3
		Insecta	Diptera	Ceratopogonidae	*Dasyhelea* sp.	biting midge	12
		Insecta	Diptera	Chironomidae	–	nematoceran fly	109
		Insecta	Ephemeroptera	Baetidae	*Baetis* sp.	mayfly	26
		Insecta	Ephemeroptera	Leptohyphidae	*Tricorythodes* sp.	little stout crawler mayfly	3
		Gastropoda	–	–	–	snail	3
		Insecta	Hemiptera	Gerridae	*Rheumatobates* sp.	water striders	12
		Gastropoda	Limnophila	Ancylidae	*Hebetancylus* sp.	limpet	3
		Oligochaeta-	–	–	–	earthworm	56
4	Sep 1993	Insecta	Coleoptera	Dytiscidae	*Celina* sp.	predaceous diving beetle	9
		Insecta	Coleoptera	Haliplidae	*Peltodytes* sp.	crawling water beetle	26
		Malacostraca	Decapoda	Palaemonidae	*Palamonetes* sp.	caridean shrimp	12
		Insecta	Diptera	Ceratopogonidae	–	biting midges	18
		Insecta	Diptera	Chironomidae	–	non-biting midge	294
		Insecta	Ephemeroptera	Baetidae	*Baetis* sp.	small minnow mayfly	35
		Insecta	Ephemeroptera	Leptohyphidae-	*Leptohyphes* sp.	mayfly	68
		Gastropoda	–	–	–	snail	9
		Insecta	Hemiptera	Corixidae	–	–	3
		Insecta	Hemiptera	Corixidae	*Gerris* sp.	water strider	15
		Insecta	Hemiptera	Veliidae	*Rhagovelia* sp.	ripple bug	6

Survey Area	Date	Class	Order	Family	Species	Common Name	Count
		Anellida	–	–	–	earthworm	3
	Nov 1993	Malacostraca	Decapoda	Cambaridae	*Cambarellus shufeldtii*	Cajun dwarf crayfish	9
		Insecta	Diptera	Chironomidae	–	chironomid	54
		Insecta	Ephemeroptera	Baetidae	*Baetis* sp.	mayfly	3
		Insecta	Ephemeroptera	Tricorythidae	*Leptohyphes* sp.	mayfly	32
		Arachnida	Trombidiformes	Hydrachnidae	*Hydrachna* sp.	mite	3
		Insecta	Odonata	Gomphidae	*Erpetogomphus* sp.	dragonfly	3
		Insecta	Coleoptera	Elmidae	–	riffle beetle	3
5	Sep 1993	Malacostraca	Decapoda	Palaemonidae	*Palamonetes* sp.	caridean shrimp	6
		Insecta	Diptera	Chironomidae	–	non-biting midge	12
		Insecta	Diptera	Tipulidae	*Rhabdomastix* sp.	crane fly	3
		Bivalvia	Unionida	Unionidae	*Popenaias popeii*	Texas hornshell	3
	Oct 1993	Insecta	Coleoptera	Elmidae	–	riffle beetle	3
		Insecta	Coleoptera	Hydrophilidae	–	water scavenger beetle	3
		Malacostraca	Decapoda	Palaemonidae	*Palaemonetes* sp.	caridean shrimp	9
		Insecta	Diptera	Chironomidae	–	nematoceran fly	62
		Insecta	Diptera	Limoniidae	*Rhabdomastix* sp.	crane fly	3
		Insecta	Ephemeroptera	Leptophlebiidae	*Thraulodes* sp.	mayfly	3
		Insecta	Ephemeroptera	Leptohyphidae	*Tricorythodes* sp.	little stout crawler mayfly	9
		Anellida	–	–	–	earthworm	3
	Nov 1993	Insecta	Coleoptera	Psephenidae	*Psephenus* sp.	water penny beetle	3
		Malacostraca	Decapoda	Palaemonidae	*Palamonetes* sp.	caridean shrimp	3
		Insecta	Diptera	Chironomidae	–	chironomids	12
		Insecta	Ephemeroptera	Baetidae	*Baetis* sp.	mayfly	6
		Insecta	Ephemeroptera	Tricorythidae	*Leptohyphes* sp.	mayfly	6
		Anellida	–	–	–	earthworm	54
6	Sep 1993	Bivalvia	Unionida	Unionidae	–	Texas hornshell	43
		Insecta	Diptera	Ceratopogonidae	–	biting midges	22

Survey Area	Date	Class	Order	Family	Species	Common Name	Count
		Insecta	Diptera	Chironomidae	–	non-biting midge	261
		Bivalvia	Unionida	Unionidae	*Popenaias popeii*	Texas hornshell	22
	Oct 1993	Insecta	Diptera	Chironomidae	–	nematoceran fly	11
		Insecta	Diptera	Chironomidae	–	nematoceran fly	120
		Insecta	Odonata	Macromiidae	*Didymops* sp.	dragonfly	22
	Nov 1993	Insecta	Coleoptera	Elmidae	–	riffle beetle	3
		Insecta	Diptera	Chironomidae	–	chironomids	9
		Insecta	Ephemeroptera	Tricorythidae	*Leptohyphes* sp.	mayfly	3

2.5.2 Fishes

Evaluation of the National Oceanographic and Atmospheric Administration (NOAA) website indicates four essential fish habitats (EFH) that extend up the Brazos River and Oyster Creek from the Gulf of Mexico. In particular, these EFH areas are for shrimp fisheries, red drum (*Sciaenops ocellatus*) fisheries, coastal migratory pelagic species, and reef fish. Based on the locations of these areas, implementation of the proposed project would have no effect on these areas because discharges from the proposed reservoir will be extracted from the rivers prior to reaching these essential habitats.

As with the benthic invertebrate studies, fish data were collected by a meta-analysis of fisheries studies in the area (Bonner and Runyan 2007; Linam and Kleinsasser 1987; SWCA 2019). Because these surveys were completed with disparate methods, the results of the meta-analysis were converted into a species list (Table 4).

Table 4. Fish Species Associated with Oyster Creek, Brazos River, and Their Tributaries

Family	Species	Common Name
Amiidae	*Amia calva*	Bowfin
Aphredoderidae	*Aphredoderus sayanus*	Pirate perch
Atherinopsidae	*Labidesthes sicculus*	Brook silverside
	Menidia beryllina	Inland silverside
	Menidia peninsulae	Tidewater silverside
Catostomidae	*Carpiodes carpio*	River carpsucker
	Ictiobus bubalus	Smallmouth buffalo
	Minytrema melanops	Spotted sucker
Centrachidae	*Ellasoma zonatum*	Banded pygmy sunfish
	Lepomis cyanellus	Green sunfish
	Lepomis gulosus	Warmouth
	Lepomis humilis	Orangespotted sunfish
	Lepomis macrochirus	Bluegill sunfish
	Lepomis megalotis	Longear sunfish
	Lepomis microlophus	Redear sunfish
	Micropterus punctulatus	Spotted bass
	Micropterus salmoides	Largemouth bass
	Pomoxis annularis	White crappie
	Poxomis nigromaculatus	Black crappie
	Lepomis spp.	Sunfish hybrid
Cichliformes	*Oreochromis aureus**	Blue tilapia
Clupeidae	*Dorosoma cepedianum*	Gizzard shad
	Dorosoma petense	Threadfin shad

Family	Species	Common Name
Cyprinidae	*Carassius auratus**	Goldfish
	Cyprinus carpio	Common carp
	Macrhybopsis aestivalis	Speckled chub
	Macrhybopsis storeriana	Silver chub
	Notemigonus crysoleucas	Golden shiner
	Opsopoeodus emiliae	Pugnose minnow
	Pimephales vigilax	Bullhead minnow
Fundulidae	*Fundulus chrysotus*	Golden topminnow
	Fundulus notatus	Blackstripe topminnow
Ictaluridae	*Ameiurus melas*	Black bullhead
	Ameiurus natalis	Yellow bullhead
	Ictalurus furcatus	Blue catfish
	Ictalurus punctatus	Channel catfish
	Noturus gyrinus	Tadpole madtom
	Pylodictis olivaris	Flathead catfish
Lepisosteidae	*Atractosteus spatula*	Alligator gar
	Lepisosteus oculatus	Spotted gar
	Lepisosteus osseus	Longnose gar
Leuciscidae	*Cyprinella lutrensis*	Red shiner
	Cyprinella venusta	Blacktail shiner
	Hybognathus nuchalis	Mississippi silvery minnow
	Lythrurus fumeus	Ribbon shiner
	Notropis buchanani	Ghost shiner
	Notropis shumardi	Silverband shiner
Loricariidae	Spp.*	Suckermouth catfish
Mugilidae	*Mugil cephalus*	Striped mullet
	Mugil curema	White mullet
Percidae	*Etheostoma gracile*	Slough darter
Poecillidae	*Gambusia affinis*	Western mosquitofish
	Poecilia latipinna	Sailfin molly

Sources: Linam and Kleinsasser (1987); Bonner and Runyan (2007); SWCA (2019).

3 HYDROLOGICAL MODEL OUTPUTS

To assess the hydrology and hydraulic impacts associated with implementing the proposed reservoir project on Oyster Creek, Waterearth performed a number of model assessments (Watearth, Inc. 2021). In particular, the models examined a no-build scenario as well as four constant discharge scenarios from the proposed reservoir into Oyster Creek during a 180-day drought to identify how these would influence water quantity and quality, sedimentation, and scouring. These scenarios are listed below:

- Scenario One – 334 cubic feet per second (cfs) discharge (matching Dow's Lake Jackson maximum pump station capacity),

- Scenario Two – 216 cfs discharge (matching Dow's typical water use),
- Scenario Three – 133 cfs discharge (the average discharge to draw down the proposed reservoir in 180 days), and
- Scenario Four – 22 cfs outfall (the environmental releases stipulated in Dow's Operations and Maintenance Plan.

A summary of the models, their outputs, and pertinent information are provided below.

3.1 BASINS/HSPF Model

BASINS is a geographic information system (GIS)-based, multipurpose environmental analysis system developed by the U.S. Environmental Protection Agency (EPA) to assist in watershed management. BASINS provides a core framework with various EPA and third party-supported model plug-ins. HSPF is an EPA-supported BASINS model plug-in for estimating in-stream concentrations of pollutants from point and non-point sources.

The BASINS model assesses land use and meteorological data. However, HSPF calculates sediment transport from overland runoff and in-stream re-suspension. Specifically, the HSPF tool calculates expected advection, sediment transport, and heat exchange between a waterbody and the atmosphere, providing the ability to gather velocity, water temperature, deposition, and scour data.

A complete write-up of the output of the BASINS/HSPF Model output is provided in the *Oyster Creek Downstream Hydrologic and Hydraulic Impacts Report* (Watearth, Inc. 2021); however, brief descriptions of these findings are provided below.

3.2 HEC-RAS Modeling

The HEC-RAS model was used to evaluate possible impacts associated with 10-, 50-, and 100-year design storms in combination with four outfall scenarios. Unlike the constant reservoir discharges anticipated for the 180-day drought scenarios which were analyzed in the BASINS/HSPF model, design storms last 24 hours and do not increase average velocities in Oyster Creek. The HEC-RAS model developed by Watearth, included the integration of interbasin flows into the Oyster Creek model.

For the 50-year storm, the peak flow into Oyster Creek takes place in 89 hours and 30 minutes. For the 100-year storm the peak flow into the creek takes place in 87 hours and 30 minutes. The average velocities for both 50- and 100- year 24-hour design storms are 0.69 feet per second (ft/s) and 0.7 ft/s, respectively. As these values do not indicate a substantial change in the channel velocity, there is no cause for concern on aquatic resources based on HEC-RAS design storm velocities. For this report, the velocities used to analyze the effect on aquatic life were calculated using BASINS/HSPF model under drought conditions because these values better represent "typical" conditions within Oyster Creek.

3.3 Model Findings

Velocities calculated with constant flows in HEC-RAS just downstream of the proposed project ranged from 0.37 ft/s for constant outflow of 22 cfs to 1.05 ft/s for constant outflow of 334 cfs, which are lower than the velocities calculated using the HSPF model. In both models, as outflow from the proposed project increases, the stream velocity increases. The velocities calculated using BASINS/HSPF model are higher in magnitude due to constant discharges for 180 days. Therefore, these values, together with other

HSPF model results, are used in the assessment of aquatic life. A summary of the BASINS/HSPF model outputs are provided in Table 5.

Table 5. Summary of BASINS/HSPF Model Outputs

Parameter		No Reservoir	Scenario 1 (334 cfs)	Scenario 2 (216 cfs)	Scenario 3 (133 cfs)	Scenario 4 (22 cfs)
Velocity (ft/sec)	Average	1.68	2.36	2.20	2.03	1.71
	Maximum	1.75	2.40	2.26	2.10	1.86
Shear velocity (ft/sec)	Average	0.04	0.05	0.05	0.05	0.04
	Maximum	0.05	0.05	0.05	0.05	0.05
Bed shear stress (lb/ft^2)	Average	0.0032	0.0042	0.0041	0.0041	0.0032
	Maximum	0.0041	0.0043	0.0041	0.0042	0.0041
Deposition/scour	Average	-0.0001	-0.0219	-0.0125	-0.0067	-0.0008
	Maximum	0.0175	-0.0107	0.0004	0.0073	0.0162
Sediment outflow (ton/ac-ft)	Average	0.0021	0.0239	0.0145	0.0087	0.0029
	Maximum	0.0508	0.0821	0.0706	0.0630	0.0530
Sediment inflow (ton/ac-ft)	Average	0.0020	0.0020	0.0020	0.0020	0.0020
	Maximum	0.0808	0.0808	0.0808	0.0808	0.0808
Total suspended sediment (mg/L)	Average	0.6466	0.5864	0.5279	0.4775	0.4784
	Maximum	11.075	1.9078	2.38	3.1306	7.1945
Water temperature (˚F)	Average	71.86	52.00	53.78	55.52	63.56
	Maximum	78.29	62.25	64.36	65.88	73.40

Sources: Watearth, Inc. (2021).

Note: cfs = cubic feet per second, ˚F = degrees Fahrenheit, ft = feet, ft/sec = feet per second, lb/ft^2 = pound per square foot, mg/L = milligrams per liter, ton/ac-ft = ton per acre-foot

The most notable change that would occur as a result of construction of the proposed project is expected changes in stream velocity. Compared to existing conditions, all four of the possible scenarios modeled will increase stream velocity, as would be expected with increased discharge volumes. Under Scenarios 1, 2, and 3, there is increasing average velocity that corresponds with the increased discharge volumes. Scenario 4 indicates that the average velocity of the stream would remain relatively consistent with the no-build scenario, except velocity would be greater during mid-drought than it would be if the reservoir were not constructed.

Under current conditions, sediment deposition is predominant, with thick layers of silt deposited throughout Oyster Creek due to sluggish currents and high sediment loads in the existing reservoir's discharge. Under modeled drought conditions, deposition is expected to continue throughout the 180-day period of the drought. Generally, the model maintaining environmental flows (Scenario 4) indicates a relatively similar pattern. However, the higher discharge scenarios (Scenarios 1, 2, and 3) all indicate that deposition will give way to scouring of sediments as higher velocity is able to carry low density sediments downstream. Scouring will likely lead to deepening and widening of the riverbed as well as increased suspension of material in the water column and decreased water clarity during the drought.

Water temperature in Oyster Creek generally trends with air temperature. Under the no-build scenario, this trend is expected to stand, with temperatures showing a slight increase over the period of the drought. Although four modeled scenarios demonstrate that the water temperature is expected to increase over approximately the first 100 days of the drought, the temperature then shows a consistent decline in water temperature. The modeled decline indicates that water temperature in Oyster Creek is expected to be approximately 10 to 20 degrees Fahrenheit (˚F) cooler than what would be expected if the reservoir were not constructed. Modeled temperatures for Scenarios 1, 2, and 3 generally match one another well; however, the environmental flows associated with Scenario 4 are intermediate between those of the no-build scenario and the higher discharge volume scenarios.

4 IMPACTS TO BIOTA

Many of the benthic macroinvertebrates and fishes associated with Oyster Creek are well-adapted to stagnant, low-current, warm waters as is indicated by the species tabulated in Section 2. Most are tolerant of or prefer turbid waterbodies with poor dissolved oxygen and often have adaptations that allow them to thrive under these circumstances. That said, the diversity of species endemic to the Brazos/Oyster Basin represents a variety of lifestyles, adaptive characteristics, and behaviors that are difficult to characterize. Furthermore, assessing the biodiversity of the fish community would be impracticable because the species interactions are too numerous and diffuse to appropriately quantify. Therefore, we have selected a subset of species to assess the long-term effects of the project on the aquatic community. For the fish community, we examined the brook silverside (*Labidesthes sicculus*), tadpole madtom (*Noturus gyrinus*), white crappie (*Pomoxis annularis*), and largemouth bass (*Micropterus salmoides*). Similarly, the benthic macroinvertebrate community is represented by caddisflies, mayflies, and the unionid mussels endemic to the streams. These represent species that are relatively intolerant of poor water quality and game fish that are common to the area. Brief species accounts for these species are provided.

4.1 Species Accounts

4.1.1 Brook Silverside

The brook silverside is a small, slender, elongate schooling fish belonging to the Family Atherinopsidae. This species grows to a maximum length of 13 centimeters and is characterized by a long, beaklike snout, and a long and flattened head. Brook silversides are nearly transparent with a pale green dorsal region, silver lateral region, a silver midlateral stripe, and a silver-white ventral region (Texas Freshwater Fishes [TFF] 2021a; Thomas et al. 2007).

Brook silversides may be found from the Great Lakes southward through the Mississippi Basin and Gulf Coastal Plain drainages (TFF 2021a). Within Texas, the species' range stretches from the Brazos River basin to the Sabine basin and portions of the Red River basin (Thomas et al. 2007). They occur near or at the surface, typically in open water of lakes, ponds, backwaters, and pools within streams and small to large rivers (Gilpin 2012; Page and Burr 2011; TFF 2021a). Additionally, they prefer waters with no noticeable current and clear warm water with low turbidity (Missouri Department of Conservation [MDC] 2021a; University of Kentucky 2021).

This species is short-lived, reaching maturity at 1 year and typically does not live for longer than 2 years (TFF 2021a). Spawning occurs in spring and early summer when water temperatures reach 20 degrees Celsius (°C) (U.S. Geological Survey [USGS] 2021a). Brook silversides are phytolithophils and deposit their eggs on submerged plants and, to a lesser extent, logs, gravel, and rocks (TFF 2021a).

The brook silverside is a planktivore and invertivore and primarily feeds at the surface of the water (TFF 2021a; USGS 2021a). Their diet primarily consists of plankton, cladocerans, copepods, aquatic insect larvae or pupae, terrestrial insects, and small flying insects (TFF 2021a; USGS 2021a). The young and smaller individuals primarily eat planktonic microcrustaceans such as cladocerans and copepods (TFF

2021a; USGS 2021a). As the fish grow, their diet shifts to feeding on immature and adult insects (TFF 2021a).

4.1.2 Tadpole Madtom

The tadpole madtom is a small ictalurid (Thomas et al. 2007) that grows to a maximum length of 13 centimeters and is characterized by small eyes, a terminal mouth, and a heavy, round body (TFF 2021b; Page and Burr 2011). Tadpole madtoms have a light tan to brown dorsal region and fins, a black midlateral stripe extending from the head to the base of the caudal fin base, and a white or pale yellow ventral region (Thomas et al. 2007).

Within the United States, the tadpole madtom has a wide range east of the Rocky Mountains but excludes the upland streams that drain from the Appalachian Mountain chain (TFF 2021b). This species has a wide range in eastern Texas, ranging from the Red River to the Nueces Basin (TFF 2021b). According to Warren et al. (2000), this species is found in the Red River (from the mouth upstream to and including the Kiamichi River), Sabine Lake (including minor coastal drainages west to Galveston Bay), Galveston Bay (including minor coastal drainages west to the mouth of the Brazos River), Brazos River, Colorado River, San Antonio Bay (including minor coastal drainages west of the mouth of Colorado River to the mouth of Nueces River), and Nueces River drainages. Habitat includes clear to moderately turbid and quiet or slow-moving waters within reservoirs, lakes, ponds, sloughs, swamps, backwaters, streams, and small to large rivers (Gilpin 2012; NatureServe 2021a; MDC 2021b). Furthermore, unlike other madtom species which prefer to live among rocks or pebbles, the tadpole madtom prefers soft, muddy bottoms with an extensive cover of vegetation or detritus (Gilpin 2012; NatureServe 2021a).

This species is fairly short-lived, reaching maturity at 1 or 2 years and rarely lives for longer than 3 to 4 years (TFF 2021b; NatureServe 2021a). Spawning typically occurs in June or July (TFF 2021b; NatureServe 2021a). Tadpole madtoms are speleophils and deposit their eggs in clusters in cavities along the bottom or under objects (TFF 2021b; NatureServe 2021a). After spawning, one or both of the parents will care for and guard their egg clusters (TFF 2021b; MDC 2021b).

The tadpole madtom is an invertivore and feeds at night along the bottom and among aquatic vegetation (NatureServe 2021a). Their diet primarily consists of insect larvae, crustaceans, and occasionally small fishes (TFF 2021b; USGS 2021). The smaller individuals mainly feed on crustaceans and oligochaetes while the larger individuals mainly feed on insects (NatureServe 2021a).

4.1.3 White Crappie

The white crappie is a fairly large schooling fish belonging to the sunfish family (Family Centrarchidae) (Gilpin 2012; Thomas et al. 2007; USGS 2021b). This species grows to a maximum length of 53 centimeters and is characterized by a laterally compressed body, large terminal mouth, and a small head (TFF 2021c; Thomas et al. 2007). White crappies have greenish yellow eyes, a dark olive dorsal region, a silver lateral region with dark blotches forming 5 to 10 vertical bars, and the median fins are striped and mottled with black (TFF 2021c; Thomas et al. 2007). Breeding male white crappies will become darker and have an almost black head and breast (Thomas et al. 2007; USGS 2021b).

The native range within the United States is from southern Ontario and southwestern New York, west of the Appalachians, and south to the Gulf Coast and west to Texas, South Dakota, and southern Minnesota (TFF 2021c). Within Texas, this species occurred naturally in the eastern two-thirds of the state but has been introduced to other portions of the state as well as other parts of the United States (TFF 2021c; USGS 2021b). Habitats include warm turbid waters within sand and mud-bottom pools and backwaters of streams, small to large rivers, lakes, and ponds (NatureServe 2021b; Page and Burr 2011).

This species reaches maturity at 1 year and typically lives for about 8 years but may live up to 10 years (TFF 2021c). Spawning season in Texas occurs in late March to early May (TFF 2021c). White crappies are phytophils and nest in colonies in or near plant growth, typically depositing eggs onto hard clay, gravel, or on roots of aquatic or terrestrial plants (TFF 2021c; MDC 2021b). After spawning, males will guard their nest area from predators (TFF 2021c).

The white crappie is an invertivore and piscivore and considered an opportunistic feeder (TFF 2021c; USGS 2021b). Their diet primarily consists of aquatic insects, small crustaceans, and small fish (MDC 2021c). The young, typically less than a year old, feed on zooplankton (USGS 2021b). As the fish grows and matures, their diet shifts to feeding on insects and small fish (TFF 2021c; USGS 2021b).

4.1.4 Largemouth Bass

The largemouth bass is a large, slender, elongated fish belonging to the Family Centrarchidae (MCD 2021d; Thomas et al. 2007). This species grows to a maximum length of 97 centimeters and may weigh 21 pounds or more. The species is characterized by a large, terminal mouth (TFF 2021d; Thomas et al. 2007). Largemouth bass have an olive to dark olive dorsal region with mottling, an olive to green lateral region with a dark midlateral stripe, and white on the ventral region and may have scattered dark spots (Thomas et al. 2007).

The largemouth bass range was originally throughout most of the United States east of the Rocky Mountains (TFF 2021d). Other than the Panhandle region of Texas, this species' range covers the entire state (TFF 2021d). According to Warren et al. (2000), this species is found in the Red River (from the mouth upstream to and including the Kiamichi River), Sabine Lake (including minor coastal drainages west to Galveston Bay), Galveston Bay (including minor coastal drainages west to the mouth of the Brazos River), Brazos River, Colorado River, San Antonio Bay (including minor coastal drainages west of the mouth of Colorado River to the mouth of Nueces River), and Nueces River drainages. Habitats include reservoirs, lakes, ponds, sloughs, swamps, backwaters, creek pools, and slow-moving streams and rivers (TFF 2021d; NatureServe 2021c). Additionally, they prefer warm, clear, quiet waters with low turbidity, soft bottoms, and aquatic vegetation (TFF 2021d; NatureServe 2021c).

Females of this species reach maturity at approximately 200 grams and 25 centimeters total length while males reach maturity at approximately 160 grams and 22 centimeters total length, which typically occurs between 2 and 5 years (TFF 2021d; NatureServe 2021c). Furthermore, the females tend to live for up to 10 years while males typically live no longer than 5 to 7 years (TFF 2021d). Spawning season occurs in late winter to early spring but has been known to occur as late as May in Texas, when water temperatures reach approximately 15.5°C (TFF 2021d; NatureServe 2021c). Largemouth bass are polyphils and nest in miscellaneous substrate and materials (TFF 2021d). The males make shallow, cleared depressional nests in sand, gravel, or debris-littered bottoms (NatureServe 2021c). After spawning, males will guard their nest from predators for several weeks (TFF 2021d).

The largemouth bass is a piscivore, invertivore, and carnivore and considered an opportunistic feeder and uses two basic feeding modes which include midwater attack and benthic attack (TFF 2021d; USGS 2021c; NatureServe 2021c). Their diet primarily consists of aquatic insect larvae, aquatic insects, crustaceans, fish, and occasionally frogs, mice, snakes, and other small animals (TFF 2021d; MDC 2021d). The young (i.e., fry) typically feed on zooplankton while the larger young typically feed on insects, crustaceans, and fish fry (NatureServe 2021c). As the fish reaches adulthood, their diet shifts to mainly feeding on fish, crayfish, and amphibians (NatureServe 2021c).

4.1.5 Caddisflies

Trumpet-net or tubemaker caddisflies belong to the Family Polycentropodidae with several genera found in Texas including *Cernotina* sp., *Neureclipsis* sp., *Nyctiophylax* sp., *Phylocentropus* sp., *Polycentropus* sp., and *Polyplectropus* sp. (TCEQ 2014). Tubemaker caddisflies tend to be a light peach in color with accents of brown or reddish markings on each segment with a body length up to approximately 1 centimeter (Keller and Krieger 2009). Their larvae are characterized by inhabiting a silken net retreat formed into a funnel, tubular, or flattened shape or a more ambiguous shape resembling a spiderweb (Atlas of Common Freshwater Macroinvertebrates of Eastern North America [ACFMENA] 2021a). These larvae are morphologically similar to some aquatic moth, beetle or dobsonfly larva species; however, they are distinguishable by the claws on the thoracic legs and the anal prolegs (ACFMENA 2021a; Texas A&M Agrilife Extension 2021a).

Tubemaker caddisflies hold a global distribution with recent studies showing a 15 percent increase in reported number of species within the Order (Trichoptera) in 9 years (de Moor and Ivanov 2008; Perry 2018). Tubemaker caddisflies remain secure overall within the south-central United States as its pollution tolerance levels range from poor to intermediate depending on the genus (ACFMENA 2021a; Perry 2018; TCEQ 2014).

Adult tubemaker caddisflies are short-lived using most of this stage for mating or laying eggs (Texas A&M Agrilife Extension 2021a). Females lay eggs along freshwater shores or by dipping their abdomen into the surface of freshwater habitats (Texas A&M Agrilife Extension 2021a). Caddisfly larvae develop through four to five stages (instars) over several months or in some cases up to a year sustaining an annual generation cycle (Keller and Krieger 2009; Texas A&M Agrilife Extension 2021a). Pupation is primarily aquatic (Texas A&M Agrilife Extension 2021a).

Though larvae have chewing mouth parts, feeding habits vary between filtering collectors, where the silk used for webbing form nets to strain material from the water to eat, and engulfing predators (ACFMENA 2021a; Texas A&M Agrilife Extension 2021a; TCEQ 2014). Caddisfly larvae move by clinging and crawling using the thoracic legs and the anal prolegs (ACFMENA 2021a; TCEQ 2014).

4.1.6 Mayflies

Mayflies belong to the Order Ephemeroptera with several families found in Texas including Baetidae, Caenidae, Ephemeridae, Oligoneuriidae, Heptageniidae, Tricorythidae, Leptophlebiidae, and Ephemerellidae (TCEQ 2014). Immature mayflies (naiads) tend to be translucent with green to dark brown coloration, depending on diet (ACFMENA 2021b; Texas A&M Agrilife Extension 2021b). Aquatic immature stages are elongate, and flattened or cylindrical with long legs and plate-like gills on the sides of the abdomen and short antennae (Texas A&M Agrilife Extension 2021b). They typically have three long thin tail projections, or cerci; however, a few species bear two (Texas A&M Agrilife Extension 2021b). Cylindrically shaped naiads are better swimmers, while naiads with a flattened morphology tend to attach themselves to rocks and other substrates within freshwater stream habitats (Texas A&M Agrilife Extension 2021b). Mayfly naiads have chewing mouth parts, while adults have non-functional mouthparts and do not feed (National Wildlife Federation [NWF] 2021; Texas A&M Agrilife Extension 2021b). Naiads feed primarily on detritus plant material or algae which accumulate on the stream bottom.

Mayflies are distributed globally and throughout North America and are present in fast-running, highly-oxygenated streams with little to no pollutants as the pollution tolerance level for mayfly species remains fairly sensitive (ACFMENA 2021b; NWF 2021; TCEQ 2014; Texas A&M Agrilife Extension 2021b).

Mayflies are exceptionally short lived while in their adult stage, lasting up to 24 hours, while naiads may reside in their aquatic habitat for up to two years (ACFMENA 2021b). Adult mayflies mate while swarming in the air, and the females lay their eggs by either dipping their abdomen into the surface of freshwater habitats or by submerging themselves underwater prior to placing the eggs underwater and dying shortly afterward (Texas A&M Agrilife Extension 2021b). The larval stages develop through multiple instars via molting, where the number of instars depend on the species, temperature, and water conditions (Texas A&M Agrilife Extension 2021b). The last two molting stages result in the development of wings, while all other orders only form wings on their last molting stage (Texas A&M Agrilife Extension 2021b). The first winged-form molting results in subimagoes, which then quickly fly from the water to a dry location where they molt again into adults (imagoes) (Texas A&M Agrilife Extension 2021b).

4.1.7 Unionid Mussels

4.1.7.1 ROUND PEARLSHELL

The round pearlshell is a Unionid mussel that grows to approximately 10 centimeters long and 9 centimeters wide and is characterized by an elliptical to nearly round solid shell (Howells 2014; NatureServe 2021d; University of North Texas [UNT] 2021). Round pearlshells have white internal coloring and tan to brown or black external coloring with no external sculpturing (Howells 2014; UNT 2021).

Round pearlshell is endemic to the United States and ranges from the Gulf Coast drainages in Texas to the Apalachicola River in Florida (NatureServe 2021d). Within Texas, this species ranges from the lower Guadalupe River east to the Sabine (Howells 2014). They occur in shallow and deep freshwater habitats, typically less than 50 miles from tidal waters, in small to large rivers, bayous, pools, sloughs, oxbows, and backwaters (NatureServe 2021d). Additionally, they occur in muddy, silty, sand, clay, or detritus substrates with a moderate current (NatureServe 2021d).

Upon release from the female, the yellow sandshell larvae (i.e., glochidia) must find a host species (Howells 2014). According to Howells (2014), reported host species include bay anchovy, spotted gar, common carp, green sunfish, bluegill, white bass, and hogchoker.

This species is parasitic on fish in its larval stage (NatureServe 2021d). As an adult, the round pearlshell is a detritivore and feeds primarily on fine particulate organic matter such as detritus, zooplankton, and/or phytoplankton (NatureServe 2021d).

4.1.7.2 PAPER PONDSHELL

The paper pondshell is a Unionid mussel that grows to approximately 11 centimeters long and 4 centimeters wide and is characterized by an oblong and elongated shape (Mulcrone 2006; NatureServe 2021e). Paper pondshells have a white, silvery, or bluish-white internal coloring with an iridescence at the posterior end (Mulcrone 2006). The external coloring of the shell in younger individuals is yellow (Mulcrone 2006). Older individuals are usually glossy with off-white, tan, or black coloring and typically have greenish highlights (Howells et al. 1996; Mulcrone 2006).

Paper pondshell have a widespread range in the United States (NatureServe 2021e). Within Texas, this species is found in all major drainages (Howells et al. 1996). They occur in shallow and deep freshwater habitats in medium to large rivers, streams, creeks, pools, ponds, reservoirs, and lakes (Howells et al. 1996; NatureServe 2021e). Paper pondshell typically occur in silt, silt and sand, muddy, muddy sand, and occasionally in gravel and cobble substrates (Howells et al. 1996; NatureServe 2021e). Additionally, they have most often been found in still or slow-moving waters but have been found in waters with moderate current and are tolerant of moderately poor water and habitat quality (Howells et al. 1996; NatureServe 2021e).

The paper pondshell are gonochoristic and viviparous and some individuals have been found to be hermaphroditic. Increasing water temperatures initiate gametogenesis and the release of sperm into the water from the males. The females then taken in the sperm through their respiratory current. The females fertilize the eggs internally and the larvae (i.e., glochidia) are released from the female after they are fully developed (Mulcrone 2006).

This species is a detritivore and planktivore in both its immature and adult stages and feeds primarily on fine particulate organic matter such as detritus, zooplankton, and/or phytoplankton (NatureServe 2021e).

4.1.7.3 YELLOW SANDSHELL

The yellow sandshell is a Unionid mussel growing to approximately 13 centimeters long and 6 centimeters wide and is characterized by an oblong and elongated shape (Howells 2014; NatureServe 2021f). Internal coloration of the yellow sandshell is a white, pearly, iridescent posterior coloring and occasionally with a yellow or orange tint dorsally (Howells 2014). The external coloring of the shell is yellow to horn-yellow (Howells 2014).

Yellow sandshell have a widespread range in the United States (NatureServe 2021f). Within Texas, this species is found from the Rio Grande north to the Red River (Howells 2014). They occur in shallow freshwater habitats in medium to large rivers, creeks, pools, reservoirs, and lakes (Howells 2014; NatureServe 2021f). Yellow sandshell typically occur sand and muddy sand substrates but are known to occur on most substrate types other than deep, soft silt and scoured bedrock (Howells 2014; NatureServe 2021f). They have most often been found in still to swift moving waters and slow to moderate currents (Howells 2014; NatureServe 2021f). Additionally, they are tolerant of silt and reservoirs (NatureServe 2021f).

The yellow sandshell begin spawning during the summer, when males release sperm into the water column and flows downstream to the females, which siphon the sperm to fertilize the eggs (Steele 2014). During the following spring, females release the larvae (i.e., glochidia) which then attach to a host species (Steele 2014). According to Howells (2014), reported host species include gars, shovelnose sturgeon, several sunfish species, largemouth bass, and crappies. The lifespan of yellow sandshell is variable and can range from 10 years to 100 years (Steele 2014).

This species is parasitic on fish in its larval stage (NatureServe 2021f). As an adult, the yellow sandshell is a detritivore and feeds primarily on fine particulate organic matter such as detritus, zooplankton, and/or phytoplankton (NatureServe 2021f).

4.2 Expected Species Impacts

As described above, the modeled impacts to water quality associated with all discharge scenarios are fairly well dependent on velocity. In particular, the higher discharge scenarios result in higher stream velocities, greater scouring, increased turbidity, and decreased temperatures. Although the environmental flow discharge scenario (Scenario 4) generally tracks with the no-build alternative, the higher discharge scenarios (Scenarios 1, 2, and 3) appear to match one another relatively closely during the modeled drought conditions. Therefore, this assessment will generalize the anticipated effects associated with the no-build alternative and high flow (Scenario 1) alternative.

4.2.1 Brook Silverside

As surface feeding denizens of slow-moving surface water, it is expected that the no-build alternative will likely have no significant impact on the brook silverside. The decreased flow velocity and increased temperatures associated with drought conditions should have a negligible effect on the species.

High flow discharges of 334 cfs (Scenario 1) are modeled to increase average stream velocity from 1.68 (no-build) to 2.36 ft/sec. Although brook silverside is adapted to low-flow velocities, a flow rate of 2.36 ft/sec would still be unlikely to be considered “high velocity.” Furthermore, the existing turbidity of Oyster Creek, both upstream and downstream of the existing reservoir’s discharge structure, generally ranges from 40 to 110 NTU, indicating that water clarity within Oyster Creek is generally poor. Considering that turbidity generally decreases downstream of the existing discharge structure, it is likely that implementation of the planned reservoir will improve surface clarity. Based on their preferred location in the water column, sediment scouring is unlikely to influence adult brook silversides and their breeding habits because much of Oyster Creek is dominated by fine sediments already.

4.2.2 Tadpole Madtom

The sluggish flow, turbidity, soft sediments, and abundance of allochthonous and autochthonous materials in Oyster Creek provide excellent habitat for the tadpole madtom. The no-build alternative would do little to impact those characteristics.

The results of implementing Scenario 1 through the construction of the proposed reservoir would not noticeably increase stream velocity beyond what is typical for the tadpole madtom. The species is endemic to the Brazos River basin and likely can sustain substantially higher velocity flows. However, scouring is likely to increase benthic turbidity, possibly decreasing predatory efficiency to some degree. That same scouring is likely to provide benefits to the providing substrate that may provide valuable submerged, waterlogged vegetation that may provide nursery areas.

Overall, the higher discharge volumes with Scenario 1 are likely to provide minimum, if any, negative impacts to the tadpole madtom during drought conditions.

4.2.3 White Crappie

The size, behavior, and habitat use of white crappies is such that neither the no-build nor the high volume (Scenario 1) scenarios are likely to cause significant impact to the species. White crappies are well-adapted to the conditions present in the Brazos River and its tributaries. Portions of Oyster Creek bear vegetation that may serve as valuable breeding areas for white crappie. Alterations in discharge volume are unlikely to result in substantial alteration to habitat.

4.2.4 Largemouth Bass

As with the white crappie, the size, behavior, and habitat use of largemouth bass is such that neither the no-build nor the high volume (Scenario 1) scenarios are likely to cause significant impact to the species. Although largemouth bass are also well-adapted to the conditions present in the Brazos River and its tributaries, the silt deposits within Oyster Creek provide minimal spawning areas for the species. Increasing the discharge volume may allow for increased sediment scouring, but it is unlikely to expose gravel or sandy substrate necessary for largemouth bass to establish breeding grounds. Therefore, implementation of the project is unlikely to have any substantial influence on largemouth bass populations in Oyster Creek.

4.2.5 Caddisflies

Tubemaker caddisflies are associated with generally good water quality. Their larvae are well-equipped to survive in moderate to low-oxygen environments. Their clinging lifestyle allows them to withstand increased velocities. Oyster Creek, in its current condition, should be able to sustain these species on a regular basis under typical flow regimes.

Under both the no-build and the high velocity scenario (Scenario 1), caddisflies should be sustained. The vegetation, substrate, and flow regimes under all planned scenarios should permit sustained populations of caddisflies. The increased velocities are unlikely to cause them to be washed downstream and sediment scour should not provide substantial impact to larvae that typically cling to larger substrate.

4.2.6 Mayflies

Considering the relatively long aquatic life stage of mayflies, it is not surprising that they are considered an indication of good long-term water quality in a waterbody. Their naiads feed in detritus and algae along the bottom of the waterbody. Oyster Creek's sluggish flow likely makes it sub-optimal habitat for these species; however, it is clear that they frequent the existing Harris Reservoir (Richard Howard, personal observation).

Under drought conditions, it is expected the reach of Oyster Creek between the existing discharge site and the planned construction site will likely sustain reduced flows with concomitant temperature increases, it is likely that the no-build scenario will reduce oxygen availability. All of the discharge scenarios will lead to increased discharges which will sustain the water quality in this area to the degree that the reach provides suitable habitat.

4.2.7 Unionid Mussels

4.2.7.1 ROUND PEARLSHELL

The round pearlshell is generally associated with deep, freshwater habitats and, therefore, is unlikely to be found in large numbers in Oyster Creek. Round pearlshells were detected by SWCA through field surveys in relatively small numbers. The species uses several fish species native to Oyster Creek as hosts for their larvae, especially spotted gar, green sunfish, and bluegill. As such, their lifecycles are generally unlikely to be altered by alteration in the flow velocities in Oyster Creek. None of the alterations represented by any of the build alternatives is likely to influence these fish species. Based on this, changing the flow dynamics in Oyster Creek are unlikely to negatively or positively influence round pearlshells.

4.2.7.2 PAPER PONDSHELL AND YELLOW SANDSHELL

The existing conditions of Oyster Creek provide habitat that may be able to support paper pondshells and yellow sandshells. The shallow, flowing water and soft sediments provide good substrate for the species. Considering their tolerance of poor water quality, it is possible that this species may be found within the stream.

The no-build scenario will lead to reduced water volume and velocity between the existing discharge location and the proposed discharge location. This would likely have a negative impact on individuals that may inhabit this area. Considering that all construction scenarios result in sustained or increased velocities and that the species is tolerant of suspended materials, it is probable that the construction of the project will not have substantial impact on the species, its habitat, or food source.

5 CONCLUSIONS

The modeled scenarios indicate that there will be a number of relatively minor impacts to the flow regimes and water quality of Oyster Creek. The alterations appear to be within the tolerances of the species discussed and, as such, are unlikely to result in deleterious effects on the species considered.

6 LITERATURE CITED

Atlas of Common Freshwater Macroinvertebrates of Eastern North America (ACFMENA). 2021a. Polycentropodidae Available at: https://www.macroinvertebrates.org/taxa-info/trichoptera-larva/polycentropodidae. Accessed October 2021.

———. 2021b. Ephemoptera Available at: https://www.macroinvertebrates.org/taxa-info/ephemeroptera-larva. Accessed October 2021.

Bonner, T.H. and D.T. Runyan. 2007. *Fish Assemblage Changes in Three Western Gulf Slope Drainages*. Texas Water Development Board. Project 2005-483-033.

de Moor, F.C. and V.D. Ivanov. 2008. Global diversity of caddisflies (Trichoptera) in freshwater. *Hydrobiologia* 595: 393-407.

Gilpin, D. 2009. *The Illustrated World Encyclopedia of Freshwater Fish and River Creatures*. London, England. Lorenz Books.

Howells, Robert G. 2014. *Field Guide to Texas Freshwater Mussels*. 2nd. ed. Kerrville, Texas: BioStudies.

Howells, R.G., R.W. Neck, and H.D. Murray. 1996. *Freshwater Mussels of Texas*. Austin, Texas: Texas Parks and Wildlife Press.

Keller, Tamara S. and Kenneth A. Krieger. 2009. Taxonomic Atlas of the Caddisfly Larvae (Class Insecta: Order Trichoptera) Recorded at the Old Woman Creek National Estuarine Research Reserve and State Nature Preserve, Ohio. Available at: https://ohiodnr.gov/static/documents/coastal/owc/OWCAtlas_Caddisfly.pdf. Accessed October 2021.

Linam, G.W. and L.J. Kleinsasser. 1987. Fisheries Use Attainability Study for Oyster Creek (Segment 1110). Texas Parks and Wildlife Department. July 1987.

Missouri Department of Conservation (MDC). 2021a. Missouri Department of Conservation: Field Guide [Brook Silverside]. Available at: https://mdc.mo.gov/discover-nature/field-guide. Accessed September 2021.

———. 2021b. Missouri Department of Conservation: Field Guide [Tadpole Madtom]. Available at: https://mdc.mo.gov/discover-nature/field-guide. Accessed September 2021.

———. 2021c. Missouri Department of Conservation: Field Guide [White Crappie]. Available at: https://mdc.mo.gov/discover-nature/field-guide. Accessed September 2021.

———. 2021d. Missouri Department of Conservation: Field Guide [Largemouth Bass]. Available at: https://mdc.mo.gov/discover-nature/field-guide. Accessed September 2021.

Mulcrone, R. 2006. Utterbackia imbecillis (On-line), Animal Diversity Web. Available at: https://animaldiversity.org/accounts/Utterbackia_imbecillis/. Accessed October 2021.

National Wildlife Federation (NWF). 2021. Mayflies. Available at: https://www.nwf.org/Educational-Resources/Wildlife-Guide/Invertebrates/Mayflies. Accessed October 2021.

NatureServe. 2021a. NatureServe Explorer: An online encyclopedia of life [Noturus gyrinus]. NatureServe, Arlington, Virginia. Available at: http://explorer.natureserve.org. Accessed September 2021.

———. 2021b. NatureServe Explorer: An online encyclopedia of life [Pomoxis annularis]. NatureServe, Arlington, Virginia. Available at: http://explorer.natureserve.org. Accessed September 2021.

———. 2021c. NatureServe Explorer: An online encyclopedia of life [Micropterus salmoides]. NatureServe, Arlington, Virginia. Available at: http://explorer.natureserve.org. Accessed September 2021.

———. 2021d. NatureServe Explorer: An online encyclopedia of life [Glebula rotundata]. NatureServe, Arlington, Virginia. Available at: http://explorer.natureserve.org. Accessed October 2021.

———. 2021e. NatureServe Explorer: An online encyclopedia of life [Utterbackia imbecillis]. NatureServe, Arlington, Virginia. Available at: http://explorer.natureserve.org. Accessed October 2021.

———. 2021f. NatureServe Explorer: An online encyclopedia of life [Lampsilis teres]. NatureServe, Arlington, Virginia. Available at: http://explorer.natureserve.org. Accessed October 2021.

Page, L.M. and B.M. Burr. 2011. Peterson Field Guide to Freshwater Fishes of North America North of Mexico, Second Edition. Houghton Mifflin Harcourt Publishing Company.

Perry, Heather A. 2018. The Biogeographic Distribution of Caddisflies (Insecta: Trichoptera) within the South-Central United States. Available at: https://digital.library.unt.edu/ark:/67531/metadc1157554/m2/1/high_res_d/PERRY-DISSERTATION-2018.pdf. Accessed October 2021.

Steele, M. 2014. Lampsilis teres (On-line), Animal Diversity Web. Available at: https://animaldiversity.org/accounts/Lampsilis_teres/. Accessed October 2021.

SWCA Environmental Consultants. 2019. *Stream Condition Assessment Report for the Dow Harris Reservoir Expansion Project in Brazoria County, Texas*. Houston, Texas: SWCA Environmental Consultants. November 2019.

Texas A&M Agrilife Extension. 2021a. Caddisfly. Available at: https://texasinsects.tamu.edu/trichoptera/caddisfly/. Accessed October 2021.

———. 2021b. Mayfly. Available at: https://texasinsects.tamu.edu/mayfly/. Accessed October 2021.

Texas Commission for Environmental Quality (TCEQ). 2014. Surface Water Quality Monitoring Procedures, Volume 2: Methods for Collecting and Analyzing Biological Assemblage and Habitat Data. Available at: https://www.tceq.texas.gov/assets/public/comm_exec/pubs/rg/rg416/rg-416.pdf. Accessed October 2021.

Texas Freshwater Fishes (TFF). 2021a. Texas Freshwater Fishes: Brazos River [Labidesthes sicculus]. Texas State University, San Marcos, Department of Biology. Available at: http://txstate.fishesoftexas.org/index.htm. Accessed September 2021.

———. 2021b. Texas Freshwater Fishes: Brazos River [Noturus gyrinus]. Texas State University, San Marcos, Department of Biology. Available at: http://txstate.fishesoftexas.org/index.htm. Accessed September 2021.

———. 2021c. Texas Freshwater Fishes: Brazos River [Pomoxis annularis]. Texas State University, San Marcos, Department of Biology. Available at: http://txstate.fishesoftexas.org/index.htm. Accessed September 2021.

———. 2021d. Texas Freshwater Fishes: Brazos River [Micropterus salmoides]. Texas State University, San Marcos, Department of Biology. Available at: http://txstate.fishesoftexas.org/index.htm. Accessed September 2021.

Thomas, C., T.H. Bonner, and B.G. Whiteside. 2007. *Freshwater Fishes of Texas*. College Station, Texas: Texas A&M University Press.

United States Department of Agriculture (USDA). 2016. Web Soil Survey. Available online at http://websoilsurvey.nrcs.usda.gov/. Accessed August 2021.

U.S. Geological Survey (USGS). 2021a. NAS – Nonindigenous Aquatic Species – Labidesthes sicculus (Brook Silverside). Available at: https://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=318. Accessed September 2021.

———. 2021b. NAS – Nonindigenous Aquatic Species – Pomoxis annularis (White Crappie). Available at: https://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=408. Accessed September 2021.

———. 2021c. NAS – Nonindigenous Aquatic Species – Micropterus salmoides (Largemouth Bass). Available at: https://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=401. Accessed September 2021.

University of Kentucky. 2021. Brook Silverside. College of Agriculture, Food and Environment: Office for Environmental Programs Outreach Services. Available at: https://oepos.ca.uky.edu/content/brook-silverside. Accessed September 2021.

University of North Texas (UNT). 2021. UNT Digital Library: Glebula rotundata, Specimen #259. University Libraries. Available at: https://digital.library.unt.edu/ark:/67531/metadc35514/. Accessed October 2021.

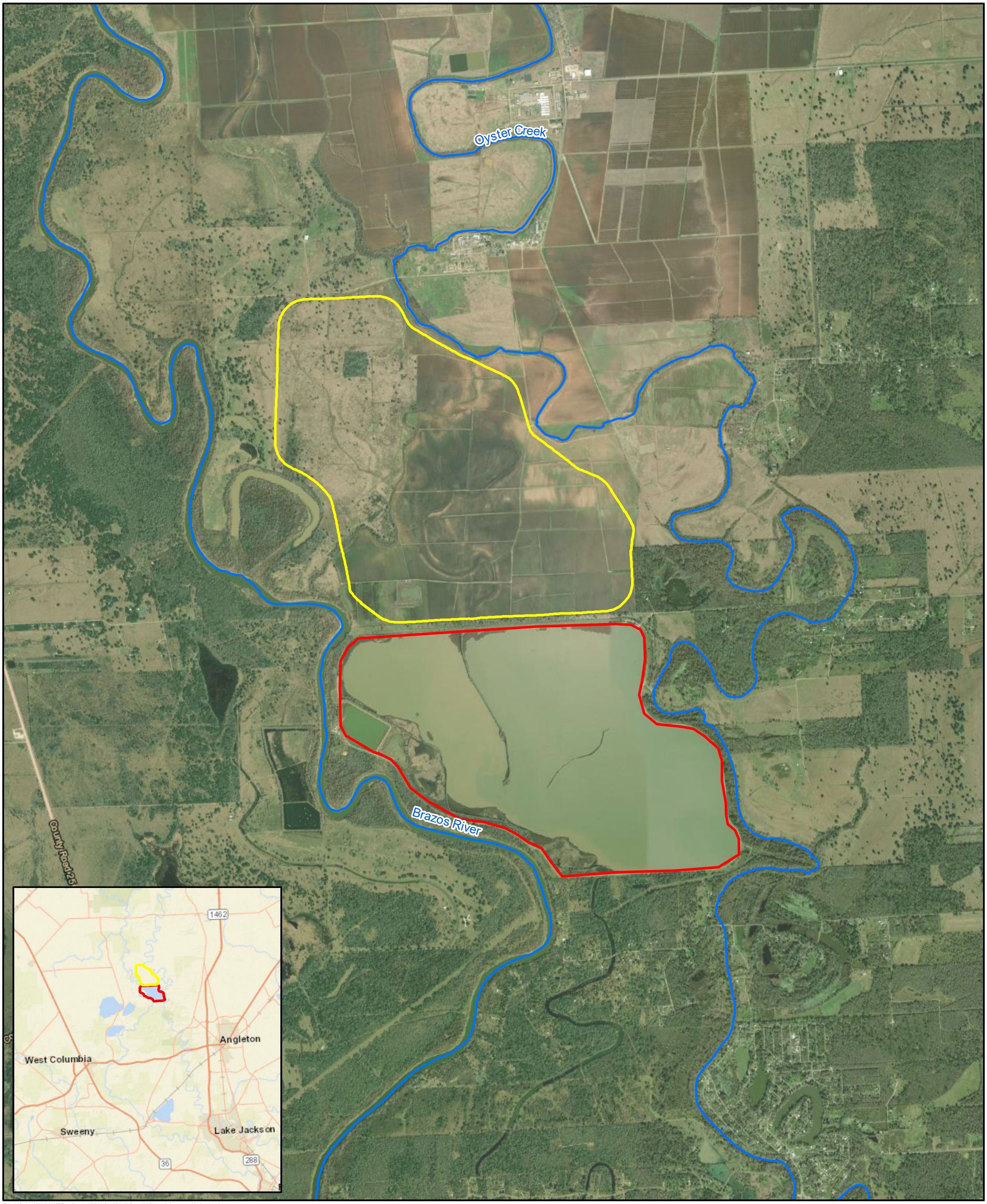
Warren, M.L., Jr., B.M. Burr, S.J. Walsh, H.L. Bart, Jr., R.C. Cashner, D.A. Etnier, B.J. Freeman, B.R. Kuhajda, R.L. Mayden, H.W. Robison, S.T. Ross, and W.C. Starnes. 2000. Diversity, Distribution, and Conservation Status of the Native Freshwater Fishes of the Southern United States. *Fisheries* 25(10):7-31.

Watearth, Inc. 2021. *Oyster Creek Downstream Hydrologic and Hydraulic Impacts Final Report for the DCC Harris Reservoir Expansion EIS.*

Wood, C.R., T.L. Arsuffi, and M.K. Cauble. 1994. *Macroinvertebrate Assessment of Allens Creek and the Brazos River, Austin County, Texas*. Texas Parks and Wildlife Department. Contract Number 333-0222. December 1994.

APPENDIX A

Exhibits



SWCA ENVIRONMENTAL CONSULTANTS

HARRIS RESERVOIR EXPANSION PROJECT
AERIAL PHOTOGRAPH
BRAZORIA COUNTY, TEXAS
EXHIBIT 1

Proposed Harris Reservoir Expansion
Existing Harris Reservoir
Stream

1:50,000

Created By: JS
Project Number: 52872
Date: 3/25/2022
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

0 0.25 0.5 Miles

0 0.25 0.5 0.75 Kilometers

HARRIS RESERVOIR EXPANSION PROJECT

TOPOGRAPHIC MAP

BRAZORIA COUNTY, TEXAS

EXHIBIT 2

Proposed Harris Reservoir Expansion

Existing Harris Reservoir

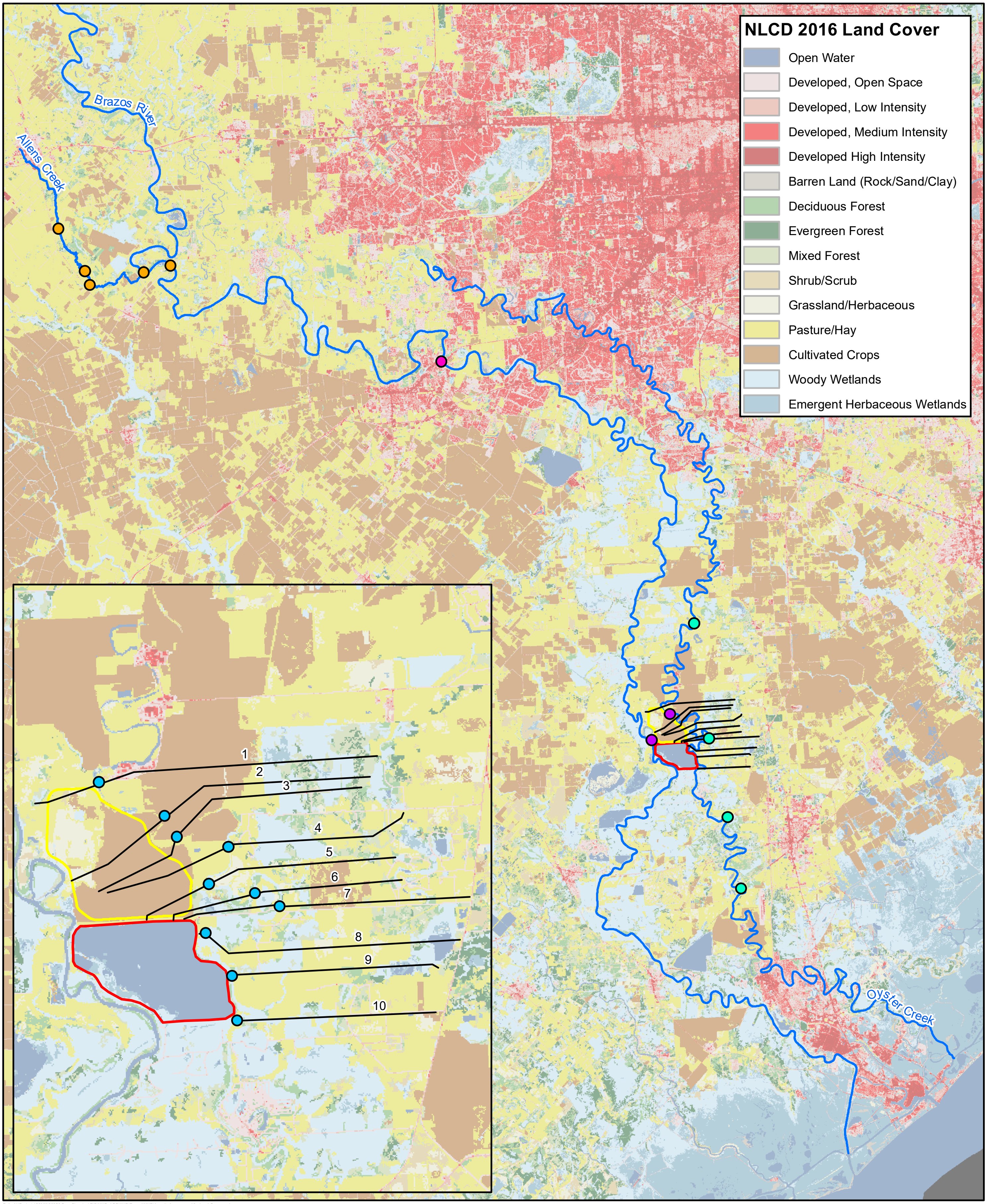
1:36,000

Created By: JS
Project Number: 52872
Date: 3/28/2022
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

0 0.25 0.5 Miles

0 0.25 0.5 0.75 Kilometers

SWCA ENVIRONMENTAL CONSULTANTS



SWCA ENVIRONMENTAL CONSULTANTS

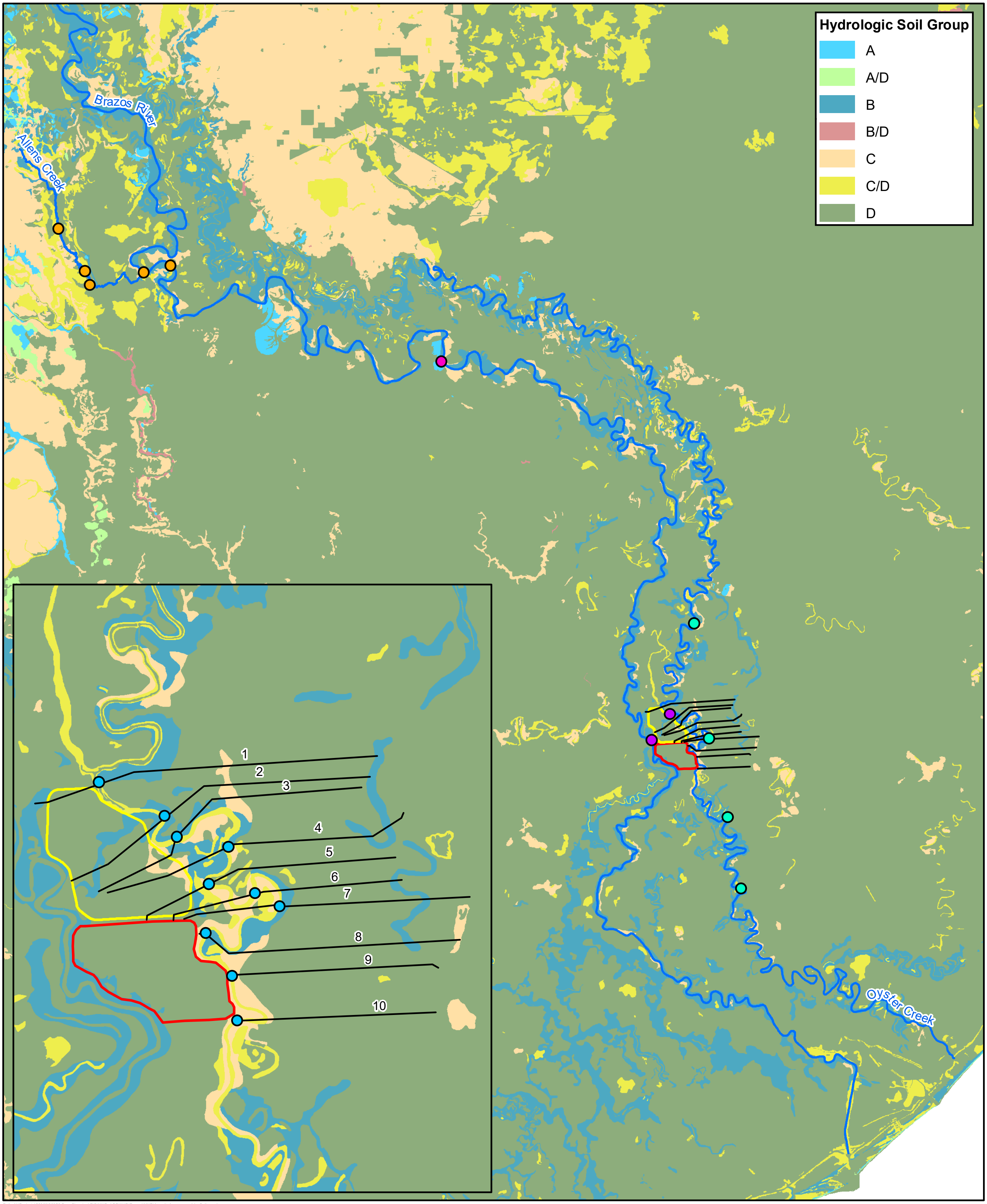
HARRIS RESERVOIR EXPANSION PROJECT
LAND COVER MAP
BRAZORIA COUNTY, TEXAS
EXHIBIT 3

Proposed Harris Reservoir Expansion
Existing Harris Reservoir
Stream
Transects
1987 Sampling Sites
1993 Sampling Sites
2007 Sampling Sites
2019 Sampling Sites

1:475,000

Created By: JS
Project Number: 52872
Date: 3/28/2022
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

0 2.5 5 Miles
0 2.5 5 7.5 Kilometers



SWCA ENVIRONMENTAL CONSULTANTS

HARRIS RESERVOIR EXPANSION PROJECT
HYDROLOGIC SOIL GROUP MAP
BRAZORIA COUNTY, TEXAS
EXHIBIT 4

Proposed Harris Reservoir Expansion
Existing Harris Reservoir
Stream
Transects
1987 Sampling Sites
1993 Sampling Sites
2007 Sampling Sites
2019 Sampling Sites

1:475,000

Created By: JS
Project Number: 52872
Date: 3/28/2022
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

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0 2.5 5 Miles
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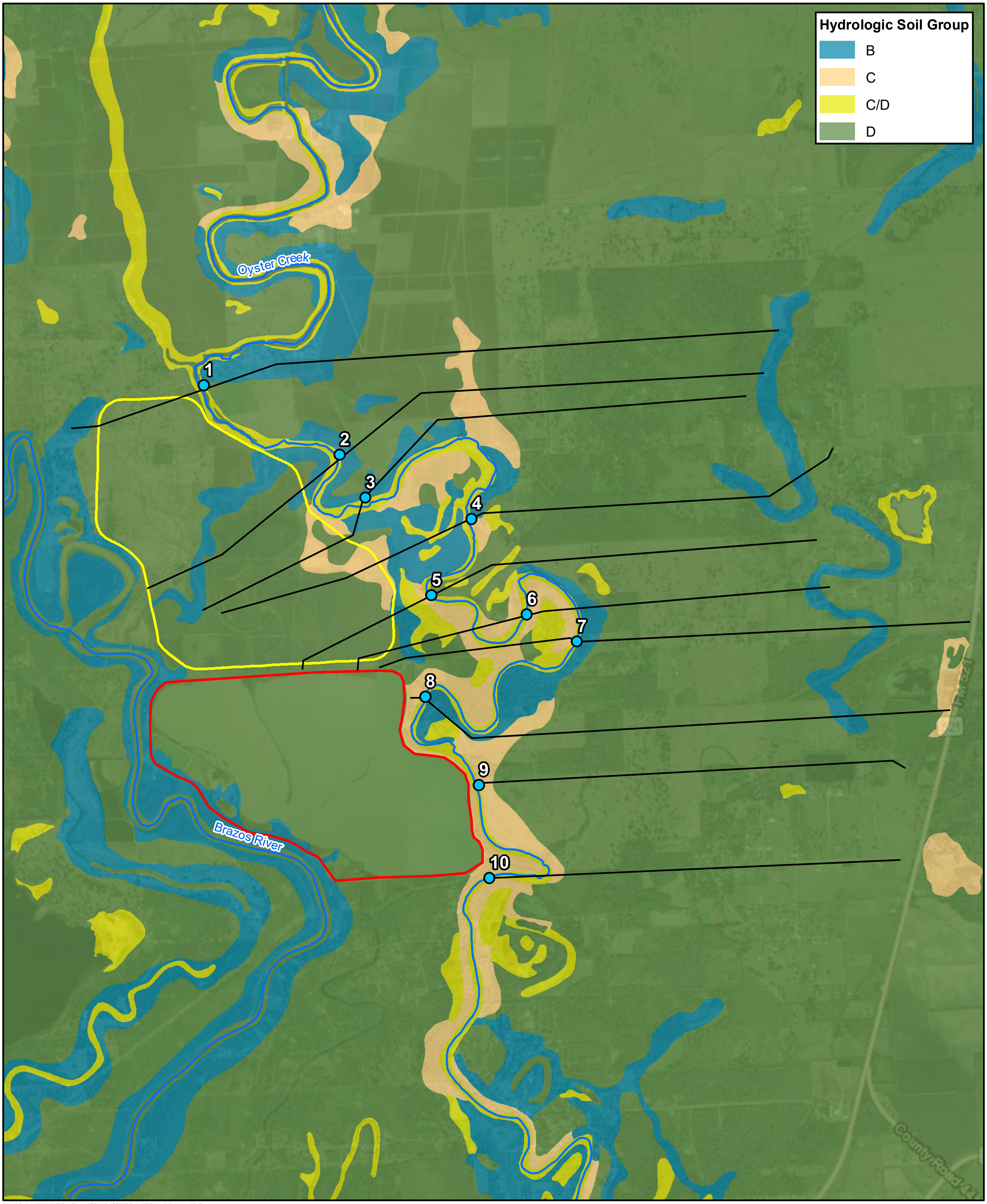


SWCA ENVIRONMENTAL CONSULTANTS

HARRIS RESERVOIR EXPANSION PROJECT

TRANSECTS MAP
BRAZORIA COUNTY, TEXAS
EXHIBIT 5

Proposed Harris Reservoir Expansion
Existing Harris Reservoir
Stream
Transects
2021 Sampling Sites

1:60,000

Created By: JS
Project Number: 52872
Date: 3/28/2022
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

0 0.5 1 Miles
0 0.5 1 1.5 Kilometers

APPENDIX B

Vegetation Cover

Table B-1. Vegetation Cover

Habitat Description	Tree Species	Sapling/Shrub Species	Herbaceous Species	Woody Vine Species
Transect 1				
Begin of Transect to Fence Line, Herbaceous, Open field, Cattle pasture	—	—	*Ambrosia psilostachya* *Ambrosia trifida* *Iva annua* *Lolium perenne* *Oenothera speciosa* *Solanum elaeagnifolium*	—
Fence Line to Top of Bank (right bank), Scrub-Shrub	*Carya sp.*	*Carya sp.*	*Ambrosia trifida* *Ampelopsis arborea* *Rubus argutus* *Solidago altissima* *Toxicodendron radicans*	—
Top of Bank (right bank) to Edge of Water (right bank), Bank slope	*Salix nigra*	*Cephalanthus occidentalis*	*Rubus argutus* *Smilax rotundifolia* *Toxicodendron radicans*	—
Oyster Creek, Edge of Water (right bank) to Edge of Water (left bank), Little to no vegetation within channel	—	—	—	—
Edge of Water (left bank) to Top of Bank (left bank), Bank slope	*Salix nigra*	*Cephalanthus occidentalis*	*Rubus argutus* *Smilax rotundifolia* *Toxicodendron radicans*	—
Top of Bank (left bank) to Fence Line, Scrub- Shrub, Slope	*Carya sp.*	*Carya sp.*	*Ambrosia trifida* *Ampelopsis arborea* *Rubus argutus* *Solidago altissima* *Toxicodendron radicans*	—
Fence Line to End of Transect, Herbaceous, Open field	—	—	*Sorghum halepense*	—

Habitat Description	Tree Species	Sapling/Shrub Species	Herbaceous Species	Woody Vine Species
Transect 2				
Begin of Transect, Herbaceous, Fallow agricultural field	—	—	*Amaranthus sp.,* *Ambrosia trifida* *Echinochloa colona* *Cucurbita foetidissima* *Parthenium hysterophorus*	—
Slope to Top of Bank (right bank), Herbaceous	—	—	*Ampelopsis arborea* *Brunnichia ovata* *Persicaria maculosa* *Rubus argutus* *Vitis mustangensis*	—
Top of Bank (right bank) to Edge of Water (right bank), Bank slope	—	—	*Alternanthera philoxeroides* *Brunnichia ovata* *Persicaria pensylvanica*	—
Oyster Creek, Edge of Water (right bank) to Edge of Water (left bank), Approximately 75% herbaceous cover/25% open water along transect	—	—	*Alternanthera philoxeroides*	—
Edge or Water (left bank) to Top of Bank (left bank), Bank slope	—	—	*Parthenium hysterophorus* *Rubus argutus*	—
Top of Bank (right bank) to Agricultural Field, Herbaceous, Open field	—	—	*Oenothera curtiflora* *Parthenium hysterophorus* *Rumex crispus*	—
Agricultural Field to End of Transect, Herbaceous, Agricultural field	—	—	*Amaranthus sp.* *Zea mays*	—
Transect 3				
Begin of Transect to Road, Herbaceous, Agricultural field	—	—	*Unknown grass*	—

Habitat Description	Tree Species	Sapling/Shrub Species	Herbaceous Species	Woody Vine Species
Road to Top of Bank (right bank), Herbaceous, recently mowed	—	—	*Brunnichia ovata* *Parthenium hysterophorus* *Rubus trivialis* *Sorghum halepense*	—
Top of Bank (right bank) to Edge of Water (right bank), Forested, Bank slope	*Salix nigra*	—	*Ambrosia trifida* *Brunnichia ovata* *Persicaria virginiana*	—
Oyster Creek, Edge of Water (right bank) to Edge of Water (left bank), No vegetation within channel	—	—	—	—
Edge or Water (left bank) to Top of Bank (left bank), Forested, Bank slope	*Salix nigra*	—	*Brunnichia ovata*	—
Top of Bank (left bank) to Top of Slope, Herbaceous, Open Field, Slope	—	—	*Ampelopsis arborea* *Rubus argutus* *Passiflora incarnata* *Johnson Grass* *Persicaria virginiana*	—
Top of Slope to Agricultural Field, Herbaceous, Open field	—	—	*Monarda punctata* *Oenothera laciniata* *Oxalis corniculate* *Rubus argutus* *Rumex crispus* *Sorghum halepense*	—
Agricultural Field to End of Transect, Herbaceous, Agricultural field	—	—	*Acalypha ostryifolia* *Parthenium hysterophorus* *Zea mays*	—
Transect 4				
Begin of Transect to Top of Slope, Herbaceous, Open field/prairie, Cattle pasture	—	—	*Ambrosia psilostachya* *Cynodon dactylon* *Lolium perenne* *Rubus argutus*	—

Habitat Description	Tree Species	Sapling/Shrub Species	Herbaceous Species	Woody Vine Species
Top of Slope to Top of Bank (right bank), Scrub-Shrub, Scattered trees and shrubs, Slope	—	*Acer negundo* *Carya sp.* *Fraxinus pennsylvanica* *Triadica sebifera*	*Ambrosia trifida* *Carex cherokeensis* *Chloracantha spinosa* *Persicaria hydropiperoides* *Rubus argutus*	—
Top of Bank (right bank) to Edge of Water (right bank), Forested, Bank slope	*Fraxinus pennsylvanica* *Salix nigra*	*Acer negundo*	*Persicaria hydropiperoides (<5%)*	—
Oyster Creek, Edge of Water (right bank) to Edge of Water (left bank), No vegetation within channel	—	—	—	—
Edge or Water (left bank) to Top of Bank (left bank), Forested, Bank slope	*Carya sp.* *Fraxinus pennsylvanica* *Salix nigra* *Triadica sebifera*	*Acer negundo*	*Ambrosia trifida* *Persicaria hydropiperoides*	—
Top of Bank (left bank) to Fence, Forested	*Celtis laevigata* *Fraxinus pennsylvanica* *Triadica sebifera*	*Carya sp.*	*Campsis radicans* *Rubus argutus* *Smilax rotundifolia*	—
Fence to Pond Top of Bank, Herbaceous, Open field	—	—	*Cynodon dactylon* *Oxalis corniculate* *Trifolium repens*	—
Pond Top of Bank to Pond Edge of Water, Herbaceous, Bank slope	—	—	*Cynodon dactylon*	—
Pond Edge of Water to Pond Edge of Water, Pond/PEM, approximately 95% emergent cover/5% open water along transect	—	—	*Ludwigia peploides*	—
Pond Edge of Water to Bottom of Slope, Herbaceous, Open field	—	—	*Cynodon dactylon* *Rumex crispus* *Salix nigra* *Trifolium repens*	—
Bottom of Slope to Pond Top of Bank, Herbaceous, Bank slope, Erosion, 70% bare ground	—	—	*Ambrosia psilostachya* *Cynodon dactylon*	—
Pond Top of Bank to End of Transect, Herbaceous, Open field	—	—	*Cynodon dactylon* *Dichondra carolinensis* *Trifolium repens*	—

Habitat Description	Tree Species	Sapling/Shrub Species	Herbaceous Species	Woody Vine Species
Transect 5				
Begin of Transect to Fence Line, Herbaceous, Open field/prairie, Cattle pasture	—	—	*Ambrosia psilostachya* *Cynodon dactylon* *Dichondra carolinensis* *Geranium carolinianum* *Lolium perenne* *Senna obtusifolia* *Oxalis corniculate* *Trifolium repens*	—
Fence Line/Top of Slope to Tree Line, Scrub-Shrub, Slope	*Triadica sebifera*	*Acer negundo* *Carya sp.*	*Ambrosia trifida* *Campsis radicans* *Cynodon dactylon* *Rubus argutus*	—
Tree Line to Edge of Water (right bank), Forested, Slope	*Acer negundo* *Fraxinus pennsylvanica* *Salix nigra* *Triadica sebifera*	*Celtis laevigata*	*Ambrosia trifida* *Ampelopsis arborea*	—
Oyster Creek, Edge of Water (right bank) to Edge of Water (left bank), No vegetation within channel	--	--	--	—
Edge or Water (left bank) to Tree Line, Forested, Slope	*Celtis laevigata* *Triadica sebifera*	*Ilex decidua*	*Calyptocarpus vialis* *Campsis radicans* *Rubus argutus* *Smilax bona-nox* *Toxicodendron radicans*	—
Tree Line to Bottom of Slope, Herbaceous, Open field	—	—	*Ampelopsis arborea* *Brunnichia ovata* *Rubus argutus* *Smilax bona-nox* *Toxicodendron radicans*	—
Bottom of Slope to Top of Slope, Forested, Small tree line along slope	*Celtis laevigata, Triadica sebifera*	*Ulmus americana*	*Ampelopsis arborea* *Campsis radicans* *Rubus argutus* *Smilax bona-nox* *Toxicodendron radicans*	—

Habitat Description	Tree Species	Sapling/Shrub Species	Herbaceous Species	Woody Vine Species
Top of Slope to End of Transect, Herbaceous, Open field, Cattle pasture	—	—	*Ambrosia psilostachya* *Ampelopsis arborea* *Cynodon dactylon* *Dichondra carolinensis* *Iva annua* *Lolium perenne* *Rubus argutus* *Smilax bona-nox*	—
Transect 6				
Begin of Transect to Top of Slope, Forested but not thick tree/overstory cover, Open understory, Cattle pasture	*Carya illinoinensis*	—	*Ambrosia psilostachya* *Calyptocarpus vialis* *Campsis radicans* *Cynodon dactylon* *Trifolium repens*	—
Top of Slope to Edge of Water (right bank), Herbaceous, Slope	—	*Sesbania drummondii* *Triadica sebifera*	*Ambrosia psilostachya* *Ampelopsis arborea* *Calyptocarpus vialis* *Campsis radicans* *Cynodon dactylon* *Cyperus entrerianus* *Hydrocotyle verticillate* *Persicaria hydropiperoides* *Saururus cernuus* *Trifolium repens*	—
Oyster Creek, Edge of Water (right bank) to Edge of Water (left bank), Very little vegetation within channel (<5%), Vegetation mainly along banks	—	—	*Saururus cernuus*	—
Edge or Water (left bank) to Top of Bank (left bank), Forested, Bank slope	*Fraxinus pennsylvanica*	—	*Carex cherokeensis* *Saururus cernuus* *Toxicodendron radicans*	—

Habitat Description	Tree Species	Sapling/Shrub Species	Herbaceous Species	Woody Vine Species
Top of Bank (left bank) to Tree Line, Forested but fairly open canopy and understory, Slope, Cattle pasture	*Carya illinoinensis*	—	*Ampelopsis arborea* *Calyptocarpus vialis* *Campsis radicans* *Carex cherokeensis* *Cynodon dactylon* *Parthenocissus quinquefolia* *Paspalum sp.* *Rubus argutus* *Smilax bona-nox* *Toxicodendron radicans* *Trifolium repens*	—
Tree Line to End of Transect, Herbaceous, Open field, Cattle pasture	—	—	*Ambrosia psilostachya* *Calyptocarpus vialis* *Cynodon dactylon* *Cyperus entrerianus* *Trifolium repens*	—
Transect 7				
Begin of Transect to Fence Line, Partially herbaceous and partially forested, Open field with scattered trees, Cattle pasture	*Acer negundo* *Carya illinoinensis* *Celtis laevigata*	—	*Cynodon dactylon,* *Oxicodendron radicans*	—
Fence Line to Edge of Water (right bank), Forested, Open understory, 90-95% bare ground	*Carya illinoinensis* *Celtis laevigata* *Fraxinus pennsylvanica*	—	—	—
Oyster Creek, Edge of Water (right bank) to Edge of Water (left bank), No vegetation within channel, Steep banks on both sides	—	—	—	—
Edge of Water (left bank) to Top of Bank (left bank), Bank slope	*Acer negundo*	—	—	—
Top of Bank (left bank) to Fence Line, Forested, Slight slope	*Acer negundo* *Carya sp.* *Celtis laevigata*	*Cornus drummondii*	*Campsis radicans* *Rubus argutus* *Toxicodendron radicans*	*Vitis sp.*
Fence Line to End of Transect, Partially herbaceous and partially forested, Forested area fairly open canopy and understory, Open pasture	*Carya illinoinensis*	—	*Carex cherokeensis* *Cynodon dactylon*	—
Transect 8				

Habitat Description	Tree Species	Sapling/Shrub Species	Herbaceous Species	Woody Vine Species
Begin of Transect to Top of Bank (right bank), Forested but fairly open understory, Slight slope, Cattle pasture	*Carya sp.* *Celtis laevigata* *Fraxinus pennsylvanica* *Triadica sebifera* *Ulmus americana* *Ulmus crassifolia*	—	*Carex cherokeensis* *Rubus trivialis* *Smilax bona-nox* *Toxicodendron radicans*	—
Top of Bank (right bank) to Edge of Water (right bank), Bank slope, No vegetation along bank	—	—	—	—
Oyster Creek, Edge of Water (right bank) to Edge of Water (left bank), No vegetation within channel	—	—	—	—
Edge of Water (left bank) to Top of Bank (left bank), Bank slope, Very little to no vegetation along bank	—	—	—	—
Top of Bank (left bank) to Top of Slope, Forested, Slight slope	*Acer negundo* *Fraxinus pennsylvanica* *Ulmus alata*	*Fraxinus pennsylvanica* *Ilex decidua* *Viburnum sp.*	*Campsis radicans* *Carex cherokeensis* *Oplismenus hirtellus* *Parthenocissus quinquefolia* *Toxicodendron radicans*	—
Top of Slope to End of Transect, Forested, Thick understory	*Celtis laevigata* *Ulmus americana*	*Ilex decidua* *Ulmus americana* *Ulmus crassifolia*	*Campsis radicans* *Elymus virginicus* *Oplismenus hirtellus* *Parthenocissus quinquefolia*	*Smilax rotundifolia* *Vitis sp.*
Transect 9				
Begin of Transect to Top of Bank (right bank), Forested, Thick canopy and understory, Slight slope	*Acer negundo* *Carya sp.* *Celtis laevigata* *Fraxinus pennsylvanica* *Quercus nigra* *Quercus viriniana*	*Ilex vomitoria* *Quercus nigra*	*Arundinaria gigantea* *Brunnichia ovata* *Carex cherokeensis* *Parthenocissus quinquefolia* *Toxicodendron radicans*	*Vitis sp.*
Top of Bank (right bank) to Edge of Water (right bank), Bank Slope, Very little to no vegetation along bank	*Fraxinus pennsylvanica*	—	—	—
Oyster Creek, Edge of Water (right bank) to Edge of Water (left bank), No vegetation within channel	—	—	—	—

Habitat Description	Tree Species	Sapling/Shrub Species	Herbaceous Species	Woody Vine Species
Edge of Water (left bank) to Top of Bank (left bank), Bank Slope, No vegetation along bank	—	—	—	—
Top of Bank (left bank) to Tree Line, Forested, Slight slope	*Celtis laevigata* *Fraxinus pennsylvanica*	—	*Ampelopsis arborea* *Ambrosia trifida* *Rubus argutus* *Smilax rotundifolia* *Toxicodendron radicans*	*Vitis sp.*
Tree Line to End of Transect, Herbaceous, Open field, Cattle pasture	—	—	*Ampelopsis arborea* *Croton monanthogynus* *Cynodon dactylon* *Paspalum sp.* *Paspalum notatum* *Rubus argutus* *Smilax bona-nox* *Triadica sebifera* *Trifolium repens*	—
Transect 10				
Begin of Transect to Fence Line, Herbaceous, Open field, Scattered trees	—	—	*Ampelopsis arborea* *Carex cherokeensis* *Paspalum sp.* *Toxicodendron radicans*	—
Fence Line to Tree Line, Herbaceous, Overgrown vegetation	—	—	*Ampelopsis arborea* *Arundinaria gigantea* *Carex cherokeensis* *Toxicodendron radicans*	—
Tree Line to Edge of Depression, Forested, Slight slope	*Fraxinus pennsylvanica* *Carya sp.* *Celtis laevigata*	*Citrus trifoliata* *Cornus drummondii* *Ilex decidua* *Ilex vomitoria*	*Campsis radicans* *Carex cherokeensis* *Parthenocissus quinquefolia* *Toxicodendron radicans*	—

Habitat Description	Tree Species	Sapling/Shrub Species	Herbaceous Species	Woody Vine Species
Edge of Depression to Edge of Depression, Small depresional wet area, becomes wetter further northeast of transect, not as vegetated as surrounding area	*Fraxinus pennsylvanica* *Carya sp.* *Celtis laevigata*	--	*Ampelopsis arborea* *Carex cherokeensis* *Parthenocissus quinquefolia* *Persicaria hydropiperoides* *Toxicodendron radicans*	—
Edge of Depression to Top of Bank (right bank), Forested, Thick ground cover of *Toxicodendron radicans*	*Fraxinus pennsylvanica* *Carya sp.* *Celtis laevigata*	*Citrus trifoliata* *Cornus drummondii* *Crataegus sp.* *Ilex decidua* *Ilex vomitoria*	*Arundinaria gigantea* *Campsis radicans* *Carex cherokeensis* *Parthenocissus quinquefolia* *Toxicodendron radicans*	*Toxicodendron radicans* *Vitis sp.*
Top of Bank (right bank) to Edge of Water (right bank), Bank slope, No vegetation along bank	—	—	—	—
Oyster Creek, Edge of Water (right bank) to Edge of Water (left bank), No vegetation within channel, Downed trees	—	—	—	—
Edge of Water (left bank) to Top of Bank (left bank), Bank slope, No vegetation along bank	—	—	—	—
Top of Bank (left bank) to Top of Slope, Forested, Open understory, Slight slope	*Celtis laevigata* *Fraxinus pennsylvanica* *Ulmus americana*	*Celtis laevigata* *Ilex decidua* *Ulmus americana* *Ulmus crassifolia*	*Carex cherokeensis* *Parthenocissus quinquefolia* *Toxicodendron radicans*	*Vitis sp.*
Top of Slope to End of Transect, Forested, Thick understory	*Carya sp.* *Celtis laevigata* *Triadica sebifera*	*Acer negundo* *Fraxinus pennsylvanica* *Ilex vomitoria*	*Arundinaria gigantea* *Elymus virginicus* *Rubus argutus* *Solidago altissima*	*Vitis sp.*

APPENDIX I

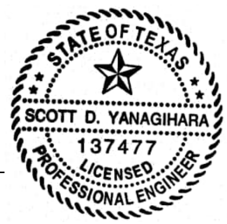
Brazos River and Oyster Creek Additional Hydraulics Modeling

Jacobs

Memorandum

2224 Bay Area Boulevard
Suite 200
Houston, TX 77058
United States
T +1.281.461.2300
F +1.281.461.5931
www.jacobs.com

Subject	**Support for EIS: Brazos River and Oyster Creek Additional Hydraulics Modeling**	**Project Name**	**Harris Reservoir Expansion**
Attention	The Dow Chemical Company	**Project Number**	WHXK8600
From	Jacobs		
Date	September 28, 2022		
Copies to	File		



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It may not be used for bidding or construction purposes.

Texas Registered Engineering Firm F-2966.

1. Introduction

This technical memorandum (TM) presents the results of a hydraulic evaluation of the potential impacts to Oyster Creek and Brazos River resulting from The Dow Chemical Company (Dow) Harris Reservoir Expansion Project (Proposed Project). Specifically, this TM addresses recent revisions to the hydraulic model that Jacobs had used to demonstrated that the Proposed Project would not cause a rise of the Brazos River during a 100-year Federal Emergency Management Agency (FEMA) base flood. These revisions were requested by the U. S. Army Corps of Engineers (USACE) and consisted of extending the Brazos River model further south to County Road 30 and evaluating whether the Proposed Project would cause a rise during the 10% and 2% annual recurrence chance events (i.e., 10-year and 50-year floods) relative to existing conditions without the Proposed Project. This model extension was requested by USACE to address questions that arose during public review of the Proposed Project's Draft Environmental Impact Statement (DEIS). The goal of this evaluation was to determine potential impacts from the Proposed Project to the flood water surface elevations (WSELs) during these more frequent storm events, between the Brazos River and Oyster Creek downstream of the Proposed Project and the existing Harris Reservoir.

Jacobs Engineering Group Inc. (Jacobs) modeled Oyster Creek and the Brazos River separately, following the same separate modeling approach used in the current FEMA regulatory models.

In July 2022, the Oyster Creek HEC-RAS model was extended downstream by adding four cross sections numbered 49 through 46, with Cross Section 49 located at the downstream (southern) edge of the existing Harris Reservoir and Cross Section 46 located at approximately County Road 30. The model was extended in order to provide comparison data on the expected 100-year and 500-year flood (1% and 0.2% annual recurrence chance, respectively) water surface elevations further downstream of the then current limits of the model. The additional cross sections added approximately 3.8 miles of downstream length. The results of that analysis were that the added cross sections showed no difference between the existing and post improvements water surface elevation. The cross sections upstream of cross section 49 were updated to include a farm bridge at station 59.5 was originally not part of the model and was not going to be modified. The approach now is to utilize a replacement of this bridge for construction traffic. The existing conditions model now includes the existing bridge and the proposed model now includes the conceptual replacement bridge. The analysis of this bridge replacement is addressed in a separate

Technical Memorandum. The remainder of the model is unchanged from the model used to inform the DEIS.

For consistency, the Brazos River Model was extended downstream by adding four cross sections in line with Cross Sections 49 to 46 on Oyster Creek. These cross sections are numbered 42.16, 41.24, 39.77, and 39.29, with Cross Section 42.16 located at the downstream edge of existing Harris Reservoir and 39.29 aligned with Oyster Creek cross section 46, at approximately County Road 30.

2. Model Inputs

HEC-RAS 5.0.7 was used for the hydraulic model. The model was run in a one-dimensional, steady state condition, using these inputs, which are discussed in the following sections.

- Flowrates
- Cross Section Data
- Boundary Conditions
- Proposed Project Improvements

2.1 Flow Rates

The flowrates used in both the HEC-RAS Brazos River model and the HEC-RAS Oyster Creek model originate from the FEMA effective hydrology published in the December 2020 Flood Insurance Study (FIS) for Brazoria County, Texas. The FIS discussed the split flow between the Brazos River and Oyster Creek and how it was accounted for in the development of the regulatory flowrates. The FIS discusses that FLOW SIM 10, a two-dimensional modeling program, was used to determine the discharge split between the Brazos River and Oyster Creek for many of the analyses and was calibrated to a known flood in the watershed (FEMA 2020, pg. 15). The model development methodology addressed the flow interaction between the Brazos River and Oyster Creek during floods and allowed separate hydraulic models for Oyster Creek and the Brazos River to be developed, linked by a common hydrologic foundation. Jacobs' current flood modeling used these published flowrates to compare post-project WSELs to WSELs for existing conditions.

2.2 Cross Section Data

The electronic digital elevation model developed for the Proposed Project was used to create the cross-section station and elevation data for new Cross Sections 42.16 through 39.29 on the Brazos River. Additional cross sections were added to the existing model geometry at Cross Sections 45.22 through 45.34 at the location of the new pump station, to allow consistent comparison of the existing and proposed WSELs there and upstream. Ground surface data available from aerial imagery and GIS land use data were used to assign the manning's n values representing the hydraulic roughness of the ground. GIS was used to measure channel lengths between the new cross sections and to locate the proposed pump station on the overbank. Inspection of the cross sections in concert with location information from aerial imagery was used to locate the left and right bank stations.

Figure 1 shows the location of the new cross sections that were added to the Brazos River and Oyster Creek models. Figures 2 and 3 show the plan view of the Brazos River and Oyster Creek HEC-RAS geometric data, respectively.

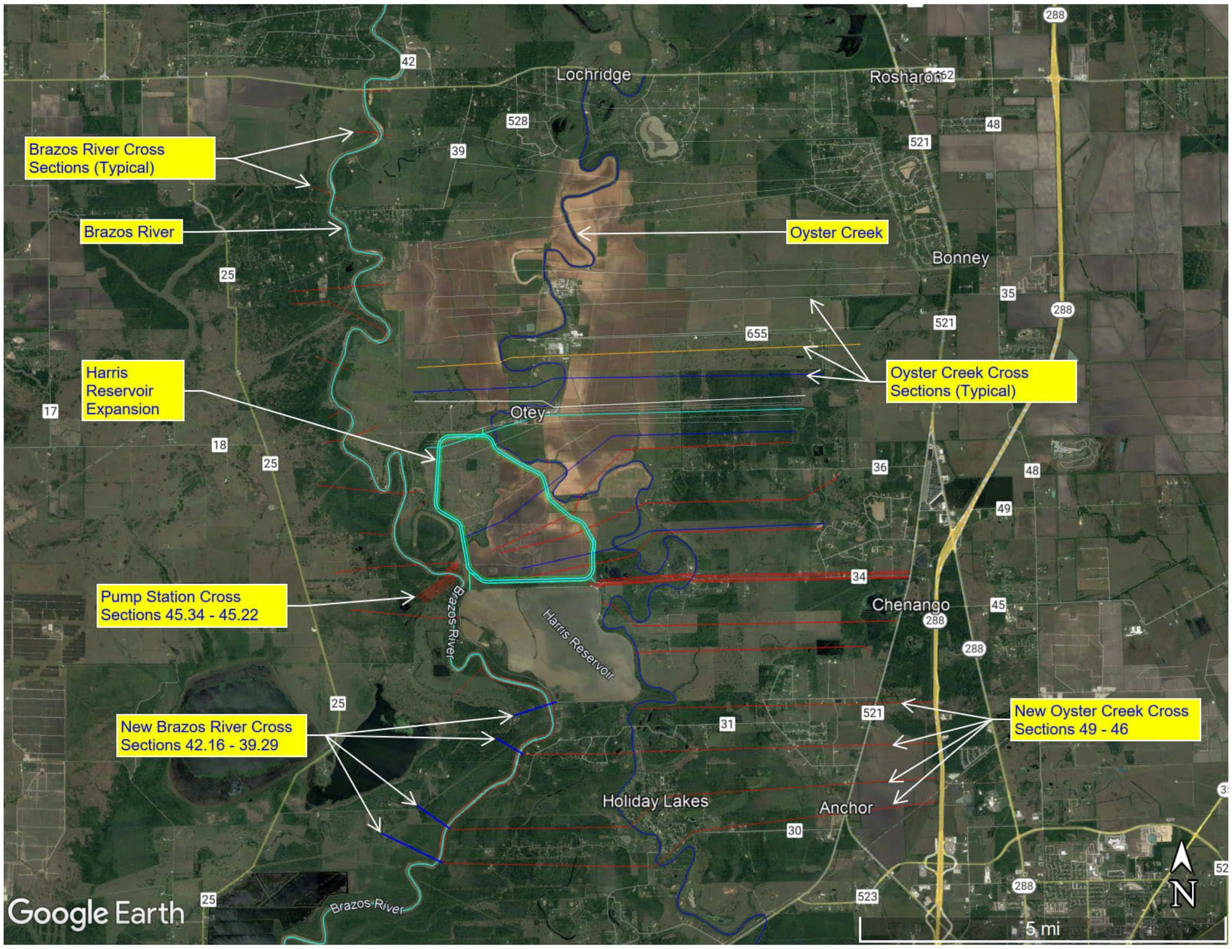


Figure 1. New HEC-RAS Cross Section Locations for the Brazos River and Oyster Creek Models

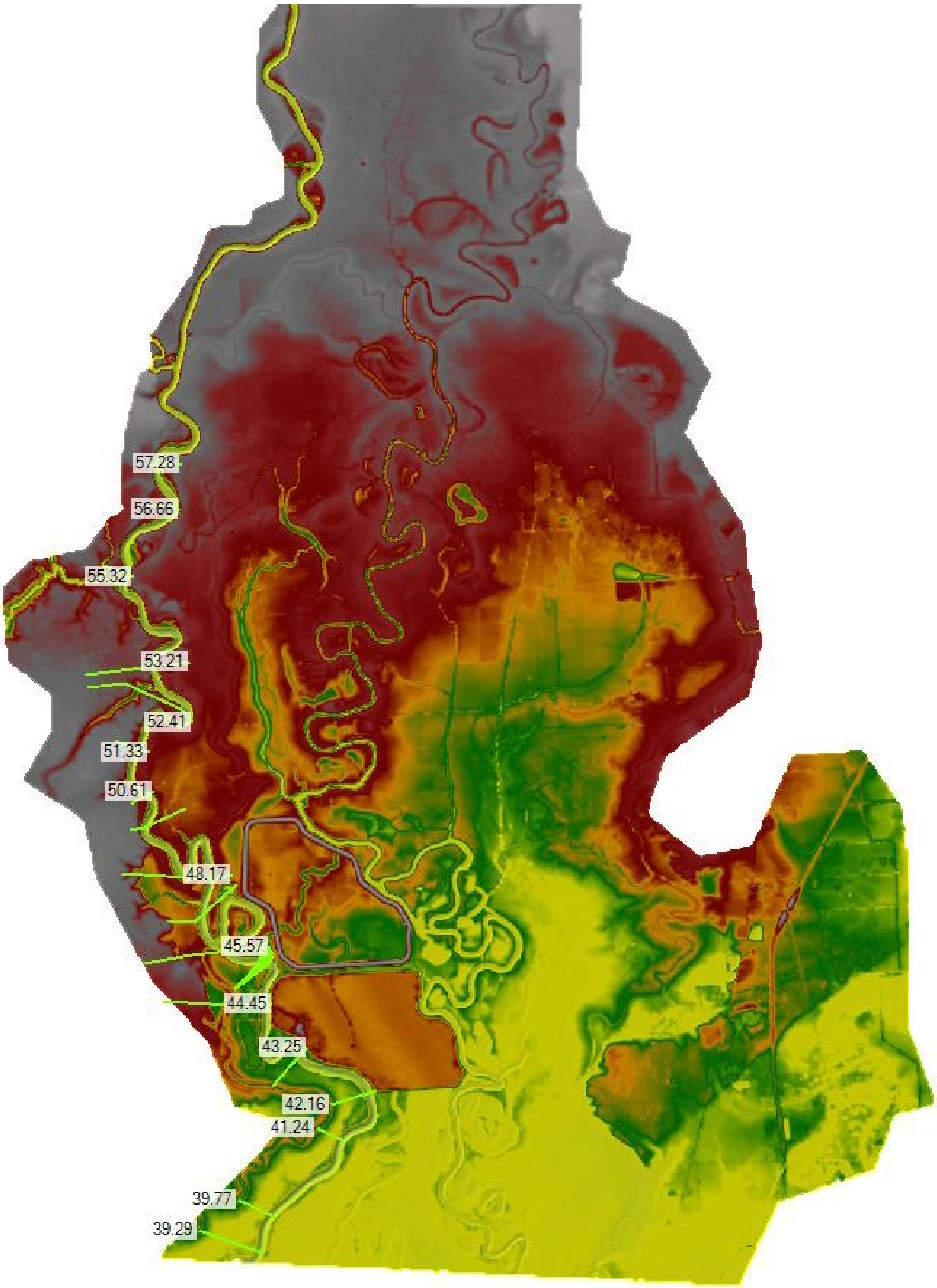


Figure 2. Brazos River HEC-RAS Cross Section Locations

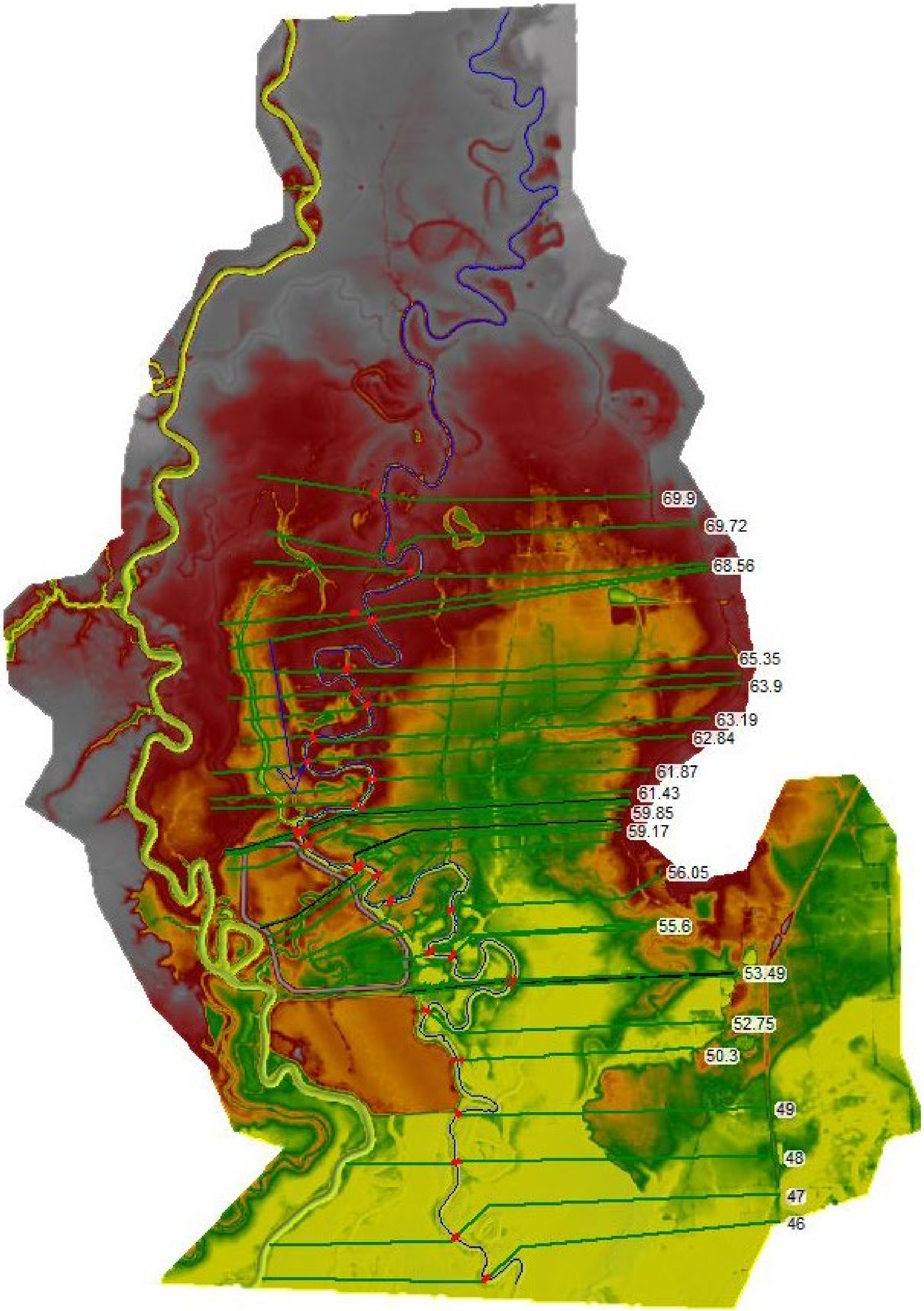


Figure 3. Oyster Creek HEC-RAS Cross Section Locations

2.3 Boundary Conditions

For steady state conditions that represent the flood peak, the downstream boundary condition used in the models were the 10-year and 50-year floods WSEL from the FIS WSEL profiles at Cross Section 39.29 on the Brazos River and at Cross Section 46.00 on Oyster Creek.

2.4 Proposed Project Floodplain Enhancement

The Proposed Project includes improvements on the floodplain between Oyster Creek and the Brazos River that were included in the original hydraulic models for proposed conditions and were not modified for this model that extended the downstream limits. The Proposed Project improvements were derived from the proposed design surfaces and layouts. The cross sections for the Oyster Creek proposed-conditions model show the new channel improvements, especially the new overflow channel adjacent to the reservoir embankment, and the reservoir embankment itself.

The Oyster Creek existing-conditions and proposed-conditions models were both updated to include a construction-access bridge that crosses Oyster Creek. A small, existing wooden farm bridge was added where it provides the northern construction access. This bridge is anticipated to be replaced with a more robust bridge to accommodate the anticipated construction traffic, so the proposed conditions model was updated to replace the existing wooden farm bridge with a conceptual steel replacement bridge. The existing and replacement bridges are addressed in a separate technical memorandum and reference this northern heavy haul access route.

The proposed Brazos River model includes the new pump station as blocked obstructions.

It should be noted that both the Brazos River and Oyster Creek physically extend further upstream and downstream than the presented cross sections. The boundary cross sections in each model represent locations far enough upstream and downstream to clearly demonstrate that the water surface elevations are no longer influenced by the Proposed Project improvements.

3. Results

A previous TM dated July 21, 2022, presented results for Oyster Creek during the 100-year and 500-year return events. Tables 3-1 to 3-4 present the results for both the Brazos River and Oyster Creek for the 10-year and 50-year return events.

The results show that the proposed conditions 10-year and 50-year WSELs are generally within 0.01 feet[1] of the existing conditions WSELs for both the Brazos River and Oyster Creek. Table 3-1 and Table 3-2 summarize the comparison of the WSELs for the 10-year and 50-year return events respectively for the Brazos River. Table 3-3 and Table 3-4 summarize the comparison of the WSELs for the 10-year and 50-year return events respectively for Oyster Creek.

The results indicate that the water surface elevations expected through the Proposed Project area and downstream of the Proposed Project area on both the Brazos River and on Oyster Creek are not impacted during either the 10-year or the 50-year return events. This result is consistent with the 100-year and 500-year results on both the Brazos River and Oyster Creek. These results demonstrate that the potential impacts of the new reservoir are fully mitigated by the Oyster Creek Channel improvements.

[1] A difference of 0.01 feet is generally considered "noise" in the model. That is, the model and its algorithms cannot be considered reliable down to the that small of a WSEL increment, therefore the model error likely exceeds 0.01 feet. A change of 0.01 feet can generally be considered negligible. In this case, the changes are flood reduction, so changes of -0.01 feet are also considered negligible.

Table 3-1. Brazos River 10-Year Return Event Water Surface Elevation Comparison

River Station	Q Total (cfs)	Existing W.S. Elev (FT) (1)	Proposed W.S. Elev (FT) (2)	W.S. Elev Difference (FT) (2) - (1)
57.28	96100	50.61	50.61	0.00
56.66	96100	50.31	50.31	0.00
55.32	96100	49.86	49.86	0.00
53.21	96100	48.58	48.58	0.00
52.41	96100	47.67	47.67	0.00
51.33	96100	46.57	46.57	0.00
50.61	96100	45.74	45.74	0.00
50.17	96100	45.59	45.59	0.00
48.17	96100	43.95	43.95	0.00
46.21	95328	43.27	43.27	0.00
45.57	95076	42.16	42.16	0.00
45.34	95076	41.38	41.38	0.00
45.31	95076	41.43	41.43	0.00
45.29	95076	41.45	41.45	0.00
45.27	95076	41.45	41.44	-0.01
45.24	95076	41.44	41.43	-0.01
45.22	95076	41.42	41.42	0.00
44.45	94635	40.23	40.23	0.00
43.25	94162	38.94	38.94	0.00
42.16	94162	38.11	38.11	0.00
41.24	94162	37.31	37.31	0.00
39.77	94162	35.66	35.66	0.00
39.29	94162	33.40	33.40	0.00

Table 3-2 Brazos River 50-Year Return Event Water Surface Elevation Comparison

River Station	Q Total (cfs)	Existing W.S. Elev (FT) (1)	Proposed W.S. Elev (FT) (2)	W.S. Elev Difference (FT) (2) - (1)
57.28	102487	51.10	51.10	0.00
56.66	101800	50.77	50.77	0.00
55.32	101722	50.30	50.30	0.00
53.21	101600	48.97	48.97	0.00
52.41	101311	48.00	48.00	0.00
51.33	100920	46.84	46.84	0.00
50.61	100659	45.95	45.95	0.00
50.17	100500	45.80	45.80	0.00
48.17	99300	44.12	44.12	0.00
46.21	98193	43.44	43.44	0.00
45.57	97831	42.30	42.30	0.00
45.34	97831	41.49	41.49	0.00
45.31	97831	41.54	41.54	0.00
45.29	97831	41.56	41.56	0.00
45.27	97831	41.55	41.55	0.00
45.24	97831	41.55	41.54	-0.01
45.22	97831	41.53	41.53	0.00
44.45	97198	40.29	40.29	0.00
43.25	96520	38.94	38.94	0.00
42.16	95495	38.08	38.08	0.00
41.24	94470	37.27	37.27	0.00
39.77	93445	35.63	35.63	0.00
39.29	92421	33.50	33.50	0.00

Table 3-3 Oyster Creek 10-Year Return Event Water Surface Elevation Comparison

River Station	Q Total (cfs)	Existing W.S. Elev (FT) (1)	Proposed W.S. Elev (FT) (2)	W.S. Elev Difference (FT) (2) - (1)
69.9	1960	41.05	41.05	0.00
69.72	2050	40.93	40.93	0.00
68.56	2210	40.13	40.13	0.00
67.62	2250	39.88	39.88	0.00
66.85	2310	39.78	39.78	0.00
65.35	2520	38.48	38.48	0.00
64.6	2520	38.14	38.14	0.00
63.9	2550	38.00	38.00	0.00
63.19	2640	37.80	37.80	0.00
62.84	2670	37.72	37.72	0.00
61.87	2740	37.39	37.39	0.00
61.43	2780	37.32	37.32	0.00
60.49	2780	37.15	37.15	0.00
60.485	Bridge			0.00
60.48	2780	37.14	37.13	-0.01
60.47	2860	37.11	37.11	0.00
59.85	2880	37.02	37.02	0.00
59.52	2880	36.79	36.78	-0.01
59.5	Bridge			0.00
59.47	2880	36.75	36.75	0.00
59.17	2960	36.63	36.63	0.00
58.67	3000	36.13	36.13	0.00
56.05	3180	33.53	33.53	0.00
55.6	3240	33.14	33.14	0.00
55.3	3260	33.07	33.07	0.00
53.49	3410	32.25	32.25	0.00
53.48	3410	32.18	32.18	0.00
53.475	Bridge			0.00
53.47	3410	32.01	32.01	0.00
53.46	3410	31.98	31.98	0.00
52.75	3470	29.51	29.51	0.00

River Station	Q Total (cfs)	Existing W.S. Elev (FT) (1)	Proposed W.S. Elev (FT) (2)	W.S. Elev Difference (FT) (2) - (1)
50.3	3610	29.15	29.15	0.00
49	3630	28.13	28.13	0.00
48	3649	27.68	27.68	0.00
47	3669	27.29	27.29	0.00
46	3688	27.00	27.00	0.00

Table 3-4. Oyster Creek 50-Year Return Event Water Surface Elevation Comparison

River Station	Q Total (cfs)	Existing W.S. Elev (FT) (1)	Proposed W.S. Elev (FT) (2)	W.S. Elev Difference (FT) (2) - (1)
69.9	13900	44.13	44.13	0.00
69.72	13900	43.78	43.78	0.00
68.56	13900	42.07	42.07	0.00
67.62	14100	41.58	41.58	0.00
66.85	14100	41.44	41.44	0.00
65.35	14600	40.52	40.52	0.00
64.6	14600	40.40	40.40	0.00
63.9	14600	40.35	40.35	0.00
63.19	14800	40.18	40.18	0.00
62.84	14800	40.11	40.11	0.00
61.87	14900	39.85	39.85	0.00
61.43	15000	39.73	39.73	0.00
60.49	15000	39.44	39.44	0.00
60.485	Bridge			0.00
60.48	15000	39.43	39.43	0.00
60.47	15100	39.41	39.41	0.00
59.85	15100	39.32	39.32	0.00
59.52	15100	39.00	39.00	0.00
59.5	Bridge			0.00
59.47	15100	38.97	38.97	0.00
59.17	15300	38.84	38.84	0.00
58.67	15400	38.33	38.33	0.00
56.05	15300	36.43	36.43	0.00
55.6	15200	36.16	36.16	0.00
55.3	15200	36.10	36.10	0.00
53.49	15100	35.55	35.55	0.00
53.48	15100	35.53	35.53	0.00
53.475	Bridge			0.00
53.47	15100	35.42	35.42	0.00
53.46	15100	35.41	35.41	0.00
52.75	15100	34.59	34.59	0.00

River Station	Q Total (cfs)	Existing W.S. Elev (FT) (1)	Proposed W.S. Elev (FT) (2)	W.S. Elev Difference (FT) (2) - (1)
50.3	16100	34.39	34.39	0.00
49	16239	33.82	33.82	0.00
48	16378	33.61	33.61	0.00
47	16517	33.53	33.53	0.00
46	16656	33.50	33.50	0.00

4. Conclusions

The Brazos River model was updated to extend the model downstream to match the Oyster Creek model at approximately County Road 34. The Brazos River model was updated to include additional cross sections in the vicinity of the proposed pump station to allow for comparison with the post Project conditions.

The Oyster Creek model was updated to include a small existing wooden farm road bridge at Station 59.5 as well as a conceptual replacement bridge to handle construction traffic from the north.

The differences between the existing conditions and the post Project conditions WSELs for the 10-year and 50-year floods on both the Brazos River and Oyster Creek are essentially zero (between 0.00 and a flood reduction of 0.01 feet, which is considered negligible) through the Proposed Project area and downstream to approximately County Road 34. This negligible difference in WSELs indicates that the Proposed Project improvements successfully mitigate impacts to flood flows from the proposed reservoir expansion, not only for the regulatory 100-year base flood, but also during more frequent 10-year and 50-year floods. As floods become smaller (more frequent), there is less transbasin transfer of flow from the Brazos River to Oyster Creek, so the Proposed Project improvements should be adequate for all flow rates, tested up to a 500-year flood.

5. References

Federal Emergency Management Agency (FEMA). 2020. *Revised Preliminary Flood Insurance Study, Brazoria County, Texas and Incorporated Areas*.

U.S. Army Corps of Engineers (USACE). 2016. *HEC-RAS River Analysis System User's Manual.* Hydrologic Engineering Center. February.

APPENDIX J

Extended Hydraulics Modeling

Jacobs

Memorandum

2224 Bay Area Boulevard
Suite 200
Houston, TX 77058
United States
T +1.281.461.2300
F +1.281.461.5931
www.jacobs.com

Subject	**Extended Hydraulics Modeling Technical Memorandum**	**Project Name**	Oyster Creek
Attention	The Dow Chemical Company	**Project Number**	WHXK8600
From	Jacobs		
Date	July 21, 2022		
Copies to	File		

This document is released for the purpose of interim review under the authority of Scott Yanagihara, Texas P.E. No. 137477, on July 21, 2022.

It may not be used for bidding or construction purposes.

Texas Registered Engineering Firm F-2966.

1. Introduction

This technical memorandum (TM) presents the results of the hydraulic evaluation of the potential impacts to Oyster Creek resulting from The Dow Chemical Company (Dow) Harris Reservoir Expansion Project (project). Specifically, this TM discussed the changes to the hydraulic model requested by the U. S. Army Corps of Engineers that the hydraulic model of Oyster Creek be extended further south to County Road 30.

This hydraulic model builds upon the previous model by adding four cross sections numbered 46 through 49, starting with cross section 46 being at approximately County Road 30. The cross sections upstream of cross section 49 are the same as in the previously submitted model. The additional cross sections add approximately 3.8 miles of stream length.

2. Model Inputs

HEC-RAS 5.0.7 was used for the hydraulic model. The model was run in a one-dimensional, steady state condition, using several inputs. The main inputs are listed below and discussed in the following sections.

- Flowrates
- Boundary Conditions
- Cross Section Data
- Project Improvements

2.1 Flow Rates

The flowrates used in the model originate from the FEMA effective hydrology published in the December 2020 Flood Insurance Study (FIS) for Brazoria County Texas. The FIS discussed the split flow between the Brazos River and Oyster Creek and how it was accounted for in the development of the regulatory flowrates.

2.2 Boundary Conditions

The main boundary condition used in the model was the starting water surface elevation. The elevations were derived from the FIS and approximate the water surface elevations at given flowrates based on the flood profiles in the FIS for Oyster Creek at the approximate location of cross section 46.

2.3 Cross Section Data

The electronic digital elevation model developed for the project was used create the cross section station and elevation data for the new cross sections, cross sections 46 through 49. Ground surface data available from aerial imagery and GIS land use data was used to approximate the manning's n values representing the hydraulic roughness of the ground. GIS was used to measure the left and right overbank and channel lengths. Inspection of the cross section in concert with locations information relative to aerial imagery was used to define the left and right bank stations. Figure 1 shows the location of the new cross sections.

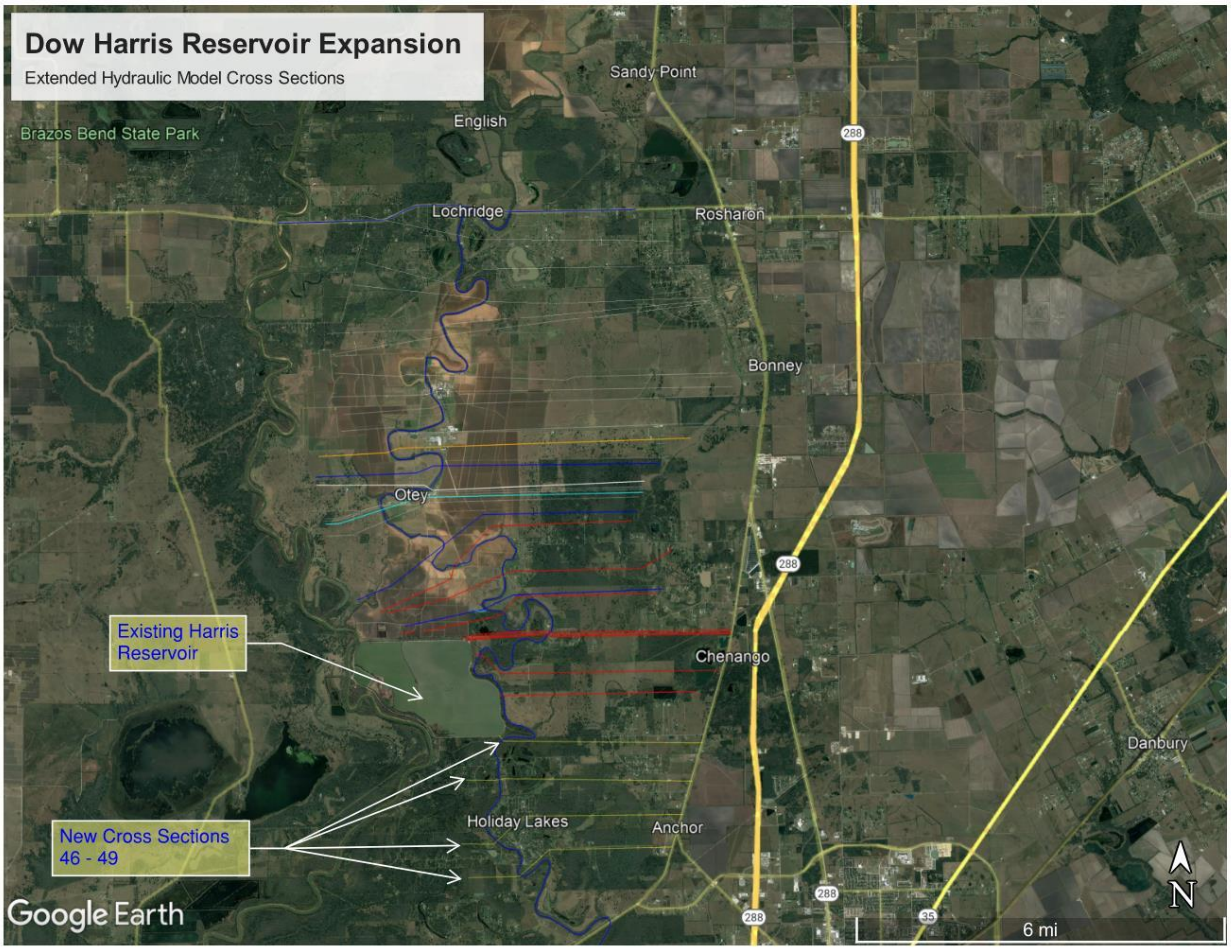


Figure 1. New HEC-RAS Cross Section Locations

2.4 Project Improvement

The project improvements were part of the original hydraulic model and were not modified for this model that extended the downstream limits. The project improvements came from the proposed design surfaces and layouts. An examination of the cross sections shows the new channel improvements, especially the new over flow channel adjacent to the reservoir expansion, and the reservoir expansion embankment itself.

3. Results

The model results show that the proposed conditions 100-year water surface elevations are generally within 0.01 feet of the existing water surface elevations. The 500-year water surface elevations show water surface elevation increases of up to 0.28 feet at cross section 59.17, which passes through the reservoir expansion. This result is not unexpected. The 500-year water surface elevations are approximately 1.5 feet higher than the 100-year water surface elevations, and therefore the reservoir expansion embankment has a greater effect on the 500-year flows. Table 3-1 and Table 3-2 summarize the comparison of the water surface elevations for the 100-year and 500-year return events respectively.

Table 3-1. 100-Year Return Event Water Surface Elevation Comparison

River Station	Q Total (cfs)	Existing W.S. Elev (FT) (1)	Proposed W.S. Elev (FT) (2)	WSE Difference (FT) (2)-(1)
69.9	19600	44.7	44.7	0
69.72	20400	44.39	44.39	0
68.56	22000	42.7	42.7	0
67.62	21800	42.11	42.11	0
66.85	21700	41.95	41.95	0
65.35	21200	41.15	41.15	0
64.6	21200	41.06	41.06	0
63.9	21300	41.02	41.02	0
63.19	21500	40.85	40.85	0
62.84	21600	40.78	40.78	0
61.87	21800	40.54	40.54	0
61.43	21900	40.41	40.41	0
60.49	21900	40.07	40.07	0
60.48	21900	40.06	40.06	0
60.47	22100	40.05	40.04	-0.01
59.85	22200	39.96	39.96	0
59.17	22500	39.45	39.44	-0.01
58.67	22700	38.95	38.94	-0.01
56.05	22700	37.21	37.2	-0.01
55.6	22800	36.92	36.93	0.01
55.3	22800	36.86	36.86	0
53.49	22800	36.22	36.23	0.01
53.48	22800	36.2	36.2	0
53.47	22800	36.13	36.13	0
53.46	22800	36.11	36.12	0.01

River Station	Q Total (cfs)	Existing W.S. Elev (FT) (1)	Proposed W.S. Elev (FT) (2)	WSE Difference (FT) (2)-(1)
52.75	22800	35.27	35.29	0.02
50.3	23300	35.05	35.04	-0.01
49	23400	34.42	34.42	0
48	21300	34.14	34.14	0
47	19600	34.05	34.05	0
46	19600	34.02	34.02	0

Table 3-2. 500-Year Return Event Water Surface Elevation Comparison

River Station	Q Total (cfs)	Existing W.S. Elev (FT) (1)	Proposed W.S. Elev (FT) (2)	WSE Difference (FT) (2)-(1)
69.9	38700	45.54	45.55	0.01
69.72	39900	45.25	45.25	0
68.56	42100	43.71	43.74	0.03
67.62	40000	43.02	43.08	0.06
66.85	39200	42.86	42.93	0.07
65.35	32800	42.22	42.37	0.15
64.6	32800	42.16	42.32	0.16
63.9	33000	42.13	42.29	0.16
63.19	33800	41.99	42.17	0.18
62.84	34000	41.94	42.13	0.19
61.87	34700	41.76	41.97	0.21
61.43	35000	41.65	41.88	0.23
60.49	35000	41.37	41.64	0.27
60.48	35000	41.36	41.63	0.27
60.47	35600	41.35	41.62	0.27
59.85	35800	41.3	41.57	0.27
59.17	37300	40.99	41.27	0.28
58.67	38100	40.75	41.01	0.26
56.05	53200	40.1	40.21	0.11
55.6	58400	39.94	40	0.06
55.3	60600	39.89	39.94	0.05
53.49	73100	39.35	39.37	0.02
53.48	73100	39.33	39.35	0.02

River Station	Q Total (cfs)	Existing W.S. Elev (FT) (1)	Proposed W.S. Elev (FT) (2)	WSE Difference (FT) (2)-(1)
53.47	73100	39.32	39.33	0.01
53.46	73100	39.31	39.32	0.01
52.75	78600	38.77	38.8	0.03
50.3	42200	38.66	38.67	0.01
49	38900	38.51	38.51	0
48	41500	38.44	38.44	0
47	43700	38.41	38.41	0
46	43700	38.4	38.4	0

4. Conclusions

The extension of the hydraulic model downstream of cross section 50.3 to cross section 46 shows that from cross sections 46 through 49 there will be no increase to the 100-year and 500-year water surface elevations.

APPENDIX K

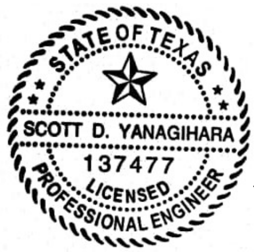
Oyster Creek Haul Road Bridge Hydraulic Modeling

Jacobs

Memorandum

2224 Bay Area Boulevard
Suite 200
Houston, TX 77058
United States
T +1.281.461.2300
F +1.281.461.5931
www.jacobs.com

Subject	**Oyster Creek Haul Road Bridge: Hydraulic Modeling**	**Project Name**	**Harris Reservoir Expansion**
Attention	The Dow Chemical Company	**Project Number**	WHXK8600
From	Jacobs		
Date	September 29, 2022		
Copies to	File		



This document is released for the purpose of interim review under the authority of Scott Yanagihara, Texas P.E. No. 137477, on September 29, 2022.

It may not be used for bidding or construction purposes.

Texas Registered Engineering Firm F-2966.

1. Introduction

This technical memorandum (TM) presents the results of a hydraulic evaluation of the potential impacts to Oyster Creek resulting from The Dow Chemical Company (Dow) Harris Reservoir Expansion Project (Proposed Project). Specifically, this TM presents the evaluation of a proposed northern access haul road and bridge over Oyster Creek that will provide construction access to the project site from the north. The proposed haul road will improve an existing dirt farm road that runs approximately perpendicular to and south of Farm to Market (FM) 655, approximately 0.2 miles southeast of the Stringfellow Prison Unit on FM 655. The northern access will cross Oyster Creek and requires replacing an existing wooden bridge with a steel girder replacement bridge to accommodate the anticipated heavy equipment construction traffic. Figures 1 and Figure 2 are vicinity maps showing the existing road and the existing bridge.

The existing wooden bridge was surveyed in August 2022 and the survey data was used to add the bridge to the existing conditions HEC-RAS model of Oyster Creek.

Typically, the 1% recurrence chance event (commonly called the 100-year flood) would be used to evaluate potential water surface elevation (WSEL) impacts of the bridge replacement. However, to address comments received by the U. S. Army Corps of Engineers on the Draft Environmental Impact Statement (DEIS), Jacobs Engineering Group Inc. evaluated more frequent 10% and 2% annual recurrence chance events (i.e., 10-year and 50-year floods) to demonstrate that project-mitigating improvements to Oyster Creek prevent flood rise in both Oyster Creek and the Brazos River. This analysis will therefore use all three flood events (10-year, 50-year, and 100-year floods) to evaluate potential impacts to flood WSELs due to replacement of the existing wood bridge with a conceptual haul road bridge.

The design team is providing performance specifications to guide the selection of a replacement bridge. The intent of this analysis is to be conservative so as to allow selection of the replacement bridge using a premanufactured-type steel bridge that does not impact WSEL in Oyster Creek.

A previous TM, dated July 21, 2022, presented results for Oyster Creek during the 100-year and 500-year after extending the HEC-RAS model downstream by adding four cross sections numbered 49 through 46, with Cross Section 49 located at the downstream (southern) edge of the existing Harris Reservoir and Cross Section 46 located at approximately County Road 30 (Jacobs 2022). The cross sections upstream of cross section 49 were left the same as in the previously submitted model used in the DEIS. The additional cross sections add approximately 3.8 miles of downstream length.

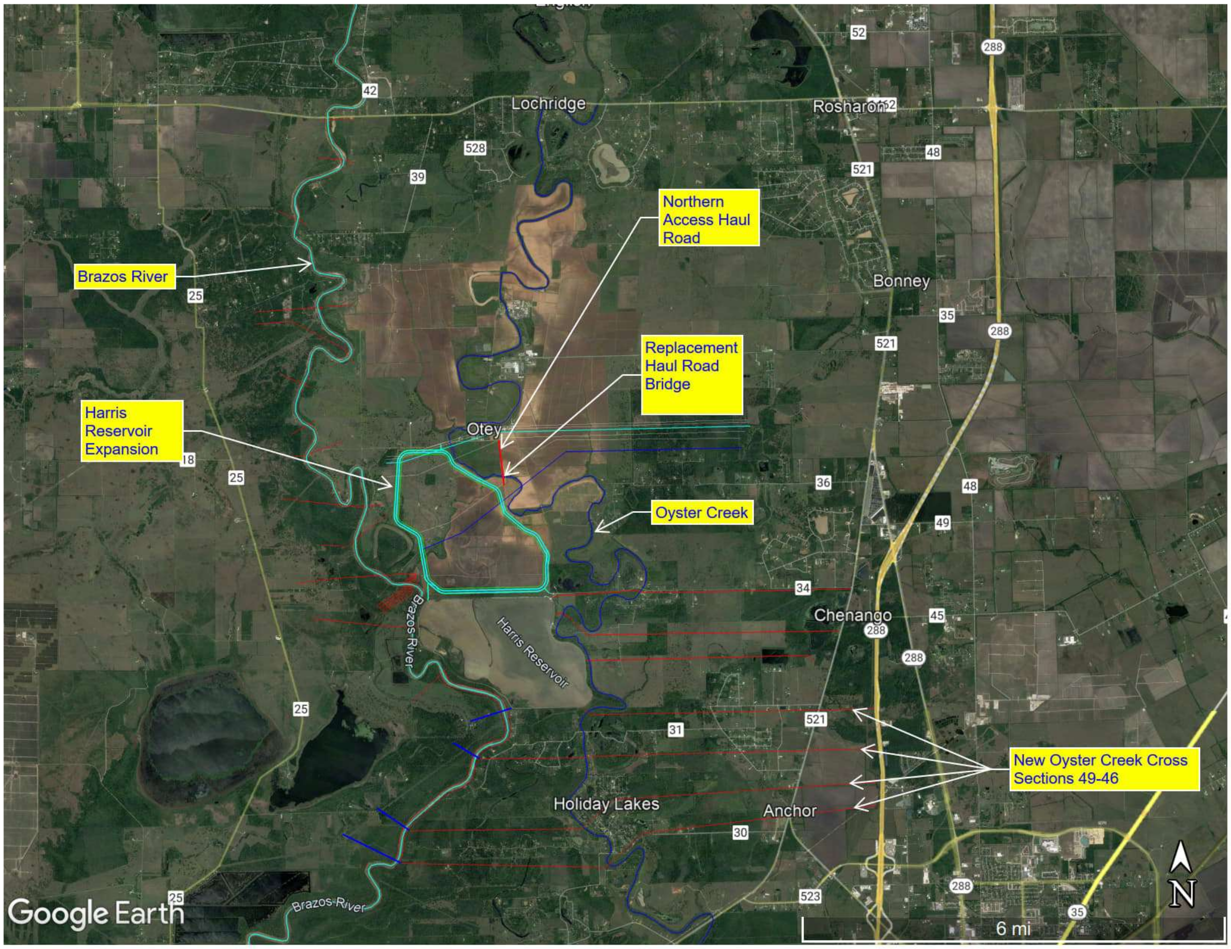


Figure 1. Vicinity Map of New Haul Road Bridge Location

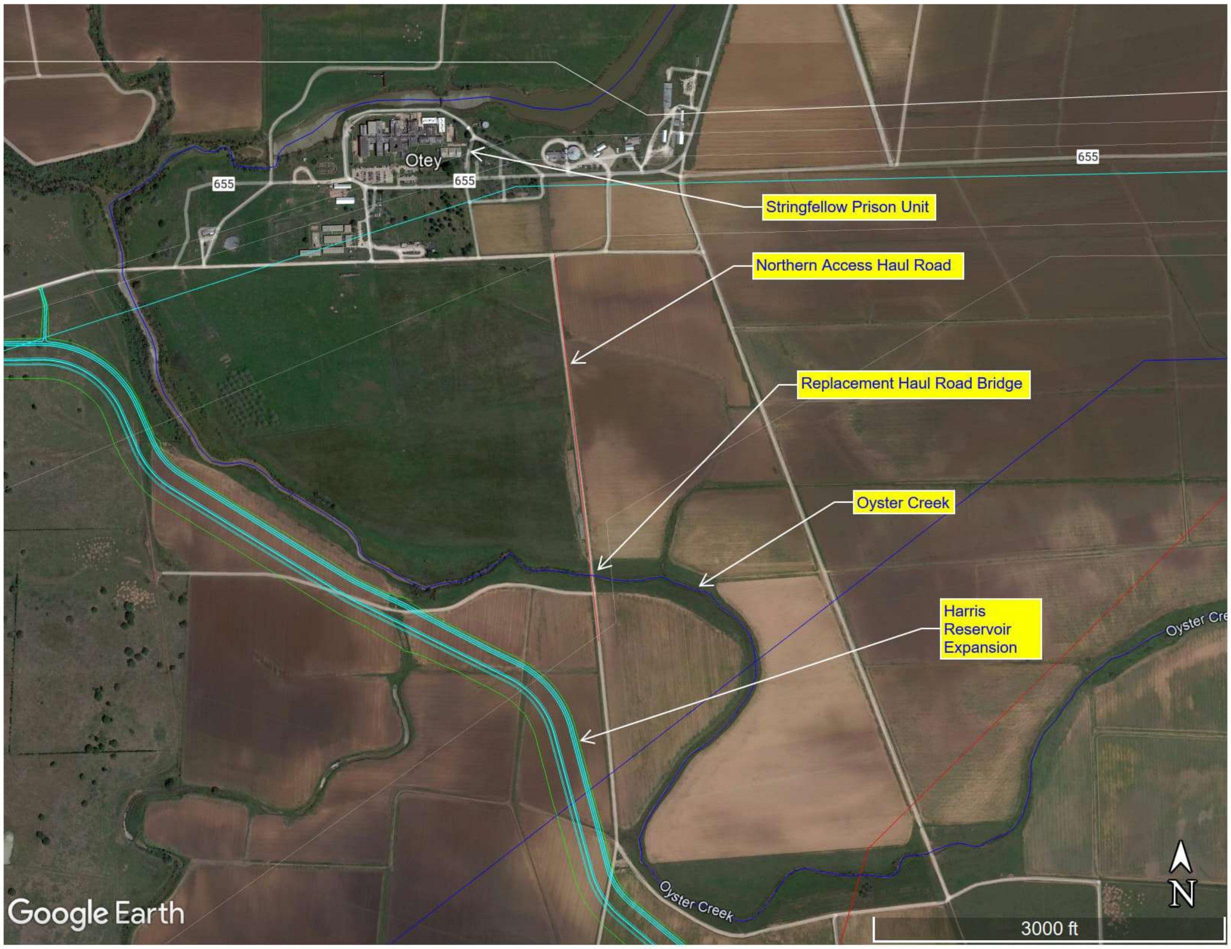


Figure 2. New Haul road Bridge Location

2. Model Inputs

HEC-RAS 5.0.7 was used for the hydraulic model. The model was run in a one-dimensional, steady state condition, using these inputs, which are discussed in the following sections.

- Flowrates
- Cross Section Data
- Boundary Conditions
- Proposed Project Floodplain Enhancement

2.1 Flow Rates

The flowrates used in the HEC-RAS Oyster Creek model originate from the FEMA effective hydrology published in the December 2020 Flood Insurance Study (FIS) for Brazoria County Texas. The FIS discussed the split flow between the Brazos River and Oyster Creek and how it was accounted for in the development of the regulatory flowrates. The FIS discusses that FLOW SIM 10, a two-dimensional modeling program, was used to determine the discharge split between the Brazos River and Oyster Creek for many of the analyses and was calibrated to a known flood in the watershed (FEMA, pg. 15). The model development methodology recognizes the interaction between the Brazos River and Oyster Creek and allowed separate hydraulic models for Oyster Creek and the Brazos River to be developed, linked by a common hydrologic foundation. This analysis seeks to compare the water surface elevations using these published flowrates for Oyster Creek.

2.2 Cross Section Data

The electronic digital elevation model developed for the Proposed Project was used to create the cross-section station and elevation data for the new cross sections added to model the existing bridge and the proposed haul road bridge. The existing bridge is located at river station 59.5. Cross-sections were added upstream and downstream of the bridge at cross-sections 59.47 and 59.52 to allow modeling the bridge. Ground surface data available from aerial imagery and GIS land use data were used to assign the manning's n values representing the hydraulic roughness of the ground. GIS was used to measure channel lengths between the new cross sections. Inspection of the cross sections in concert with location information from aerial imagery was used to locate the left and right bank stations.

The existing bridge is a single-lane, 5-span bridge without side rails constructed of wood with timber piles and timber abutments. The existing bridge, piers, and abutments were added to the existing conditions model.

The proposed bridge is envisioned to replace the existing bridge at the same location. Figure 3 depicts the proposed bridge plan, elevation, and typical section. The low chord of the proposed bridge was kept at the same elevation as the existing low cord, while the proposed high cord will reflect the addition of safety rails. The configuration of the rails could include a "W" style guard rail, which has significant open space below the top of the rail. However, the proposed bridge was conservatively modeled by equating the top of rail with the top of the bridge deck, representing the rail as solid.

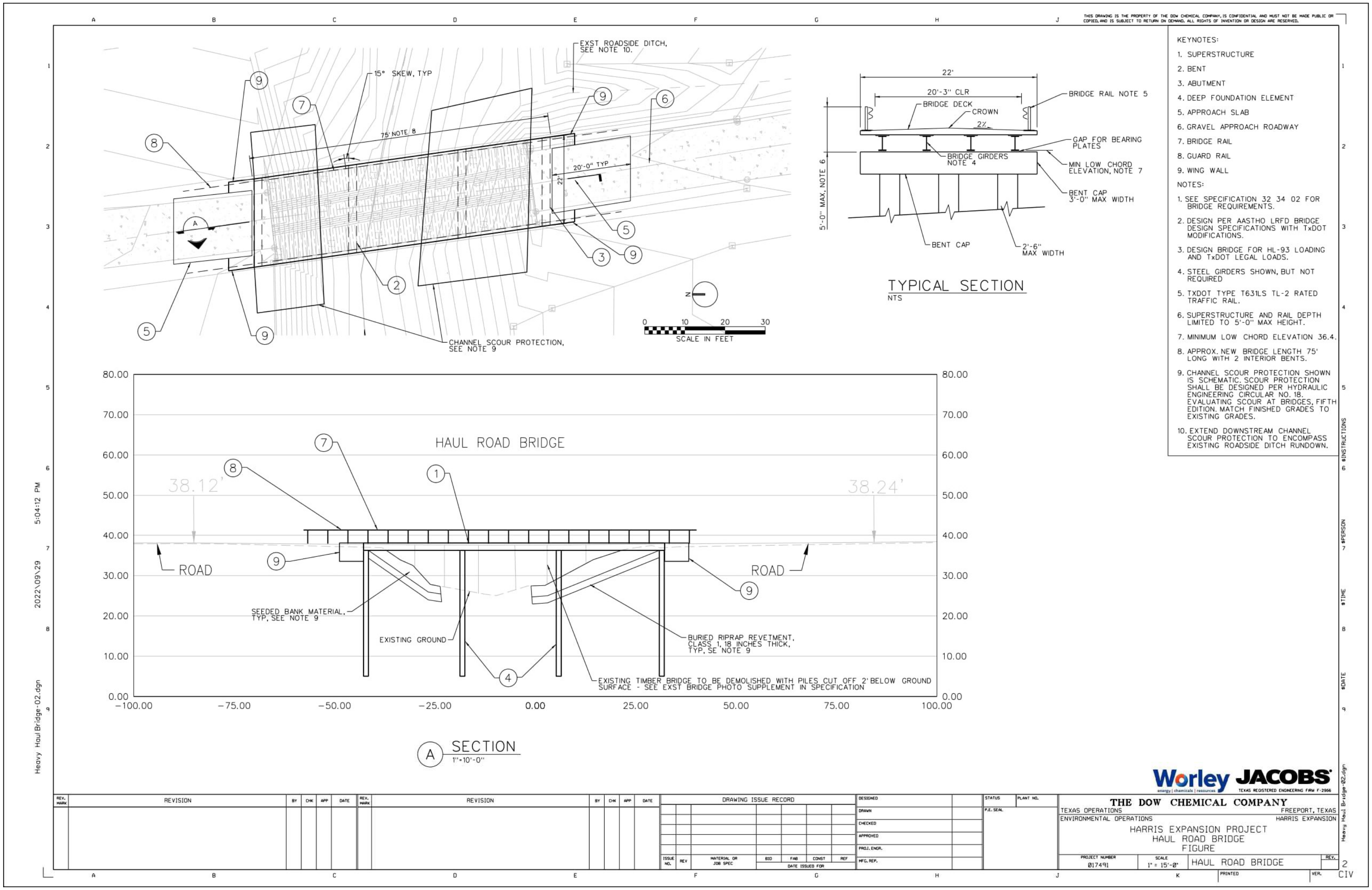


Figure 3. Existing Bridge and Proposed Haul Road Bridge

The proposed bridge is a three-span bridge that allows the construction of the two piers to be spaced to avoid the existing piers. It was assumed that the existing piers will be cut off as low as possible and the buried portion will remain, so avoiding the existing pier locations is required. The proposed overall bridge span length was chosen to allow sloping abutments to be further outside of the existing timber pile supported timber wall abutments. The sloping abutments are modeled to match the existing side slopes of Oyster Creek which are approximately 2 feet horizontal to 1 foot vertical (2:1 slope). Other components of the replacement bridge, such as the approach slabs, are not captured by the hydraulic model because they have no impact on the hydraulic performance of the bridge.

2.3 Boundary Conditions

The main boundary condition used in the model was the starting WSEL. The elevations were derived from the FIS and approximate the water surface elevations at the given flowrates based on the flood profiles in the FIS for Oyster Creek at the approximate location of cross section 46, and in the Brazos River at the approximate location of cross section 39.29.

2.4 Proposed Project Floodplain Enhancement

The existing-conditions Oyster Creek model now includes the existing wooden farm bridge, and the proposed-conditions Oyster Creek model now includes the conceptual replacement haul road bridge that will replace the existing wooden farm bridge. The other Proposed Project improvements on Oyster Creek were part of the original hydraulic model work evaluated in the DEIS and were not modified for this model. Those modeled Proposed Project improvements represent proposed design surfaces and layouts. The cross sections for proposed-conditions Oyster Creek model show the new channel improvements, especially the new overflow channel adjacent to the reservoir embankment, and the reservoir embankment itself.

It should be noted that Oyster Creek physically extends further upstream and downstream than the presented cross sections. The boundary cross sections in the model represent locations far enough upstream and downstream to clearly demonstrate that the water surface elevations are no longer influenced by the project improvements.

3. Results

Tables 3-1 to 3-3 present the results for Oyster Creek for the 10-year, 50-year, and 100-year return events.

The model results show that the proposed conditions 10-, 50-, and 100-year WSELs are generally within 0.01 feet[1] of the existing conditions WSELs. The tables summarize the project-induced rise in WSEs for the 10-, 50-, and 100-year return floods respectively.

The results indicate that the with-project WSELs do not produce an incremental rise above existing conditions during any of the floods.

[1] A difference of 0.01 feet is generally considered "noise" in the model. That is, the model and its algorithms cannot be considered reliable down to the that small of a WSEL increment, therefore the model error likely exceeds 0.01 feet. A change of 0.01 feet can generally be considered negligible. In this case, the changes are flood reduction, so changes of -0.01 feet are also considered negligible.

Table 3-1 Oyster Creek 10-Year Return Event Water Surface Elevation Comparison

River Station	Q Total (cfs)	Existing W.S. Elev (FT) (1)	Proposed W.S. Elev (FT) (2)	WSE Difference (FT) (2) - (1)
69.9	1960	41.05	41.05	0.00
69.72	2050	40.93	40.93	0.00
68.56	2210	40.13	40.13	0.00
67.62	2250	39.88	39.88	0.00
66.85	2310	39.78	39.78	0.00
65.35	2520	38.48	38.48	0.00
64.6	2520	38.14	38.14	0.00
63.9	2550	38.00	38.00	0.00
63.19	2640	37.80	37.80	0.00
62.84	2670	37.72	37.72	0.00
61.87	2740	37.39	37.39	0.00
61.43	2780	37.32	37.32	0.00
60.49	2780	37.15	37.15	0.00
60.485	Bridge			0.00
60.48	2780	37.14	37.13	-0.01
60.47	2860	37.11	37.11	0.00
59.85	2880	37.02	37.02	0.00
59.52	2880	36.79	36.78	-0.01
59.5	Bridge			0.00
59.47	2880	36.75	36.75	0.00
59.17	2960	36.63	36.63	0.00
58.67	3000	36.13	36.13	0.00
56.05	3180	33.53	33.53	0.00
55.6	3240	33.14	33.14	0.00
55.3	3260	33.07	33.07	0.00
53.49	3410	32.25	32.25	0.00
53.48	3410	32.18	32.18	0.00
53.475	Bridge			0.00
53.47	3410	32.01	32.01	0.00

River Station	Q Total (cfs)	Existing W.S. Elev (FT) (1)	Proposed W.S. Elev (FT) (2)	WSE Difference (FT) (2) - (1)
53.46	3410	31.98	31.98	0.00
52.75	3470	29.51	29.51	0.00
50.3	3610	29.15	29.15	0.00
49	3630	28.13	28.13	0.00
48	3649	27.68	27.68	0.00
47	3669	27.29	27.29	0.00
46	3688	27.00	27.00	0.00

Table 3-2. Oyster Creek 50-Year Return Event Water Surface Elevation Comparison

River Station	Q Total (cfs)	Existing W.S. Elev (FT) (1)	Proposed W.S. Elev (FT) (2)	WSE Difference (FT) (2) - (1)
69.9	13900	44.13	44.13	0.00
69.72	13900	43.78	43.78	0.00
68.56	13900	42.07	42.07	0.00
67.62	14100	41.58	41.58	0.00
66.85	14100	41.44	41.44	0.00
65.35	14600	40.52	40.52	0.00
64.6	14600	40.40	40.40	0.00
63.9	14600	40.35	40.35	0.00
63.19	14800	40.18	40.18	0.00
62.84	14800	40.11	40.11	0.00
61.87	14900	39.85	39.85	0.00
61.43	15000	39.73	39.73	0.00
60.49	15000	39.44	39.44	0.00
60.485	Bridge			0.00
60.48	15000	39.43	39.43	0.00
60.47	15100	39.41	39.41	0.00
59.85	15100	39.32	39.32	0.00
59.52	15100	39.00	39.00	0.00
59.5	Bridge			0.00
59.47	15100	38.97	38.97	0.00
59.17	15300	38.84	38.84	0.00
58.67	15400	38.33	38.33	0.00
56.05	15300	36.43	36.43	0.00
55.6	15200	36.16	36.16	0.00
55.3	15200	36.10	36.10	0.00
53.49	15100	35.55	35.55	0.00
53.48	15100	35.53	35.53	0.00
53.475	Bridge			0.00
53.47	15100	35.42	35.42	0.00
53.46	15100	35.41	35.41	0.00

River Station	Q Total (cfs)	Existing W.S. Elev (FT) (1)	Proposed W.S. Elev (FT) (2)	WSE Difference (FT) (2) - (1)
52.75	15100	34.59	34.59	0.00
50.3	16100	34.39	34.39	0.00
49	16239	33.82	33.82	0.00
48	16378	33.61	33.61	0.00
47	16517	33.53	33.53	0.00
46	16656	33.50	33.50	0.00

Table 3-3. Oyster Creek 100-Year Return Event Water Surface Elevation Comparison

River Station	Q Total (cfs)	Existing W.S. Elev (FT) (1)	Proposed W.S. Elev (FT) (2)	WSE Difference (FT) (2) - (1)
69.9	19600	44.70	44.70	0.00
69.72	20400	44.39	44.39	0.00
68.56	22000	42.7	42.7	0.00
67.62	21800	42.10	42.10	0.00
66.85	21700	41.95	41.95	0.00
65.35	21200	41.15	41.15	0.00
64.6	21200	41.06	41.06	0.00
63.9	21300	41.01	41.01	0.00
63.19	21500	40.84	40.84	0.00
62.84	21600	40.77	40.77	0.00
61.87	21800	40.53	40.53	0.00
61.43	21900	40.40	40.40	0.00
60.49	21900	40.06	40.06	0.00
60.485	Bridge			0.00
60.48	21900	40.05	40.05	0.00
60.47	22100	40.03	40.03	0.00
59.85	22200	39.94	39.94	0.00
59.52	22200	39.61	39.61	0.00
59.5	Bridge			0.00
59.47	22200	39.58	39.58	0.00
59.17	22500	39.45	39.45	0.00
58.67	22700	38.95	38.95	0.00
56.05	22700	37.27	37.27	0.00
55.6	22800	37.00	37.00	0.00
55.3	22800	36.94	36.94	0.00
53.49	22800	36.36	36.36	0.00
53.48	22800	36.34	36.34	0.00
53.475	Bridge			0.00
53.47	22800	36.29	36.29	0.00
53.46	22800	36.28	36.28	0.00

River Station	Q Total (cfs)	Existing W.S. Elev (FT) (1)	Proposed W.S. Elev (FT) (2)	WSE Difference (FT) (2) - (1)
52.75	22800	35.67	35.67	0.00
50.3	23300	35.53	35.53	0.00
49	23400	35.14	35.14	0.00
48	21300	34.97	34.97	0.00
47	19600	34.92	34.92	0.00
46	19600	34.90	34.90	0.00

4. Conclusions

The Oyster Creek model was updated to include a small existing wooden farm road bridge at Station 59.5 as well as a conceptual replacement haul road bridge to handle construction traffic from the north.

The differences between the existing conditions and the post project conditions WSELs for the 10-, 50-, and 100-year floods on Oyster Creek are essentially zero (between 0.00 and a flood reduction of 0.01 feet, which is considered negligible) with differences between 0.00 and -0.01 ft occurring in the vicinity of the two upstream bridges that were already in the existing model. This negligible difference in WSELs indicates that the project improvements successfully mitigate impacts to flood flows from the proposed reservoir expansion, and that the conceptual haul road bridge will have no adverse impacts to flood WSELs. This is an expected result, as the 75 ft span replacement haul road bridge is not expected to constrict the Oyster Creek channel more than the 66 ft span existing wooden bridge. In comparison, the 75-foot span replacement bridge is part of a flood cross section that is over 5 miles wide.

5. References

Federal Emergency Management Agency (FEMA). 2020. *Revised Preliminary Flood Insurance Study, Brazoria County, Texas and Incorporated Areas*.

Jacobs Engineering Group Inc. 2022. *Extended Hydraulics Modeling Technical Memorandum, Oyster Creek.*

U.S. Army Corps of Engineers (USACE). 2016. *HEC-RAS River Analysis System User's Manual.* Hydrologic Engineering Center. February.

APPENDIX N

Draft Environmental Impact Statement Comments and Responses

INTRODUCTION

During public scoping, 11 comment letters and two verbal comments were submitted with a total of 140 comments and 10 duplicative comments. Comments were grouped into six main issues (Issue IDs 1–6), and each issue was broken into subcategories. The comments are summarized below by issue and subcategory, followed by the U.S. Army Corps of Engineers' (Corps') responses. The comment number, associated text of the comments, and how they were grouped are depicted in landscape table that follows.

ISSUE 1: NATIONAL ENVIRONMENTAL POLICY ACT, DRAFT ENVIRONMENTAL IMPACT STATEMENT

Public Involvement, Public Interest

Comments 1 and 85. The Corps is to conduct a Public Interest Review (PIR) pursuant to 33 CFR 320.4. The factors to be considered as part of the public interest review explicitly include "flood hazards" and "floodplain values." One commentor suggested that the Corps did not conduct a PIR and states that "the Corps must determine that the Project is in the 'public interest' by weighing all 'relevant' considerations and balancing all probable impacts of the proposed action against its alleged benefits" (33 CFR 320.4(a)(1)).

> Response: 33 CFR 320.4(a)(1) public interest review states "[t]he decision whether to issue a permit will be based on an evaluation of the probable impacts, including cumulative impacts, of the proposed activity and its intended use on the public interest. Evaluation of the probable impact which the proposed activity may have on the public interest requires a careful weighing of all those factors which become relevant in each particular case. The benefits which reasonably may be expected to accrue from the proposal must be balanced against its reasonably foreseeable detriments. The decision whether to authorize a proposal, and if so, the conditions under which it will be allowed to occur, are therefore determined by the outcome of this general balancing process." To aid the reader in conducting their public interest review, the Corps has used common PIR factors such as Flood Hazards and Flood Hazard Values (Section 3.3.2 and Section 4.3.2) and Environmental Justice (Section 3.10.6 and Section 4.10.4) as section headers. This approach can be found throughout Chapter 3 and Chapter 4.

Comment 2. Commentor indicated that the public website was not readily accessible as of May 3, 2022.

> Response: The website issues did not prohibit the commenters from submitting comments or speaking in the virtual public meeting. Also, the commenter was sent the NOA and Affected Party letter, which listed the Corps' website and provided access to the DEIS and all attachments: https://www.swg.usace.army.mil/Missions/Regulatory/Special-Projects-Environmental-Impact-Statements.aspx.

Comment 3. Commentor indicated that they had inadequate time to review the DEIS and all appendices and that they had requested a review of any materials that were prepared or underway during scoping in 2020. The Project was incorrectly identified on the Corps' main public notice page as the Harris County Reservoir Expansion.

> Response: Commentors who requested extensions of time were provided until June 10, 2022, to submit comments. The word *County* was an error that only showed up on the

Corps' website for a few days. The materials requested during scoping are not used to substantiate any analysis fundamental to the impact statement and will not be used in the Corps' decision.

Purpose and Need, Alternatives

Comments 4, 5, 6, 7, 8, 9, 15, 17, 22, and 138. Commentors state that the Purpose and Need is narrowly focused because it only considers use of Dow's existing water rights. This prevents looking at acquiring water from other sources and limiting the range of alternatives. Commentors provided a list of several potential additional alternatives, including use of conservation practices. Commentors also indicate that Oyster Creek modifications equate to increased delivery capacity.

> Response: The Corps developed the overall purpose of the Proposed Action in coordination with the cooperating agencies in February 2020 and developed the alternatives based on the Corps' overall purpose statement in coordination with the cooperating agencies in July 2020. Water conservation measures and operational changes are a need-reducing activity, not a practicable alternative. Sections 1.3.3 and 3.3.3.2.1 of the DEIS discuss conservation measures, however, water conservation does not provide the additional storage capacity required to sustain operations during extended drought per TCEQ's standard of 180 days. The applicant's stated need is not trying to meet a future projected need; it is proposing a project that will meet the current need under future climatic conditions (i.e., drought). The excavation of the existing reservoirs beyond engineered design is not a practicable alternative. The construction of a dam (salt-water barrier) on a navigable water is not a practicable alternative. Equating the purchasing of property, which is amply available, to the availability of water rights, which are not amply available, does not comport with the definition of practicable in the 404(b)(1) guidelines. The proposed modifications to Oyster Creek are to address impacts to the floodplain and aquatic resources documented in the EIS.

Comments 8 and 10. Allens Creek Reservoir should be an alternative for this permit proposal due to recent developments from the Brazos River Authority in the article "*Brazos River Authority Purchases Full Rights to the Proposed Allens Creek Reservoir Project From the City of Houston*."

> Response: The city's sale of their rights in the proposed Allens Creek Reservoir does not change the availability of water rights for Dow or now make the alternative reasonable.

Comments 8, 11, 14, 15, and 22. The Corps design for Alternative 3 (West Bank alternative) requires that CR 25 be moved and constructed at a new location and that a bridge be built for a large water pipeline. The alternative should be modified.

> Response: The alternatives were developed by scientists and engineers at Dow, and reviewed by the Corps, to ensure that they represent functional alternatives that are appropriate for the site where they are proposed to be located.

Comments 12 and 22. The Corps must consider drought contingency planning as a reasonable alternative.

> Response: The O&M plan includes a procedure (or drought contingency plan) for monitoring the progression of a drought and preparing a response. The remaining alternatives proposed by the commenter have previously been determined not to be practicable.

Comments 13, 15, and 22. The Corps must consider as a reasonable alternative, or as an adjunct to alternatives, the digging out of Brazoria and Harris Reservoirs to deepen their water-holding capacities.

Response: Due to dam safety requirements, you cannot dig the reservoirs beyond their engineering design.

Comment 16. The must conduct detailed modeling studies that will help to estimate the effects of the proposed Project on movement and storage of Brazos River floodwaters in the floodplain and propose mitigation to reduce these risks.

Response: In response to these comments, Dow has conducted additional hydraulic modeling of the Brazos River floodwaters. The report is titled “Support for EIS: Brazos River and Oyster Creek Additional Hydraulics Modeling” (Jacobs 2022a, Appendix I) and concludes that the Project improvements would successfully mitigate impacts to flood flows from the proposed reservoir expansion, not only for the regulatory 100-year base flood, but also during more frequent 10-year and 50-year floods. As floods become smaller (more frequent), there is less interbasin transfer of flow from the Brazos River to Oyster Creek, so the Proposed Project improvements should be adequate for all flow rates, tested up to a 500-year flood.

Proposed Action

Comments 18 and 19. Commentors indicate that dredging of the existing and proposed reservoirs was not described and impacts were not analyzed.

Response: Section 2.3.6 indicates that evaluating changes in storage capacity and sediment dredging are part of regular maintenance. Appendix G of the DEIS states that contour surveys are to be conducted every 10 years (see Table 2 of Dow’s O&M plan). The statement in Section 3.3.3.2 that the existing reservoirs have lost half of their storage capacity is incorrect. In several locations in the DEIS (see Executive Summary; Section 1.2.1, Purpose and Need; and Appendix B, *Brazos River Hydrology and Hydraulics Final Report*), the discussion correctly cites the 2020 survey indicating that the current combined storage capacity in the existing Brazoria and Harris Reservoirs is approximately 27,343 AF (Doyle & Wachtstetter, Inc. 2020a, 2020b). This equates to a 15% capacity reduction in both reservoirs. Section 3.3.3.2 has been edited to reflect the correct capacity reduction.

Comment 20. Commentor stated that the Corps needs to indicate efficacy of standard BMPs and show how it will enforce BMPs during construction and postconstruction monitoring.

Response: The Corps will enforce monitoring and adaptive management efforts undertaken as part of the compensatory mitigation plan. Standard BMPs implemented as part of construction will be part of Brazoria County–approved engineering plans and specifications. TCEQ is responsible for enforcing construction BMPs as part of their General Construction Permit Program.

Comment 21. One commentor requested that additional vegetation, visual, light pollution, and air quality BMPs be added, including use of electric vehicles.

Response: No additional BMPs are needed for these resources beyond those provided in the EIS. The vegetation at the site is an active agricultural operation, and a requirement to use electric vehicles is not reasonable. Lighting and visual requirements are limited to those listed in Section 2.8.7.2 of the DEIS.

Cumulative Impacts

Comment 23. The commenter raised the issue of sea level rise as a significant consideration when evaluating the longer-term and cumulative impacts from the proposed Project.

> Response: Appendix B, *Brazos River Hydrology and Hydraulics Report*, evaluates sea level rise. In Section 6.5, Relative Sea Level Rise Analysis, and Section 6.65, Salinity Analysis, it was determined that an increase in the sea level water surface has the same effect as the saltwater wedge moving upstream during a drought. As the sea level rises, the river flow will have to be greater than the current 1,750 cfs now required to allow Dow to pump the freshwater from the river into Brazoria Reservoir at the maximum pump capacity. The sea level rise also requires a greater river flow than currently required at the existing Harris Reservoir and the proposed Harris Reservoir. This could greatly limit the availability of Dow to get freshwater with its water rights. Dow's existing Harris Reservoir intake pumps (River Mile 46) can be impacted by the salt wedge, which can extend up to River Mile 49. Dow found it can operate the existing Harris Reservoir intake pumps at full capacity (approximately 290 cfs) as long as there is 400 cfs river flow at the Rosharon gage. Sea level rise is not expected to inundate the proposed reservoir.

Comment 24. One commentor suggested the cumulative analysis consider projects in Brazoria and Harris Counties.

> Response: The Corps is careful to consider that scale is the critical factor when studying patterns and the processes that cause them. Larger geographic regions, such as the one proposed that includes the fourth largest city in the continental United States, influences the outcomes of environmental reviews. The effect of the impacts from the proposed Project, when evaluated cumulatively in the context of the greater Houston metropolitan (regional) area, will not have the same significance as the context of our review area (local).

Comment 25. Other Dow permits should be included in the cumulative analysis, including Permit Application Nos. SWG-1999-02548 and SWG-1999-02549.

> Response: The cited permits are Dow's existing outfall permits for controlled sediment discharge during periodic dredging of the existing Harris and Brazoria Reservoirs. The DEIS discusses the fact that the reservoirs are not dredged routinely. See Section 1.3.1 and Section 3.3.3.2.1.

Comment 26. Commentor requests additional study related to safety of impoundment due to hurricanes, storms, and climate change over the next 100 years.

> Response: The TCEQ's Dam Safety Program will require Dow to have an Emergency Action Plan (Title 30 Texas Administrative Code (TAC) Chapter 299, Dams and Reservoirs, 299.61(b)). The Corps will rely on the TCEQ's Dam Safety Program to oversee Dow's reservoir operations. The Corps does not evaluate speculative growth beyond what it can reasonably identify in the cumulative effects analysis.

Comments 27, 28, 34, 35, 36, 38, 44, 45, and 57. Several commenters indicated that the DEIS failed to address increased or expanded water rights/water usage and associated effects related to population growth/urbanization, the expansion of the Dow facility, and operations and effects to multiple resources that would result from that expanded or increased water rights use, as well as an analysis of raw materials and finished products used for and produced by the petrochemical facility.

Response: The Proposed Action is expanded storage, not expanded or increased water rights or usage. The DEIS (pages 2–18 and Section 4.3.3.1) states that Dow does not intend to increase the use of their water right under the No Action, Proposed Action, or any action alternative. Under the action alternatives, Dow would fill the proposed reservoir over a 3- to 4-month period once construction is complete and does not propose withdrawing water over its existing right to do so. The federal action is the permit to fill WOUS for construction of a reservoir. An evaluation of the entirety of DOW's operations is outside the context, and therefore scope, of this project.

Comments 29 and 33. The EIS does not analyze cumulative effects due to expansions of other chemical companies, climate change, or highway projects. Cumulative projects should include transportation, government, institutional, commercial, and residential projects; other Dow projects; Gulf Intracoastal Waterway projects, Coastal Study of Texas projects, the Corps' own Section 10/404 permit program, and Corps permit projects from 2021.

Response: As discussed in Section 5.1, an evaluation of cumulative effects should be completed for a resource found to be affected by a Project, and resource impacts that do not have a reasonably close causal relationship to the Proposed Action or alternatives are not considered in the CEA. The CEA used a watershed-based study area because the Project is located along the Brazos River and Oyster Creek, affects both streams, and could potentially affect resources downstream of proposed Project components. The upper portion of the Lower Brazos watershed, which primarily falls within Waller, Washington, and Austin Counties, has not been included in the CEA study area, as the Project is not anticipated to affect resources in the upper portion of the Lower Brazos watershed. Resources carried forward in the CEA correlate to those resources for which the Project or alternatives would have moderate or major long-term impacts, and/or resources in poor or declining health or at risk even if the Project impacts were relatively minor (Section 5.2). The reasonably foreseeable past and present projects that were carried forward for the CEA are described in Section 5.3. and correlate to the key resources potentially affected by the Proposed Action or alternatives. Corps permits from 2021 would not change the CEA.

Comment 30. Commentor stated that the cumulative effects section does not discuss the enforcement/compliance efforts for BMPs, if inspections are frequent enough and rigorous enough to make BMPs work, disposal of dredge material from the reservoir, Prime Farmland, and land subsidence. The cumulative Sedimentation and Erosion section does not discuss water quality impacts as runoff occurs and turbidity increases, how inspections will reduce water pollution, compliance with BMPs, or impacts of dredging out reservoirs.

Response: Compliance with a permit, including mitigation (BMPs), is required. The purpose of the EIS is not to analyze if standard BMPs are effective. The Corps is not evaluating dredging of the reservoirs; there are two permits with EAs that cover those activities.

Comment 31. Commentor stated that the cumulative analysis for land subsidence, system flows/environmental flows, floodplains/flood hazards, aquatic vegetation, federal and state threatened and endangered species, and visual resources do not define *localized*, *substantial*, *incremental contribution to cumulative effects*, *substantively contribute*, and *consistent with the existing landscape* for specific concerns/issues.

Response: Impact determination thresholds are defined in Sections 4.1.2, 4.1.3, and 4.1.4 and are used accordingly to describe effects throughout Chapter 4, Environmental Consequences, and Chapter 5, Cumulative Effects.

Comments 32 and 33. The cumulative sections do not include wetland delineation of Alternative 3 for comparison; amount of conversion of undeveloped land for residential, commercial, and industrial uses; and documentation on why there would be no introduction of invasive species, surveys to support conclusions on threatened and endangered species in alternative sites, or the effects of other Corps permits. Cumulative sections do not discuss conversion of undeveloped land to developed land due to projected growth in the region.

Response: Under NEPA, alternatives must be considered and discussed to a comparable level of detail, which usually also necessitates that the alternatives be developed to a comparable level. Section 1502.14 of the CEQ guidelines states that in the “Alternatives” section of an EIS, agencies shall “devote substantial treatment to each alternative considered in detail including the proposed action so that reviewers may evaluate their comparative merits.” This regulation does not dictate an amount of information to be provided, but rather prescribes a level of treatment that could in turn require varying amounts of information, to enable a reviewer to evaluate and compare alternatives. The Corps often develops an applicant’s preferred alternative to a higher level of detail than the other alternatives to facilitate the development of mitigation measures and to facilitate concurrent compliance with other applicable environmental laws. The DEIS devotes substantial treatment to each alternative considered in detail, including the Proposed Action, so that reviewers may evaluate their comparative merits.

Comment 33. A. Cumulative spatial boundaries for land subsidence and socioeconomic resources should include Matagorda and Wharton Counties.

B. Cumulative temporal limits should be the life of the Project.

C. The Key Resources Retained for the CEA section does not include key resources that will be cumulatively impacted due to this proposed Project, which will increase population growth and development and impact groundwater, wildlife, invasive wildlife, employment, environmental justice, air quality, noise, historic and archeological resources, urbanization, hazardous waste, and infrastructure.

D. The Project “may adversely affect Oyster Creek downstream of the reservoir outfall,” but there is no quantitative analysis about this cumulative impact to terrestrial and aquatic wildlife.

Response: A. The overall spatial boundary for the CEA is the Lower Brazos River watershed. With the exception of visual resources, socioeconomics was not carried forward in the CEA as effects to these resources from the Proposed Action or alternatives would not have moderate or major long-term impacts, and/or they were not resources in poor or declining health or at risk even if the Project impacts were relatively minor (Section 5.2). Land subsidence was analyzed in the CEA in Section 5.4.3.3.1 and Section 5.4.3.3.2, which determined that projects in the CEA are anticipated to have localized effects on subsidence but would not change the rate of land subsidence within the CEA study area, thus there would be no long-term impacts that would increase the rate of subsidence. Potential subsidence caused by the Proposed Action or the alternatives would be localized and no groundwater withdrawals would occur, which is the primary cause of regional subsidence.

Response B. Section 5.2.2 describes the reasoning for selecting 5 years as the temporal boundary for the CEA.

Response C. The Proposed Action is expanded storage, not expanded or increased water rights or usage. The DEIS (pages 2–18 and Section 4.3.3.1) states that Dow does not intend to increase the use of its water right under the No Action, Proposed Action, or any action alternative. Therefore, no growth-inducing effects (population growth, urbanization, etc.) would occur as a result.

Response D: Section 5.4.3.9.2 states that the Proposed Action, Alternative 2A, and Alternative 2B could result in a contribution to cumulative effects to terrestrial and aquatic species in the CEA study area due to the effects to Oyster Creek downstream of the proposed reservoir outfall. It also states that there could a beneficial contribution to cumulative effects on Oyster Creek from the stream restoration proposed under the Proposed Action, Alternative 2A, and Alternative 2B, and the addition of open water habitat from reservoir construction could also provide a beneficial contribution to aquatic species and some birds that may use the reservoir.

Scope of Analysis

Comment 33, 37. Commentor requests that the Corps consider the ineffectiveness of Prime Farmland compliance and enforcement with Clean Water Act regulations regarding placement of landfills near communities and next to protected federal lands; the Wetland Reserve and Conservation Reserve Programs in Texas; the lack of ESA critical habitat protected in Texas; and failures of no-rise certifications, among others.

Response: The commentor has expressed an opinion outside the purview of the Corps.

Comments 43, 44, 45. Commentor states that throughout their comment letter that additional analysis is needed in a Supplemental EIS.

Response: A supplemental EIS is required when changes to the proposed action would result in significant environmental impacts or there are significant new circumstances or information relevant to the environmental concerns that have bearing on the proposed action or its impacts. There are no major changes to the project and no new information or circumstances that are significant.

Impact Thresholds

Comments 39, 40. Commentor suggests that impact thresholds should be better defined, and methodology and quantification are not included for determinations and are therefore arbitrary. Commenter also suggests that use of *short-term* or *temporary* do not apply to compaction, erosion, or sedimentation. Corps does not explain why moderate impacts are not significant under NEPA.

Response: DEIS Sections 4.1.1 through 4.1.4 define effect thresholds, temporal, and spatial impacts using common English language and layman-familiar words. These definitions were used throughout Chapter 4 and Chapter 5 to determine the effects of the Proposed Action and alternatives.

Incomplete Information

Comment 41. Several places in the DEIS have incomplete information that is obtainable or is unavailable but has not been addressed by the Corps as required by CEQ Section 1502.22(b)(1-4). For example, significant gaps in environmental flow standards remain for Oyster Creek. There is no information about how feral hogs and nutria will be dealt with at the Big Slough mitigation site and on the proposed Project site.

Response: Under NEPA, alternatives must be considered and discussed to a comparable level of detail, which usually also necessitates that the alternatives be developed to a comparable level. Section 1502.14 of the CEQ guidelines states that in the “Alternatives” section of an EIS, agencies shall “devote substantial treatment to each alternative considered in detail including the proposed action so that reviewers may evaluate their comparative merits.” This regulation does not dictate an amount of information to be provided, but rather prescribes a level of treatment that could in turn require varying amounts of information, to enable a reviewer to evaluate and compare alternatives. The Corps often develops an applicant’s preferred alternative to a higher level of detail than the other alternatives to facilitate the development of mitigation measures and to facilitate concurrent compliance with other applicable environmental laws. The DEIS devotes substantial treatment to each alternative considered in detail, including the Proposed Action, so that reviewers may evaluate their comparative merits.

Invasive species management is included in the comprehensive mitigation plan (Appendix G).

Comment 42. A desktop review is insufficient for wetlands and other natural and cultural resources in alternative sites. Secondary comment on visual: Commentor states that impacts levels for socioeconomic resources do not specify to which construction point or sequence of steps they apply.

Response: Under NEPA, alternatives must be considered and discussed to a comparable level of detail, which usually also necessitates that the alternatives be developed to a comparable level. Section 1502.14 of the CEQ guidelines states that in the “Alternatives” section of an EIS, agencies shall “devote substantial treatment to each alternative considered in detail including the proposed action so that reviewers may evaluate their comparative merits.” This regulation does not dictate an amount of information to be provided, but rather prescribes a level of treatment that could in turn require varying amounts of information, to enable a reviewer to evaluate and compare alternatives. The Corps often develops an applicant’s preferred alternative to a higher level of detail than the other alternatives to facilitate the development of mitigation measures and to facilitate concurrent compliance with other applicable environmental laws. The DEIS devotes substantial treatment to each alternative considered in detail, including the Proposed Action, so that reviewers may evaluate their comparative merits.

Section 4.10.6 provides the reader with specific definitions related to visual impacts (see Table 4.10 1, Criteria for Assessing the Level of Impacts on Visual Resources) and further explains that they were developed to correspond to impact levels described for socioeconomic issues in Section 4.1.3.2. Impact determinations provided in this section are consistent with impact determinations used throughout Chapter 4 and Chapter 5 (as depicted in Sections 4.1.2, 4.1.3, and 4.1.4), which provide the impact level and the associated impact duration.

Interagency Consultation

Comments 46, 47, 49, and 50. Commentor requested that interagency consultation with FEMA, the cooperating agencies, and the county be conducted for the proposed Project.

Response: Section 1.4.2 of the EIS indicates that coordination between federal, state, regional, and local agencies, including the EPA, USFWS, NMFS, TCEQ, Texas General Land Office, and TPWD, was conducted. FEMA has delegated responsibility to administer provisions of the National Flood Insurance Program (NFIP) to the State of

Texas, who has in turn delegated it to the County. The Brazoria County Floodplain Administrator evaluates floodplain impacts in association with the building permit. Based on Brazoria County's regulations, construction may not proceed unless a DA permit has been issued. There is no consultation requirement or voluntary process for consulting with FEMA or the County Floodplain Administrator.

The Corps' evaluation of the floodplain impacts is in accordance with 33 CFR 320.4(l) Floodplain Management and Executive Order 11988 - Floodplain Management. The Corps will rely on the Brazoria County Floodplain Administrator to determine compliance with the provisions of the NFIP. No additional coordination is required.

Comment 48. One commentor indicated that the Corps and the Applicant are required to coordinate with TPWD's sand and gravel permit coordinator.

Response: This information has been provided to the Applicant.

Lead Agency Review

Comment 51. Commentor requested that the Corps independently evaluate and verify information provided by the Applicant, particularly related to wetlands, WOUS, and Columbia Bottomlands.

Response: The Corps conducted an independent evaluation in conjunction with its contractors as is confirmed by Appendix A through Appendix F and Appendix H of the EIS. All of these studies and reports were prepared under the direction of the Corps.

ISSUE 2: WATER RESOURCES

Surface Water Quality, Sedimentation, Erosion

Comment 52. The modeling in Appendix B to the DEIS purports to show that velocities, elevations and flow rates in the river remain unchanged due to the Project. Yet the overflows that the Project would block during actual flood events were not changed as they were brought into that modeling. The commenter questions if the model is accurately representing what changes might occur in the Brazos River. The EIS should also address more accurately the likely increased velocities and erosive impacts.

Response: Dow has conducted additional hydraulic modeling of the WSEL for Oyster Creek (Jacobs 2022a; Appendix I) and for the Brazos River (Jacobs 2022b; Appendix J). The reports conclude that the Proposed Project improvements successfully mitigate impacts to flood flows from the proposed reservoir expansion, not only for the regulatory 100-year base flood, but also during more frequent 10-year and 50-year floods. As floods become smaller (more frequent), there is less interbasin transfer of flow from the Brazos River to Oyster Creek, so the Proposed Project improvements should be adequate for all flow rates, tested up to a 500-year flood.

Comment 53. The DEIS should discuss sediment management (maintenance dredging) of the reservoirs, including impacts at disposal sites. Any impacts to the Brazos or Oyster Creek from sediment disposal should be analyzed.

Response: Once constructed, the expanded Harris Reservoir will not be a WOUS. Excavating the reservoir will not be an activity regulated by the Corps. In future operations of the reservoir, if the Applicant proposes to excavate the reservoir and place the material in a WOUS, the Corps will evaluate the proposed action then. Until then, the

Corps assumes it will have little or no federal control and responsibility on future operations.

Groundwater

Comments 54 and 55. There may be environmental impacts to surface water and groundwater when shallow groundwater is encountered. The DEIS analysis should discuss these impacts and methods and BMPs for when groundwater is encountered so that environmental impacts to surface water and groundwater are reduced.

Response: Section 4.2.3 discusses the effects of sediment and erosion for all alternatives. Section 2.8.1.3 includes 10 BMPs, or applicant-committed measures, that would be implemented to minimize erosion and sedimentation.

Comment 56. The EIS needs to define what "natural land subsidence" is and what is human-caused. Climate change, which is human-caused, affects how much sea level rises and subsidence occurs.

Response: Section 3.2.2.3, Land Subsidence, has been revised to further define land subsidence and predicted future conditions in the Project site.

Flood Hazards

Comments 58, 59, 61, 62, 63, 64, 68, 71, 75, and 76. The basin expansion will block overbank flood flows from the Brazos River to the Oyster River and potentially increase the flooding impacts along the Brazos River. How much blocked floodwater might be redirected west and downstream? As this redirected floodwater moves downstream through the floodplain, what new areas might be impacted that generally have avoided flooding in the past? What areas might be impacted more severely than they would otherwise?

Response: Dow has conducted additional hydraulic modeling of the WSEL for Oyster Creek (Jacobs 2022a; Appendix I) and for the Brazos River (Jacobs 2022b; Appendix J) and concluded that the Proposed Project improvements successfully mitigate impacts to flood flows from the proposed reservoir expansion, not only for the regulatory 100-year base flood, but also during more frequent 10-year and 50-year floods. As floods become smaller (more frequent), there is less interbasin transfer of flow from the Brazos River to Oyster Creek, so the Proposed Project improvements should be adequate for all flow rates, tested up to a 500-year flood. Section 4.3.1.3.2 of the FEIS has been updated to include the additional modeling and analysis.

Comment 60. The DEIS seems to be focused primarily on the Oyster Creek watershed during storm events, while not really considering the impacts and needed mitigation to address what happens when there is major flooding on the Brazos River from upstream that supersedes the localized rainfall.

Response: Per the DEIS and Appendix C, the flooding on the Brazos River and the interbasin flows were studied extensively. Dow conducted additional hydraulic modeling of the WSEL for the Brazos River (Jacobs 2022b; Appendix J) which concluded that the Proposed Project improvements successfully mitigate impacts to flood flows from the proposed reservoir expansion, not only for the regulatory 100-year base flood, but also during more frequent 10-year and 50-year floods. As floods become smaller (more frequent), there is less interbasin transfer of flow from the Brazos River to Oyster Creek, so the Proposed Project improvements should be adequate for all flow rates, tested up to a

500-year flood. Section 4.3.1.3.2 of the FEIS has been updated to include this additional analysis.

Comment 62. A. Where did the value for 1,028 AF of lost floodplain storage come from? How was it derived?

B. What is the relevance of the calculated Oyster Creek floodplain losses during such major Brazos River flood events that overwhelm this area with water overflowing in the opposite direction?

C. It seems an assumption in the modeling in Appendix C, incorporated into the DEIS, is that the drawdown in the reservoir will be able to absorb the rainfall that will fall on it during the modelled localized storm event and this is credited as "floodplain storage" in the model, effectively removing that area within the reservoir from needing to be accounted for as floodplain storage losses that need to be mitigated. This might be appropriate if localized rainfall represents the greatest flooding concerns for the project. This is not the case."

Response A: Per Table 19B in Section 5.4.5 of the *Brazos River Hydrology and Hydraulics Final Report* (see Appendix B), the 1,028 AF of lost floodplain storage was determined by comparing the existing and proposed cross-sections between FM-1462 (cross-section 69.9) and Harris Reservoir Road (cross-section 50.3), as documented in the Jacobs HEC-RAS model dated May 27, 2020.

Response B: As the proposed Harris Reservoir expansion will affect both the Brazos River and Oyster Creek systems, it is essential that the potential impacts to both the Brazos River and Oyster Creek are studied. Further study was conducted to understand the interbasin flows between the two systems and how they will be affected by the proposed Project. Although Oyster Creek is a smaller system, the potential impacts to its floodplain as part of the Project must be understood. Please refer to Appendices B and C for further information.

Response C: Both localized rainfall and floodwaters from upstream were taken into consideration when working to understand the impacts associated with floodplain storage losses as a result of the proposed project.

Comment 63. Commenter's concern is the 10.5-year time frame chosen for the studies (January 1, 2009, through May 6, 2019). Beginning on May 7, 2019, the Brazos River water levels continued to rise until May 11, 2019, the peak at the Rosharon gauge for that flood event reaching the seventh highest historic crest for that gauge. The flow at that time was 78,000 cubic feet per second, the highest levels reached since Hurricane Harvey. The 10.5-year time frame used excluded this flood event. Why was this time frame selected?

Response: The time frames used are a statistically viable representation of regional storms. The use of outlier events, like a 1,000-year storms similar to Hurricane Harvey, would skew the analysis to large storms biasing the impact analysis. This bias would skew the impact results and raise the level of significant impact above the threshold for impacts resulting from smaller typical events, such as 50- and 100-year storms that already result in substantial loss.

Comment 65. There is a requirement for demonstrating "no rise" conditions for major projects, yet there does not seem to be a hard look or independent review to confirm that such calculations are accurate and impacts still can result once the Project is built.

Response: The Corps has conducted a thorough evaluation of the proposed project and the practicable alternative's adverse impacts on the floodplain as required in our public interest review. By conducting these studies on the proposed project and evaluating multiple practicable alternatives, the Corps has complied with the EO. The Corps will rely on the Brazoria County Floodplain Administrator to determine compliance with the provisions of NFIP. The studies included in the FEIS are: The *Brazos River Hydrology and Hydraulics Final Report* (Appendix B), the *Oyster Creek Downstream Hydrologic and Hydraulic Impacts Final Report* (Appendix C), the *Extended Hydraulics Modeling Technical Memorandum* for Oyster Creek (Jacobs 2022a; Appendix I), and the *Support for EIS: Brazos River and Oyster Creek Additional Hydraulics Modeling* (Jacobs 2022b; Appendix J). Section 4.3.1.3.2 of the FEIS has been updated to include this additional analysis.

Comments 66 and 67. A supplemental DEIS is needed to take a hard look at the flooding scenarios that are of actual concern. A flood caused by water flowing from upstream on the Brazos River—which had the greatest annual average flow of any river in Texas—is of much greater concern than flooding primarily driven by a localized rainfall event in the area of the proposed Project.

Response: The Corps has conducted a thorough evaluation of the proposed project and the practicable alternative's adverse impacts on the floodplain as required in our public interest review. By conducting these studies on the proposed project and evaluating multiple practicable alternatives, the Corps has complied with the EO. The Corps will rely on the Brazoria County Floodplain Administrator to determine compliance with the provisions of NFIP. The studies included in the FEIS are: The *Brazos River Hydrology and Hydraulics Final Report* (see Appendix B), the *Oyster Creek Downstream Hydrologic and Hydraulic Impacts Final Report* (Appendix C), the *Extended Hydraulics Modeling Technical Memorandum* for Oyster Creek (Jacobs 2022a; Appendix I), and the *Support for EIS: Brazos River and Oyster Creek Additional Hydraulics Modeling* (Jacobs 2022b; Appendix J). Section 4.3.1.3.2 of the FEIS has been updated to include this additional analysis.

Comment 69, 70, and 140. A. The impacts of emergency releases of water to the downstream environment and people are not modeled and the public has not been told in the DEIS what the results are for such actions for their particular property.

B. The Corps says nothing about waves kicked up during storms and hurricanes and how they impact dam proposals.

C. The Corps did not model a worst-case scenario with the dam breached and affecting both floodplains/floodways.

D. There is a proposed reevaluation of the 1995 Upper Bastrop Bayou Flood Protection Plan Study that may impact or be impacted by the Dow proposal. This reevaluation will look not only at diverting Brazos River overflow waters to Bastrop Bayou by a new diversion channel and Angleton Drainage District Ditch 22 but will also determine if additional Brazos River overflows can be diverted to Oyster Creek.

E. The environmental impacts to the Christmas Bay Coastal Preserve must be studied, evaluated, and revealed. The Corps fails to assess these impacts in the DEIS. The Corps has not provided an analysis of how the Christmas Bay Coastal Preserve and Bastrop Bayou will be affected in the DEIS.

F. This proposal sets a precedent for other future off-channel reservoirs (Sections 1508.27(4) and (5)) because it allows large parts of the floodplain to be walled off and blocks floodwaters from the flow travel corridors that exist. The precedent is that an off-channel reservoir, which should be on an upland site, will be in a floodplain/floodway where disruption of flows may occur tens of miles away and perhaps even affect Bastrop Bayou and the Christmas Bay Coastal Preserve on the Texas Coast

G. The City of Lake Jackson, Brazoria County, City of Richwood, Velasco Drainage District, Angleton Drainage District, and the City of Clute are involved in this reevaluation and these entities. along with the Texas Water Development Board, have conducted studies or have data that may be of use for direct, indirect (secondary), connected, and cumulative impacts analysis (Sections 1508.7, 1508.8, 1508.14, 1508.18, and 1508.27). This project has been ignored by the Corps in this DEIS for cumulative effects analysis.

> Response A. FEMA has delegated responsibility to administer provisions of the NFIP to the State of Texas, who has in turn delegated it to the County. The Brazoria County Floodplain administrator evaluates floodplain impacts in association with the building permit. Based on Brazoria County's regulations, construction may not proceed unless a DA permit has been issued. The Corps will rely on the Brazoria County Floodplain Administrator to determine compliance with the provisions of NFIP. The studies included in the FEIS are: The *Brazos River Hydrology and Hydraulics Final Report* (Appendix B), the *Oyster Creek Downstream Hydrologic and Hydraulic Impacts Final Report* (Appendix C), the *Extended Hydraulics Modeling Technical Memorandum* for Oyster Creek (Jacobs 2022a; Appendix I), and the *Support for EIS: Brazos River and Oyster Creek Additional Hydraulics Modeling* (Jacobs 2022b; Appendix J). Section 4.3.1.3.2 of the FEIS has been updated to include this additional analysis.
>
> Responses B and C. The dam will be designed and permitted in accordance with the TCEQ's Dam Safety Program (30 TAC Chapter 299, Dams and Reservoirs, 299.61(b)). The Corps will rely on the TCEQ's Dam Safety Program for dam design requirements, and any wave-action modeling requirements fall under the purview of the Texas Dam Safety Program. The O&M Plan (Appendix L) states that under emergency release operations that a controlled drawdown would be achieved by slowly throttling up discharges at a rate of no more than 200 cfs per hour. This release rate is based upon the existing calculated hydrograph of Oyster Creek and is intended to avoid downstream. impacts. Section 4.3.2.2 has been updated to include a more detailed emergency release discussion.
>
> Response D. The analysis contained in the EIS relies on existing information. The reevaluation referenced in this comment has not occurred and therefore cannot be used in the EIS analysis.
>
> Response E. Christmas Bay and Bastrop Bayou are approximately 8 miles east of the mouth of Oyster Creek and 12 miles east of the mouth of the Brazos River along the shoreline of the Gulf of Mexico. The *Brazos River Hydrology and Hydraulics Final Report* (see Appendix B) determined that there would be no environmental impacts downstream of the Rosharon gage. The *Oyster Creek Downstream Hydrologic and Hydraulic Impacts Final Report* (see Appendix C) determined that there would be no environmental impacts downstream of the City of Lake Jackson. For reference, the Rosharon gage and Lake Jackson are approximately 60 and 30 miles (hydrologically) from Christmas Bay and Bastrop Bayou, respectively.
>
> Response F. The Corps conducts each evaluation for a permit decision on a case-by-case basis.
>
> Response G. EISs cannot account for studies or reevaluations that are proposed but not yet complete. Most of the municipalities/entities listed in the comment received notification and were invited to participate throughout the NEPA process.

Comment 72. If the combined operation of existing reservoirs is considered, then the combined impacts need to be revealed and analyzed.

> Response: The baseline conditions for the floodplain modeling included the existing structures and reservoirs.

Comment 73. The Corps ignores that higher rainfall intensity levels are expected and that greater than 1 to 2 feet of sea level rise in the next 50 years is expected due to climate change.

> Response: As described in Section 2.6 and Section 6.5 of the *Brazos River Hydrology and Hydraulics Final Report* (see Appendix B), relative sea level rise was accounted for in both the hydraulic modeling and the salinity analysis for the Harris Reservoir expansion. Additionally, Section 2.4 of the same report describes how the study accounted for higher and more intense rainfall as a result of climate change.

Comment 74. A. Since there are two existing reservoirs, the Corps should be able to state how sedimentation and erosion have affected the Harris and Brazoria Reservoirs and provide modeling that takes these real-world examples into account for the proposed Project.

B. The assumption that a flood control project will reduce water quality problems is not documented in the DEIS with any studies that show this to be the case over the short or long term.

C. The Corps does not address how the loss of more than 2,000 acres in the floodplains of two major streams would not have an effect on flows particularly because the Corps has not conducted a worst-case modeling scenario with 50 to 60 inches of rainfall instead of 19 inches.

D. The Corps does not state what the environmental impacts are of decreased water temperatures in Oyster Creek.

> Response A: As part of the operations and maintenance plan in Appendix L, the Harris Reservoir expansion would be surveyed every 10 years to determine the changes in storage capacity. Based on the results of the survey and the water demand at the time, dredging operations could take place to restore the full storage capacity of the reservoir. This maintenance process and frequency is similar in nature to the operations and maintenance procedures of other reservoirs.
>
> Response B: Section 4.3.1.1.2 states that "[t]he proposed Project would change the land use from agriculture to water storage and associated facilities (e.g., access roadways, pump station etc.). The reduction of agriculture would reduce the amount of agricultural runoff into the Brazos River and Oyster Creek, which could provide minor improvements to water quality in the immediate vicinity of the Project site." This is the only water quality benefit anticipated for the Project, and it is simply a result of a change in land use.
>
> Response C: The rainfall values used are a statistically viable representation of regional storms. The use of outlier events, like a 1,000-year storms similar to Hurricane Harvey, would skew the analysis to large storms biasing the impact analysis. This bias would skew the impact results and raise the level of significant impact above the threshold for impacts resulting from smaller typical events, such as 50- and 100-year storms that already result in substantial loss.
>
> Response D: The planned design of the reservoir is such that its depth and discharge method will likely involve discharges of water that are of substantially similar water temperatures as those found in Oyster Creek. The specific heat of water would indicate that surface water temperatures generally lag slightly behind air temperatures. Average air temperatures for Angleton, Texas, range between January lows of approximately 54°F

to July highs of approximately 83°F. Based on this, average air temperatures are approximately 70°F. Therefore, it is reasonable to assume that typical water temperatures would be closer to 70°F, with seasonal decreases and increases. Section 4.3.1.4, Environmental Flows, has been revised to reflect the more likely temperature of water discharged into Oyster Creek when the proposed reservoir is in operation.

Comment 137. The Corps must conduct the NEPA EIS analysis as required by the President's CEQ regulations/rules and consider the effects on floodplains/floodways that are developed and or rerouted.

Response: The Corps has conducted a thorough evaluation of the proposed project and the practicable alternative's adverse impacts on the floodplain as required in our public interest review. By conducting these studies on the proposed project and evaluating multiple practicable alternatives, the Corps has complied with the EO. The Corps will rely on the Brazoria County Floodplain Administrator to determine compliance with the provisions of NFIP. The studies included in the FEIS are: The *Brazos River Hydrology and Hydraulics Final Report* (Appendix B), the *Oyster Creek Downstream Hydrologic and Hydraulic Impacts Final Report* (Appendix C), the *Extended Hydraulics Modeling Technical Memorandum* for Oyster Creek (Jacobs 2022a; Appendix I), and the *Support for EIS: Brazos River and Oyster Creek Additional Hydraulics Modeling* (Jacobs 2022b; Appendix J). Section 4.3.1.3.2 of the FEIS has been updated to include this additional analysis.

Comment 139. A hazard mitigation plan is needed for the entire area so that floods are dealt with comprehensively, including current wetlands, where wetlands can be restored, and not piecemeal analysis and plans where different projects may interfere and disrupt each other.

Response: The regulatory requirements for FEMA's hazard mitigation program are a requirement for state and local governments and are not in the Corps' scope of analysis or statutory authority. The Corps' evaluation of the floodplain impacts is in accordance with 33 CFR 320.4(l) Floodplain Management and Executive Order 11988 - Floodplain Management and the Corps looked at cumulative impacts (see Section 5.4.3.5). The Corps will rely on the Brazoria County Floodplain Administrator to determine compliance with the provisions of the NFIP. No additional coordination is required.

Wetlands/Waters of the United States

Comments 77 and 78. Commentors stated that field delineations should occur at the alternative Project locations. Alternative 3 could impact more wetlands and would not be the least environmentally damaging practicable alternative (LEDPA). The commentor additionally questioned why wetland data sheets were not provided as an appendix to the DEIS.

Response: The requirement in the 404(b)(1) guidelines is to evaluate practicable alternatives with less adverse impacts on the aquatic system, so long as the alternative does not have other significant adverse environmental consequences. The phrase *less adverse impact* does not mean acreage; it is about functions and services lost. The objection raised between using the NWI map and a field delineation is limited fundamentally to differences in acreage. The alternatives analysis has provided sufficient detail necessary to allow a complete and objective evaluation of the public interest and a fully informed decision regarding the permit application impacts on many environmental consequences. There are more than 500 pages of wetland delineation data sheets. These data sheets have been provided to the commentor.

Section 404(b)(1)/Clean Water Act Issues

Comments 79, 80, 81, 82, 83, and 84. Commentor stated that the Corps did not follow the CWA 404(b)(1) Guidelines in relation to selection of the LEDPA; in developing the overall purpose for non-water dependent–projects and alternate site analysis and selection; in analysis of significant degradation of aquatic sites and habitats, the Columbia Bottomlands in particular; in evaluation of the interconnections between streams, wetlands and groundwater; and provides inadequate mitigation, also states that the Corps did not adequately analyze the functions and services of wetlands and WOUS to be filled, including flood control functions, and preference for mitigation.

> Response: The Corps will make the decision to issue, issue with special conditions, or deny the permit in the Record of Decision. No aspect of compensatory mitigation can be used in making the LEDPA determination; an applicant cannot use compensatory mitigation to "buy down" an alternative in order to meet the LEDPA. If the permit is issued, the Corps will ensure that the mitigation plan complies with 33 CFR 332.

Columbia Bottomlands

Comments 86 and 87. There is no evidence provided that the habitats in the Proposed Alternative and Alternative 2, Alternative 2B, and Alternative 3 Project sites are not Columbia Bottomlands, despite being within the area mapped as historic Columbia Bottomlands. The species identified as occurring in the remnant impacted habitats are species that occur in Columbia Bottomlands.

> Response: The Corps has established the baseline based on contemporary site conditions and has concluded that the site does not currently have Columbia Bottomland Hardwoods. The stream compensatory mitigation plan will re-establish riparian bottomland hardwoods commonly found in the Columbia Bottomland Hardwoods currently found in the region.

Comment 88. The diversion of flood waters from Oyster Creek and other current flow travel corridors will impact wetlands, other watersheds such as Bastrop Bayou, park lands on the coast, Prime Farmlands, Christmas Bay Coastal Preserve, and Columbia Bottomlands.

> Response: The Corps is unclear what floodwater diversion is being referenced. No new diversions of water are proposed from Oyster Creek. The bypass channel proposed by Dow will have localized affect during flooding but does not remove any water from Oyster Creek.

Mitigation and Monitoring

Comments 89, 90, 91, 92, 93, 94, 97, 98, and 102. Proposed mitigation should include buffer areas for preservation and should not destroy more wetlands and riparian habitat for flood control. Focus on providing compensation for the functional values lost. Add design details, invasive plant control, grading plan, and references to the mitigation plan. This should include a robust detailed monitoring plan for on-site and off-site mitigation based on ecological performance standards, including reduced erosion, with adaptive management measuring the effectiveness over the lifetime of the Project.

> Response: Based on these comments, Dow is providing an updated detailed compensatory mitigation plan that includes monitoring and performance standards.

Comment 91. The conceptual mitigation plan does not specifically identify the name of the proposed mitigation bank(s), and so the suitability of the proposed mitigation cannot be properly assessed.

Response: The conceptual mitigation plan states the Project site is outside the primary and secondary service areas for any mitigation banks or in-lieu fee programs that offer stream credits. Therefore, permittee-responsible mitigation (PRM) through re-establishment, enhancement, and preservation of Oyster Creek (on-site) and Big Slough (offsite) was selected for stream mitigation in this plan.

Comment 92. The mitigation plan proposed does not seem to be focused on providing compensation for functional values actually lost, or in providing for the restoration of Columbia Bottomlands habitats that were on the site historically.

Response: Compensatory mitigation is for unavoidable impacts to existing wetlands that result from the proposed action (33 cfr 320.4(r)(2)), not compensation for degradation of wetlands (that may or may not have existed on the site historically) caused by other factors.

Comment 92 and 95. Mitigation projects on Oyster Creek are more flood control and floodplain enhancements than wetland mitigation.

Response: Riparian systems serve several functions such as water storage and conveyance, nutrient and sediment removal, and plant and animal habitat. The proposed modifications will improve both the water storage and conveyance functions (flood control work), as well as provide improved plant and animal habitat (mitigation). The hydrological connectivity of the floodplains and wetlands and their native vegetation are integral components of holistic stream restoration efforts (33 CFR 332.3(j)(1)(ii)).

Comment 96. The commenter asks if the wetland mitigation proposed is really a regional mitigation bank posing as a permittee-responsible program due to its magnitude and design.

Response: Dow's proposed stream compensatory plan is commensurate with the impacts proposed in the Project.

Comment 99. Mitigation design should allow Oyster Creek to meander to allow erosion and sedimentation processes to operate and for wildlife habitats to be created.

Response: The Corps considers the dynamics of fluvial geomorphology and balances that function with the stability of the pattern and profile necessary to demonstrate compliance with approved performance criteria.

Comment 100. The proposed mitigation overestimates the ecological benefits when it does not use the 80- to 100-year time frame that it takes for trees along Oyster Creek to reach ecological maturity and provide full ecological benefits.

Response: The *full ecological benefits* are essentially snapshots of functions that are found as a forest matures. Young forest systems offer benefits of their own (e.g., increased stem density, increased carbon sequestration, increased nitrogen and phosphorus uptake, greater root density per stem). As a rule, the Corps accounts for these benefits over time in calculating functional values of aquatic systems. These functional assessments consider a wide range of biological, chemical, and physical factors and account for the community differences over time.

Comment 101. Consider more in-kind stream mitigation alternatives. The types of streams impacted at the Project site are very different than Big Slough (smaller, higher in the watershed, less perennial, not tidal).

Response: The Corps appreciates the desire to compensate for impacts as locally as possible; however, the compensatory mitigation also must be actionable and achievable.

The proposed Big Slough site meets the watershed approach criteria of 33 CFR 332. The site is located in the same watershed and same ecosystem and will provide many of the same functional benefits as the impacted streams such as Jacobs Creek.

Operations and Maintenance

Comment 103. The O&M plan should have a goal that water release from Dow's water storage reservoirs will be in a manner that limits adverse impacts to Oyster Creek.

Response: The O&M plan includes a monitoring program and adaptive management plan for releases from the reservoir.

ISSUE 3: BIOLOGICAL RESOURCES

General Wildlife, Wildlife Habitat, Avian

Comments 104 and 105. While Chapter 4 states that existing and reasonably foreseeable trends and actions would continue to affect wildlife under the No Action alternative, this same statement is not made in Chapter 4 under the action alternatives.

Response: The Corps is acknowledging that impacts to the site do occur even if the Corps denies the permit. See Chapter 5 to review cumulative impacts of past, present and reasonably foreseeable actions when combined with the action alternatives.

Comment 106. The commentor encourages development of a vegetation management plan that includes avoiding disturbance or removal during migratory bird nesting season and strategies to protect native vegetation in order to protect birds and other wildlife.

Response: Standard BMPs and applicant-committed measures are stated in Section 2.8, including vegetation monitoring and strategies to minimize impacts to migratory birds and other wildlife.

Comment 107. One commentor asked if Texas Water Code, Section 11.152 (Assessment of Effects of [TCEQ] Permits on Fish and Wildlife Habitats) has been considered.

Response: TCEQ was provided a copy of the DEIS; however, the code noted in this comment is a water rights statute for the withdrawal. No new water rights are proposed as part of this project; therefore, the noted permit is not required.

Federal and State Threatened and Endangered Species

Comments 108 and 109. Commentors expressed concerns regarding impacts to freshwater mussels, including the state-listed and federally proposed Texas fawnsfoot, from the pump station, outfall, and Oyster Creek mitigation area. If surveys find Texas fawnsfoot or other state-listed freshwater mussels, continued consultation with TPWD was recommended.

Response: Permitted malacologists and biologists conducted freshwater mussel surveys within the Project site following TPWD guidelines in late April 2022. Texas fawnsfoot and other listed mussel species were not found. Six non-listed mussel species were recorded. The full report was submitted to USFWS for review and concurrence. The EIS and biological assessment has been updated to reflect this new data, and the report appended to the FEIS, which will be provided to TPWD.

Comment 110. The Corps ignores the impacts that decreased or low water temperatures will have on state-listed aquatic organisms in the summer or the rest of the year.

Response: See the response to Comment 74D. Section 4.5.2 and Section 4.7.2 have been revised accordingly.

Comment 111. The state threatened alligator snapping turtle should have a high potential, not low potential, to occur in the Brazos River and Oyster Creek because it lives in large bodies of water in Texas.

Response: According to the Brazos River Authority (2022), alligator snapping turtle has never been documented in the Brazos River. Based on known sightings, Brazoria County is not currently considered within the species range. Therefore, while not impossible, the species' occurrence is improbable. The potential will remain low.

Aquatic Species

Comment 112. Commenter requested more information on freshwater drum (*Aplodinotus grunniens*) and Brazos heelsplitter mussel (*Potamilus streckersoni*). The commenter also questions the inclusion of Allens Creek data and the identification of Texas hornshell (*Popenaias popeii*) in Allens Creek as stated in the Project's Aquatic Assessment report (SWCA 2021).

Response: Freshwater drum is presumed to be a brooding host for Texas fawnsfoot; however, this is not yet corroborated by data and drum was not collected by field biologists during any sampling events. The Brazos heelsplitter is not listed by the USFWS as a threatened or endangered species. The FEIS has been updated with information on these species and the effect on potential hosts (e.g., freshwater drum) for clarity. The published Allens Creek study (Wood et al. 1994) and other studies cited provide known data collected independently from this project. Allens Creek bears some hydrological similarity to Oyster Creek in that it is in the coastal plain, has relatively low velocity and volume, and is subject to flashy flows during storm events. There is no way to negate data presented in the publication without the authors retracting the report.

Comment 113. One commentor questions the statement in Section 4.5.2 that says "but it is anticipated that the intake would be properly screened to avoid entrainment … would not be anticipated to impact aquatic wildlife in the Brazos River during normal operations" and why screens to avoid entrainment of aquatic life are not required but are only "anticipated." Installation and O&M of intake screens to avoid entrainment of aquatic organisms should be required by the Corps.

Response: DEIS Section 2.7.3 states that the Brazos River water would be diverted through two intake pipes equipped with screens to prevent entrainment of aquatic life and debris. Section 4.5.2 of the EIS has been updated to remove the word *anticipated*.

Invasive Species

Comment 114. The DEIS fails to assess, analyze, and evaluate the impacts of invasive zebra and quagga mussels in reservoirs, the Brazos River, Oyster Creek, and downstream and movement to other waterbodies in the Lower Brazos River watershed.

Response: Zebra mussels are currently found in lakes and rivers in six river basins across the state: the Red, Trinity, Brazos, Colorado, Guadalupe, and San Antonio Rivers. The proposed Project would not increase the range or change the rate to spread of invasive bivalves beyond the existing conditions. Therefore, the Corps does not need to conduct an exhaustive review of the impact of these species.

ISSUE 4: PHYSICAL RESOURCES

Geology

Comment 115. There are overlooked channels which influence water flow, flooding, and flood modeling for the proposed Project. There are conflicting statements about elevation ranges. The description of the topography and flood flow potential of the proposed project sites is more complicated and complex for flood control than the Corps described in the DEIS. The coastal plain is a more dynamic landscape than previously thought and how the topography is distributed has significant consequences for how extreme precipitation is routed across the landscape. These forgotten channels and overland flow areas are important for mitigation projects and how they are constructed and operated, erosion, sedimentation, water quality, flood hazards, and hydromodification.

> Response: Dow has conducted additional hydraulic modeling of the WSEL for Oyster Creek (Jacobs 2022a; Appendix I) and for the Brazos River (Jacobs 2022b; Appendix J) concluded that the Proposed Project improvements successfully mitigate impacts to flood flows from the proposed reservoir expansion, not only for the regulatory 100-year base flood, but also during more frequent 10-year and 50-year floods. As floods become smaller (more frequent), there is less interbasin transfer of flow from the Brazos River to Oyster Creek, so the Proposed Project improvements should be adequate for all flow rates, tested up to a 500-year flood.

Comment 116. The presence of faults on the proposed alternatives is not eliminated. Page 3-3, 3.2.1 Geology, 3.2.1.1 Proposed Action, Alternative 2A, Alternative 2B, DEIS, the Corps states, “There are no faults mapped in or near the Project site”. The Corps also states on Page 3-7, 3.2.1.3 Alternative 4, DEIS, “There are no faults mapped in or near the Alternative 4 site.”

> Response: The DEIS reviews faults for the Proposed Action site and each alternative site and states they are absent, as stated in the comment. For Alternative 3, Section 3.2.1.2 states that there are no faults mapped in or near the Alternative 3 site limits.

Comment 117. The commentor requests that the EIS list the environmental impacts of borrow pits and what mitigation measures will be required for these impacts.

> Response: No offsite borrow sites are proposed. As stated in DEIS Section 2.3.3.1, the embankment would be constructed of compacted soils obtained from borrow areas within the reservoir interior.

Comment 118. Environmental impacts of laydown areas, workspace areas, and construction staging areas are ignored or not covered sufficiently in the DEIS. These areas total 63 acres of staging and workspaces that will have environmental impacts.

> Response: Section 2.3.4.1 includes a full description of staging areas, and these are shown on the maps in that section. Total acreage of disturbance for each of the alternatives, including all staging and laydown areas, is evaluated in Chapter 4 Environmental Consequences for all applicable resource areas.

Comments 119 and 121. Commentors state that the DEIS does not define subsidence and its causes or distinguish naturally and human-caused land subsidence or how this will change in the 50-year future. The comments suggest increased populations will increase subsidence in the alternative site areas.

Response: Section 3.2.2.3, Land Subsidence, has been revised to further define land subsidence and future subsidence predictions.

Comment 120. Chapter 3 oversimplifies how different soils erode and ignores that the Brazos River has many natural clay particles due to the formations it moves through. That is why the Brazos River is a rusty color.

Response: The Brazos River, which flows into the Harris Reservoir, has a drainage area totaling more than 42,000 square miles and extends more than 600 miles across Texas and into New Mexico. Throughout the river basin, the river and its many tributaries cross over a multitude of various geologic formations and soil units. Therefore, the Proposed Action would have a negligible impact on the sediment load and turbidity of the Brazos River at the Project site with implementation of appropriate temporary and permanent BMPs and applicant-committed measures described in Section 2.8.

Visual/Aesthetics

Comment 122. Commentor indicated that the DEIS Section 3.10.8, Visual and Aesthetic Resources, and Section 3.10.8.1.1, Characteristic Landscape, should state that the Brazos River and Oyster Creek are distinctive visual resources in the first sentence.

Response: The first paragraph of the Characteristic Landscape section states that the existing Harris Reservoir, Brazos River, and Oyster Creek all occur within the analysis area and contribute to the visual resources of the area.

Recreation

Comment 123. The commentor states that the DEIS suggests that recreational users would be free to use the river up to and on either side of a construction exclusion zone. The commenter is concerned that intake construction would block a segment of river in the center of a stretch of the Brazos used for recreation, in effect taking approximately 17.5 river miles out of public use. The duration of construction impact on recreation is not defined other than "short term." The DEIS should quantify this loss reflective of actual public use patterns. The EIS should look at opportunities to provide portage access on the west bank of the Brazos River during construction and explain how river closures are to be communicated to the public in a manner that would prevent inadvertent navigation during periods of closure. The commenter also disagrees that long-term impacts due to occasional intake cleaning is negligible because there is no intake cleaning currently occurring. The comment requests that the EIS describe the nature of construction and maintenance activities, the location and duration of navigation disruption, communications with the user public, and what mitigation measures would be undertaken to allow continuous use of the river during construction.

Response: The Corps considers the Brazos River a navigable-in-fact WOUS. Prohibiting free navigation for both commercial and recreational vessel traffic across the entire width of a navigable-in-fact WOUS is not proposed. The impact to vessel traffic, including to recreational kayakers, will be limited to the east bank of the river primarily during construction of the intake structures and would not affect navigation during operations any more than the existing Harris Reservoir intakes located immediately downstream. This has been clarified in the FEIS.

Air Quality, Climate Change, Greenhouse Gases

Comments 124 and 129. The DEIS does not adequately analyze direct, indirect, and cumulative GHG and climate impacts but concludes they are negligible. The DEIS should reference *Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews* (CEQ, Aug. 1, 2016), *Special Report: Global Warming of 1.5°C* (IPCC (2018), *Climate Change 2021* (IPCC 2021),the EPA's Carbon Equivalencies Calculator, the EPA's social cost of carbon calculator, the World Resources Protocol Institute and World Business Council on Sustainable Development's Greenhouse Gas Protocol, the Coastal Study Texas, and the EPA's Environmental Justice Screen tool.

> Response: Section 4.11.2.2 of the DEIS discusses the impacts from the construction and operation of the project and project estimates of GHG emissions over 50 years. The section has been updated to include more detailed information from several more recent studies since the drafting of the original analysis. In addition, the emissions have also been updated to reflect the additional construction activities related to additional road and bridge replacement construction..

Comment 125. The DEIS does not analyze impacts of fugitive equipment leaks even though its location in a floodplain makes it vulnerable to storm surges.

> Response: Thank you for your comment. The project would not be a significant source of air emissions from potential fugitive equipment leaks..

Comment 126. The DEIS does not analyze how the Project's direct, indirect, and cumulative contributions to climate change will impact threatened, endangered, or candidate species and their habitats.

> Response: The air section has been updated to include more detailed information from several more recent studies since the drafting of the original analysis. The Corps has completed the required consultation for ESA and the USFWS has provided their concurrence. Impacts to federally listed species from global climate change is outside of the scope of this project.

Comment 127. Climate change caused by the Project would impact Columbia Bottomlands. Also, removal of Columbia Bottomlands would impact climate change and restoration of bottomlands should be part of mitigation.

> Response: The Corps has established the baseline based on contemporary site conditions and has concluded that the site does not currently have Columbia Bottomland Hardwoods. The stream compensatory mitigation plan will re-establish bottomland hardwoods commonly found in the Columbia Bottomland Hardwoods currently found in the region.

Comment 128. Commentor states that the DEIS does not discuss ways to reduce pollution during the construction and operations of the Project and that the DEIS does not explain that saltwater intrusion itself can be a result of climate change.

> Response: BMPs to reduce air pollution during the construction and operation are specified in DEIS Section 2.8.8. Section 3.3.3 discusses salt wedge could increase with sea level rise. There are many climactic and/or coastal processes that may lead to saltwater intrusion. The DEIS evaluates the proposed project's impact, and the analysis of saltwater intrusion does not inform that evaluation.

Comment 130. Commentor states the information on Page 3-121, Section 3.11.3 states, "… criteria air pollutants …typically have localized air quality effects and relatively short atmospheric lifetimes" is false because pollutants such as ozone can travel hundreds of miles due to wind. The statement in Section 3.11.4.1, Greenhouse Gas Pollutants, "GHG … generally do not have direct impacts to human health," is also false because GHG can cause temperatures that create health emergencies although these direct impacts are delayed due to the time. The GHG discussion in Section 3.11.4.2 should discuss the current lack of air pollution controls for GHGs.

> Response: Section 4.11.1 of the DEIS includes a discussion of the magnitude of the ozone precursors (NOx and VOC) estimated to be emitted during project operations. The precursor emissions would be less than the general conformity de minimis level. Section 4.11.2.2 of the DEIS discusses the impacts from the construction and operation of the project and project estimates of GHG emissions over 50 years. The section has been updated to include more detailed information from several more recent studies since the drafting of the original analysis. In addition, the emissions have also been updated to reflect the increase in anticipated Dow production and growth in the area. BMPs to reduce SF6 leaks during operation are specified in Section 2.8.8.

Traffic

Comment 131. Traffic data is outdated and should be updated for the best picture of what traffic volume and accidents are.

> Response: This section was prepared with data available at the time of DEIS preparation. The analysis has been updated using traffic data available at the time of FEIS preparation.

Agriculture

Comment 132. The commentor requested that the EIS define and describe why removal of Prime, Unique, and Important Farmlands are only a moderate impact.

> Response: The impact to the resource is unavoidable but not major due to availability in the surrounding area. The Project affects approximately 0.3% of soils in the county that are considered potential Prime, Unique, and Important Farmland by the NRCS. The NRCS considers Prime Farmland soils found in areas of proposed water supply reservoirs to be exempt from restrictions under the Farmland Protection Policy Act.

ISSUE 5: SOCIOECONOMICS

Economy

Comment 133. The commentor points out that the DEIS does not discuss the economic benefits of the Project. The commenter cites a document in Dow's permit application and concludes that the provision of water could have an enormous productive and economic benefit for Dow and others.

> Response: This quote comes from Dow's alternatives analysis submitted with the Section 404 permit application in 2018 (page 61; https://www.swg.usace.army.mil/Portals/26/docs/regulatory/Special%20Projects/Initial%20Public%20Notice_Dow.pdf?ver=2020-04-20-171512-273). These do not constitute scoping documents, nor are they part of the

analyses that the Corps considered adequate for purposes of the EIS; therefore, the Corps did not rely on these documents.

Environmental Justice

Comment 134. EPA's Environmental Justice Screening and Mapping Tool should be used to identify vulnerable communities in the region and to consider potential impacts on them. The DEIS does not adequately consider EJ impacts, including the human health, economic, and social effects of the proposed Project on minority and low-income communities. The socioeconomic costs of a project relate to the physical environmental impacts (e.g., impacts on industries, businesses, and employment rates, housing demand and costs). The analysis must also consider problems related to the displacement or relocation of people.

The DEIS does not analyze health factors that are critical for understanding the Project's potential impact on EJ communities and should look at regional access to health care. It should also quantify the percentages of children and elderly in the Project region and recognize that these populations are more susceptible to ozone exposure, VOCs, hazardous air pollutants, and criteria pollutants. The DEIS should recognize that the Project will cause a higher level of pollutants in the air (regardless of compliance with NAAQS), water, and land, along with the associated increased threat of fires and industrial disasters, which will endanger public health, with disproportionate effect on EJ communities. The Project also has the potential to increase the risk of climate change, natural disasters, fires, and flooding in the region, which could damage the local economy and threaten livelihoods.

The DEIS should evaluate the effects the Project and its alternatives might have on Indigenous people and tribes, regardless of whether the Texas Historic Commission recognizes historic properties on-site and regardless of whether these communities are federally recognized. The Corps and DEIS should specifically include consultation with the Karankawa tribe.

Response: Section 3.10, Socioeconomic Resources, has been revised to include information from CEQ's Climate and Economic Justice Tool. This tool, which was released shortly after the DEIS was published, provides socioeconomic, environmental, human health, and climate information to inform decisions that could affect marginalized, underserved, and/or overburdened communities. In addition, Section 4.10.4, Environmental Justice and Protection of Children, has been revised to summarize more comprehensively 1) the biophysical impacts of the Project that are detailed throughout the EIS, and 2) the outreach to populations that could be impacted by the Project.

Comment 135. Census Tract 6619.01 has a minority population percentage greater than 50%, which is identified as an indicator for environmental justice analysis (Federal Interagency Working Group on Environmental Justice and NEPA Compliance Committee 2016). The EPA recommends conducting meaningful outreach to the impacted populations, such as, television and radio announcements, placing notifications at school and religious establishments, and distributing fliers in the impacted communities.

Response: Section 4.10.4, Environmental Justice and Protection of Children, has been revised to comprehensively summarize Project-related outreach to populations that could be impacted by the Project.

ISSUE 6: PUBLIC HEALTH AND SAFETY

Infrastructure Collapse

Comment 136. The DEIS does not adequately assess the direct impacts that the Project will have due to the risk caused by a collapse of its infrastructure.

> Response: The TCEQ's Dam Safety Program will require Dow to have an emergency action plan (30 TAC Chapter 299, Dams and Reservoirs, 299.61(b)). The Corps will rely on the TCEQ's Dam Safety Program to oversee Dow's reservoir operations.

REFERENCES

Brazos River Authority. 2022. Alligator Snapping Turtle (*Macrochelys temminckii*). Available at https://brazos.org/About-Us/Environmental/Species/Species-of-Interest/Threatened-Species/Alligator-Snapping-Turtle. Accessed August 2022.

Jacobs. 2022a. *Extended Hydraulics Modeling Technical Memorandum. Oyster Creek*. Prepared for The Dow Chemical Company. July 21, 2022.

Jacobs. 2022b. *Support for EIS: Brazos River and Oyster Creek Additional Hydraulics Modeling.* Prepared for The Dow Chemical Company. September 28, 2022.

Wood, C.R., T.L. Arsuffi, and M.K. Cauble. 1994. *Macroinvertebrate Assessment of Allens Creek and the Brazos River, Austin County, Texas*. Texas Parks and Wildlife Department. Contract Number 333-0222. December 1994.

Comment ID #	Issue ID	Subcategory	Letter Number	Pages	Comment	Merged Comments
1	NEPA/DEIS	Public Involvement, Public Interest This needs to be moved to 404b1 Public Interest Review	2	19	The Corps is neither a proponent nor opponent of any permit proposal. 33 CFR 320.1(a)(4). As part of its review and permitting of Dow's proposed project, the Corps of Engineers is to conduct a Public Interest Review pursuant to 33 CFR 320.4. "The benefits which reasonably may be expected to accrue from the proposal must be balanced against its reasonably foreseeable detriments." 33 CFR 320.4(a) If the potential detrimental impacts of a project are not evaluated – even ignored – as part of the DEIS and permitting process, these detriments are not able to be accurately balanced against the benefits as required by the public interest review. As this point, the DEIS has not accurately addressed the likely greatest negative environmental and economic impacts from the proposed project – the flooding impacts. The factors to be considered as part of the public interest review explicitly include "flood hazards" and "floodplain values." 33 CFR 320.4(a) These have not been adequately determined for Dow's proposed project, as addressed above. A supplemental EIS should be completed to be able to meet the public interest review requirements for his project.	Comment 1, 85.
2	NEPA/DEIS	Public Involvement, Public Interest	5	3	I also raise concerns about the "safety" and accessibility of the project website that apparently was created by the applicant's contractor. I sent a message to the Corps on May 3, 2022 raising this issue and the problem has not been resolved. When I try to reach this visit this site, my Norton antivirus program sends the message "Dangerous Website Blocked" and notes that "This is a known dangerous webpage. It is highly recommended that you do NOT visit this page." I very seldom receive such messages. See the attached screenshot from earlier this week. This message does not encourage visiting the site and becoming involved, while NEPA clearly encourages making information available and strong public involvement.	NA
3	NEPA/DEIS	Public Involvement, Public Interest	Verbal 2	0	First, I request a 30-day extension of the comment period on the DEIS. There were over -- there are over 1,600 pages of materials in the DEIS and appendices and about 2,000 pages when documents related to the scoping meetings and notices are added. This will take some time to review.· I teach at a local university, and the comment period seems almost perfectly timed to interfere with the busiest times of the spring semester. Some of the DEIS appendices were completed before the 2020 scoping period and were identified in the scoping public notices.· Before the scoping comment deadline, a few of us specifically requested that the Corps make those documents available publicly, particularly since the intent of the scoping process is to identify gaps in information. We now have a limited time to review this voluminous information.· There was no extension granted during the scoping process.· The public and agencies need more time now to review these. I commented in both 2018 and 2020. The comment period for the DEIS began on November 5th. My first email notice from the Corps or a Dow contractor was on April 13th, cutting into this already short comment period. Until April 19th, 11 days into the comment period, the project was identified on the Corps' main public notice page as the Harris County Reservoir Expansion.· The project is not located in Harris County. This mistake could have created confusion for some.	NA
4	NEPA/DEIS	Purpose & Need, Alternatives	1	1	The Army Corps has defined the project's Purpose so narrowly, to focus on reservoir construction and expansion. It thus inappropriately limits the range of potential alternatives and fails to consider alternatives for obtaining water. More specifically, stating the project purpose in such a way that it required selection only of alternatives based on the use of the applicant's existing water right, is similar to an applicant framing their project purpose so that only alternatives based on property it already owns, can be considered. The latter violates the Clean Water Act, Section 404(b)(1) Guidelines, and is unacceptable under NEPA. A supplemental EIS should be prepared based on an unbiased Purpose and Need Statement, and fully analyzing a complete range of suitable alternatives. In addition, while the purpose of the project as stated by the applicant is to expand storage capacity to provide a 180-day supply buffer against drought, some aspects of the project, such as the modification to Oyster Creek to increase channel capacity, are more consistent with increased delivery capacity. If it is Dow's intention to increase delivery to facilitate growth and industrial expansion, then this needs to be clearly stated and the environmental impacts of such expansion need to be accounted for in a supplemental EIS.	Comments 4, 5, 6, 7, 8, 9, 15, 17, 22, and 138.
5	NEPA/DEIS	Purpose & Need	2	17	An important part of any NEPA process is the project purpose and need. In the 2018 documentation for the proposed purpose, "the project's overall purpose" was stated as "providing reliable water supply during drought" by "using existing Dow-owned surface water rights." Over time, the project purpose seems to have changed to reflect the need for construction of storage capacity approximately equal to Dow's proposed reservoir. It seems the purpose is being adapted to fit the proposal.	Comments 4, 5, 6, 7, 8, 9, 15, 17, 22, and 138.
6	NEPA/DEIS	Alternatives	2	17	Another key part of any scoping and NEPA process is identifying possible alternatives to be evaluated. In this river system that is already over-allocated at many flow conditions, conservation and other options should be considered more seriously. BRC requests consideration of a broader range of alternatives to meet the objectives of reliability during a drought and use of existing water rights. Alternatives to be analyzed should include, but not be limited to those listed below:• Evaluation of an upland alternative location – or multiple locations or combination of locations – for Dow's off-channel reservoir capacity that would be outside the Brazos River and Oyster Creek 100 year floodplains. BRC realizes that Alternative 3 is such an option. Yet most of the studies, reports, and analysis in this DEIS related to the proposed reservoir expansion just north of the current Harris Reservoir. If Alternative 3 is explored in more depth, a Supplemental EIS with an appropriate public comment period is needed to provide information for evaluating the impacts of this option.• Deepening or modifying the current Harris and Brazoria reservoirs. • Conservation practices, including both continuing practices and other conservation practices that could be implemented during times of drought.• Operational changes at the Harris and Brazoria reservoirs, within Dow's facilities, or elsewhere.• A salt-water barrier downstream on the Brazos River to minimize a salt water wedge during times of drought and allow the use of water not currently available. Barriers are used on other major rivers in Texas.• Minimizing evaporative losses from the current Harris and Brazoria reservoirs, and elsewhere in the Brazos River and Oyster Creek watersheds. The BRC understands that a floating solar farm is proposed for the current Brazoria Reservoir, which also may have a side benefit in minimizing evaporation losses there.• Enhanced reclaimed water use.• Also, combinations of multiple alternatives that could in the aggregate meet the objectives should be evaluated.	Comments 4, 5, 6, 7, 8, 9, 15, 17, 22, and 138.
7	NEPA/DEIS	Purpose & Need	7	2	The Applicants Purpose and Need Statement in the DEIS is so focused on reservoir construction or expansion that it makes any other alternative method of providing water inapplicable. While the USACE's Purpose and Need Statement is better phrased, it appears more as a platitude than a functional statement. It is our opinion that the use of the applicants Purpose and Need Statement has so biased the direction of study that it effectively thwarts the NEPA process. The entire DEIS has become, rather than an objective decision document, a rationalization for a predetermined outcome. A supplemental EIS should be prepared based on an unbiased Purpose and Need Statement, and fully analyzing a complete range of suitable alternatives. In addition, while the purpose of the project as stated by the applicant is to expand storage capacity to provide a 180 day supply buffer against drought, some aspects of the project, such as the modification to Oyster Creek to increase channel capacity, are more consistent with increased delivery capacity. If it is Dow's intention to increase delivery to facilitate growth and industrial expansion, then this needs to be clearly stated and the environmental impacts of such expansion need to be accounted for in a supplemental EIS.	Comments 4, 5, 6, 7, 8, 9, 15, 17, 22, and 138.
8	NEPA/DEIS	Alternatives	7	2	The Alternative Analysis is entirely biased toward the Applicant Preferred Alternative (Alternative 1). Alternatives 2A and 2B shouldn't even be considered alternatives, since they are actually only minor variations on the Applicant Preferred Alternative. The two actual alternatives, Alternative 3, the West Bank Alternative, and Alternative 4, the Brackish Water Desalinization Alternative, are never fully evaluated nor are the specific impacts quantified in a comparable manner. Alternative 3 is poorly sited and creates an unnecessary cost bias by requiring the relocation of Brazoria County Road 25 from the footprint of the proposed upland reservoir location. There is no conservation based alternative discussed and the USACE has elected not to consider an alternative using the Allens Creek off-channel reservoir project, despite the changes in ownership of the water rights from the City of Houston to the Brazos River Authority, and Dow's involvement in advocating for the project as future	Comments 4, 8, 10, 11

Comment ID #	Issue ID	Subcategory	Letter Number	Pages	Comment	Merged Comments
					industrial water supply. Given the changes in supply ownership and commitments, Lower Brazos Riverwatch believes that this alternative should be fully evaluated as part of a Supplemental EIS. The DEIS provides conflicting evidence as to the loss of storage volume in the existing Harris Reservoir, in some places suggesting a 15 percent (Background § 1.3.1) capacity loss and in other places up to half as of 1990 (3.3.3.2 Dow's Water Need and Water Rights, 3.3.3.2.1 Proposed Action, Alternative 2A, Alternative 2B, Alternative 3, and Alternative 4). Since this storage reduction apparently had existed well prior to the 2011 drought, Lower Brazos Riverwatch believes that maintenance dredging of the existing Harris Reservoir and Brazoria Reservoirs should be evaluated as an alternative to meet water needs without reservoir expansion.	
9	NEPA/DEIS	Alternatives	9	4	Of the alternatives provided, the No Action Alternative or Alternative 3 (modified as explained in these Sierra Club comments) makes the most sense because either there will be no dam/impoundment constructed or a real off-channel reservoir in an upland location will be constructed. Alternative 3 would make even more sense if it was located outside of the 500-year floodplain/floodway (the new 100-year floodplain due to climate change) to ensure that the 1,900-acre footprint of the dam/impoundment doesn't block flood flows in any floodplain/floodway.	Comments 4, 5, 6, 7, 8, 9, 15, 17, 22, and 138.
10	NEPA/DEIS	Alternatives	9	5	The Sierra Club requests that the Corps include Allens Creek Reservoir as an alternative for this permit proposal and that a supplemental DEIS be prepared and released to the public for review, analysis, and comment.Attachment 1, for this Sierra Club comment letter, has several documents that shed light on these recent developments about Allens Creek. Attached is an April 19, 2022 news release from the Brazos River Authority, "Brazos River Authority Purchases Full Rights to the Proposed Allens Creek Reservoir Project From the City of Houston",	Comment 8, 10.
11	NEPA/DEIS	Alternatives	9	7	Alternative 3: West Bank Alternative changes enhance environmental protection and reduce costs. The Corps design for the West Bank alternative requires that County Road (CR) 25 be moved and constructed at a new location and that a bridge be built for a large water pipeline.	Comments 8, 11, 14, 15, 22.
12	NEPA/DEIS	Alternatives	9	52	Page 1-7, 1.3.3 Current Operations, DEIS, the Corps doesn't address drought contingency planning as an alternative or adjunct to alternatives for this proposal. NEPA requires that all reasonable alternatives be considered and or discussed in the DEIS. The Corps must do this and discuss drought contingency planning for this DEIS.	Comments 12, 22.
13	NEPA/DEIS	Alternatives	9	52	NEPA requires that all reasonable alternatives be considered and or discussed in the DEIS. The Corps must consider as a reasonable alternative or as an adjunct to alternatives the digging out of Brazoria and Harris Reservoirs to restore their water- holding capacities.	Comments 13, 15, 22.
14	NEPA/DEIS	Alternatives	9	55	cc. Page 4-1, 4 Environmental Consequences, 4.1 Introduction, DEIS, the Corps states, "an extensive water conveyance system and bridge over the Brazos River" for Alternative 3. If changes are made in Alternative 3 that the Sierra Club recommends as outlined in 5. Alternative 3: West Bank Alternative changes enhance environmental protection and reduce costs, of this comment letter, these costs and conveyance system and bridge will not be needed. The Corps should change Alternative 3 so that it comports with the modifications the Sierra Club recommended.	Comments 8, 11, 14, 15, 22.
15	NEPA/DEIS	Alternatives	10	1-2	USACE has defined the project's Purpose so narrowly, that it may have inappropriately limited the range of alternatives. More specifically, stating the project purpose in such a way that it required selection only of alternatives based on the use of the applicant's existing water right, is similar to an applicant framing their project purpose so that only alternatives based on property it already owns, can be considered. The latter is specifically unacceptable under the Clean Water Act, Section 404(b)(1) Guidelines, and may also be unacceptable under NEPA. However, contrary to the stated project purpose, during scoping the USACE chose to consider desalination of brackish water and desalination of marine water. I was particularly interested in seeing the latter alternative evaluated, since initially it seemed that it might result in fewer environmental impacts than either the proposed alternative, or the brackish water desalination alternative. • Without explanation, USACE eliminated desalination of marine water during scoping. • Note that brackish water desalination, while less costly than marine desalination, has significantly greater environmental impacts than desalination of actual seawater. Both desalination alternatives have fewer environmental impacts when the brine waste is disposed in the ocean rather than in estuarine waters. • However, assuming USACE's assumptions regarding desalination facility size and other requirements are correct (see Alternative 4: Brackish Water Desalination Alternative), it appears the size of any desalination facility, and its wetland impacts, would render any desalination alternative less preferable environmentally than the proposed project. This was surprising to me. Therefore, the fact that USACE adopted a purpose statement that is too narrowly defined, may not actually be a problem, in this case. Please consider my previous comments regarding the overly-narrow purpose, and its potential effect on the adequacy of the alternatives analysis, from this perspective. The USACE must consider additional alternatives, as recommended by your contractor, Watearth (2021), in response to their recognition that the proposed reservoir will cause blockage to interbasin flows from the Brazos River into Oyster Creek: • A modified design to keep the natural overflow paths, • Or a conveyance route for interbasin basin flows that are blocked by the proposed Harris Reservoir (especially B11 and B12 in the HEC-HMS model) Watearth (2021) also proposed another alternative to dealing with this problem-adding detention storage in the reservoir. However, this cannot mitigate for the reservoir effect of blocking and diverting flood flows from the Brazos River. I recognize that USACE has adopted this an alternative, and it is discussed in the DEIS. However, while this mitigates for loss of floodplain storage of precipitation directly onto the surface area of the reservoir, it cannot mitigate for the effects of the reservoir blocking and diverting flood flows from the Brazos River. This is simply not possible. • Another measure to address the blockage of interbasin flows from the proposed Harris Reservoir would be to have an additional detention storage to store 50- and 100-year storm events and mimic the current timing of overflows from the Brazos River into Oyster Creek. This would also help decrease the potential water surface elevation increases due to peak flow increases. Also, see this issue discussed below. Alternative 3 would eliminate concern for potentially unacceptable floodplain effects (e.g. potential increased flood risks to people and infrastructure) of the proposed alternative. However, wetland and other aquatic habitat impacts would be greater, and so would cost. It seems doubtful Alternative 3 would ever be the Least Environmentally Damaging Practicable Alternative, so if this alternative were selected, the Clean Water Act Section 404(b)(1) Guidelines almost certainly would not be met.	Comments 4, 11, 13, 15
16	NEPA/DEIS	Alternatives	10	3	The USACE must conduct detailed modeling studies that will help to estimate the effects of the proposed project on movement and storage of Brazos River floodwaters in the floodplain, propose mitigation to reduce these risks, and provide this information for public review and comment in a Supplemental Draft EIS. More specifically, the USACE must consider the following alternatives, as recommended by Watearth (2021): a modified design to keep the natural overflow paths, a conveyance route for interbasin basin flows that are blocked by the proposed Harris Reservoir (especially B11 and B12 in the HEC-HMS model)	NA

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17	NEPA/DEIS	Purpose & Need, Alternatives	Verbal 1	0	One is my opinion is that the project purpose was inappropriately stated and/or scoped to avoid consideration of some alternatives, specifically desalination. Now, I know that you did (indiscernible) look at desalination of brackish water, but I guess during the scoping process, you eliminated desalination of both of Mexico water and I saw no justification for doing that.· I think that alternative should be considered. And the -- the -- the criterion for elimination should have been, you know, was there (indiscernible) practicable, and practicability is kind of a very important criterion and -- and -- and issue.	Comments 4, 5, 6, 7, 8, 9, 15, 17, 22, and 138.
18	NEPA/DEIS	Proposed Action	9	34-35	Environmental impacts of sedimentation of new and existing reservoirs and dredging and placement of this material have been ignored or are poorly covered in the DEIS. Page 1-5, 1.3 Background, 1.3.1 Applicant, DEIS, the Corps states, “Dow has reported periodic but not regularly scheduled maintenance dredging on the existing reservoirs, which has resulted in loss of storage by approximately 15% of the original design volume.”	Comments 18, 19.
19	NEPA/DEIS	Proposed Action	9	44	Page 3-42, 3.3.3.2 Dow’s Water Need and Water Rights, 3.3.3.2.1 Proposed Action, Alternative 2A, Alternative 2B, Alternative 3, and Alternative 4, DEIS, the Corps states, “Dow has reported periodic but not regularly scheduled maintenance dredging on the existing reservoirs, which has resulted in loss of storage by up to half of the originally design volume. The most recent survey of the existing reservoirs was conducted in 1990.”	Comments 18, 19.
20	NEPA/DEIS	Proposed Action	9	44	10) Page 5-12, 5.4.3.1 Sedimentation and Erosion, DEIS, the Corps doesn’t discuss how well BMPs are complied with and how efficient and effective the enforcement/compliance efforts are for BMPs. The Corps doesn’t document whether inspections are frequent enough and rigorous enough to make BMPs work, inspections don’t reduce sediment, there needs to be more monitoring and more enforcement	NA
21	NEPA/DEIS	Proposed Action	9	53	l. Page 2-41, 2.8.3 Vegetation, DEIS, the Corps fails to require that equipment that is brought to a site and used and then leaves the site is cleaned before it arrives and is cleaned before it leaves so that NNIPS are not spread due to construction. This is a mitigation measure that is a BMP and must be required. n. Page 2-43, 2.8.7.2 Visual and Aesthetic Resources, DEIS, the Corps must ensure that lights are shielded so the light shines downward and not into the sky during night construction as a mitigation measure to reduce light pollution and impacts on bats, birds, insects, and other fauna. o. Pages 2-43 and 2-44, 2.8.8 Climate and Air Quality, the Corps fails to use electric vehicles and equipment to reduce climate change air pollution. The Corps must do this and require this BMP mitigation measure so that it shows leadership in climate change air pollution reduction..	NA
22	NEPA/DEIS	Alternatives	1	5-6	As explained by the Brazos River Club in their June 8, 2022 comments, in this river system that is already over-allocated at many flow conditions, conservation and other options should be considered more seriously. BCWK joins the Club in requesting consideration of a broader range of alternatives to meet the objectives of reliability during a drought and use of existing water rights. Alternatives to be analyzed should include, but not be limited to those listed below: • Evaluation of an upland alternative location – or multiple locations or combination of locations – for Dow’s off-channel reservoir capacity that would be outside the Brazos River and Oyster Creek 100 year floodplains. Alternative 3 may be such an option. Yet most of the studies, reports, and analysis in this DEIS related to the proposed reservoir expansion just north of the current Harris Reservoir. If Alternative 3 is explored in more depth, a Supplemental EIS with an appropriate public comment period is needed to provide information for evaluating the impacts of this option • Deepening or modifying the current Harris and Brazoria reservoirs. • Conservation practices, including both continuing practices and other conservation practices that could be implemented during times of drought. • Operational changes at the Harris and Brazoria reservoirs, within Dow’s facilities, or elsewhere. • A salt-water barrier downstream on the Brazos River to minimize a salt water wedge during times of drought and allow the use of water not currently available. Barriers are used on other major rivers in Texas. • Minimizing evaporative losses from the current Harris and Brazoria reservoirs, and elsewhere in the Brazos River and Oyster Creek watersheds. • Enhanced reclaimed water use. Also, BCWK agrees with the Club that combinations of multiple alternatives that could in the aggregate meet the objectives should be evaluated.	Comments 4, 11, 12, 13, 22
23	NEPA/DEIS	Cumulative Impacts	5	4	Additionally, I briefly raise the issue of sea level rise, which per the DEIS is expected to be between one and two feet in this area over the next 50 years. When we consider that the bottom of the Brazos River is still below sea level at the proposed project site, this could be a significant consideration when evaluating the longer-term and cumulative impacts from the proposed project.	NA
24	NEPA/DEIS	Cumulative Impacts	11	2	With our region facing increasing urbanization, we strongly suggest that all projects within Harris County and the surrounding counties (including Brazoria County) maintain a high level of cumulative impact of this and other nearby projects be considered when assessing impacts and mitigation strategies.	NA
25	NEPA/DEIS+B26:J35	Cumulative Impacts	9	1	Other Dow permits should be included in cumulative Analysis: The Sierra Club provided scoping comments for Permit Application Nos. SWG-1999-02548 and SWG-1999-02549, Dow Chemical Company, Brazoria and Harris Reservoirs, in the Brazos River downstream from FM 521 bridge, near the City of Brazoria, Brazoria County, Texas and in the Brazos River at a point near the City of Angleton, Brazoria County, Texas. These two permits should be analyzed as projects that add cumulative impacts to this Harris Reservoir Expansion DEIS.	NA
26	NEPA/DEIS	Cumulative Impacts	9	3-4	The Corps should require that a study, made public, that discusses the danger of construction of this dam/impoundment in relation to storms, hurricanes, heavy rainfalls, and the impacts of climate change over the next 100 years. The Corps should state clearly the direct, indirect (secondary), connected, and cumulative environmental impacts that this proposed dam/impoundment project will have via the encouragement of development in floodplains/floodways, storm surge zones, geohazard areas, and sensitive ecological places (Sections 1508.7, 1508.8, and 1508.14). The Corps has not done this in this DEIS.	NA
27	NEPA/DEIS	Cumulative Impacts	9	14	Failure to calculate indirect and cumulative effects of Dow increase or full use of water rights not analyzed.	Comments 27, 28, 34, 35, 36, 38, 44, 45, and 57.
28	NEPA/DEIS	Cumulative Impacts	9	16-24	The impacts on the Brazos River and Oyster Creek Floodplains/Floodways and the additional water from the floodplain off-channel reservoir for expansion of the Dow Freeport Works will create cumulative impacts on the floodplain, air, water, and land resources, and environmental justice communities due to Dow expansions.	Comments 27, 28, 34, 35, 36, 38, 44, 45, and 57.
29	NEPA/DEIS	Cumulative Impacts	9		In addition, the population growth, urbanization, development, highway and road construction, that would be fueled by access to more water would continue to impact wetlands, water quality, air quality, floodplains, and other parts of the natural human environment (Section 1508.27(b)(7) and (8)). c. Besides not analyzing the impacts that full or more use of Dow’s water rights has on development, population growth, and urbanization, the DEIS is deficient in its cumulative effects analysis in Section 5.	Comments 29 and 33.

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					1) Not all past, present, and future reasonably foreseeable activities are analyzed for cumulative effects. 2. There is no analysis of environmental impacts caused by expansions of other chemical companies or other companies. 3) No analysis of the effects climate change will have on the GIWW. 4) No cumulative effects due to climate change. 5) No highway projects are listed as past, present, or future foreseeable environmental actions with impacts that should be analyzed and considered. 6) The Corps doesn't analyze the Coastal Study Texas' environmental impacts and cumulative effects. 7) Page 5-9, Table 5.3.1 Past, Present, and Reasonably Foreseeable Projects Included in the Cumulative Effects Analysis, DEIS, the latest Corps Section 10/404 permits aren't analyzed because 2021 permits aren't included. 8) Pages 5-10 through 5-12, 5.4.2 Key Resources Retained for Cumulative Effects Analysis, Table 5.4-1 Key Resources Retained for the CEA, DEIS, the Corps doesn't cover, for cumulative effects, concerns/issues that should be covered including population and housing, industry and employment, environmental justice and protection of children, climate and air quality, noise, historic and archeological resources, surface water/water quality, groundwater, invasive wildlife (feral hogs, zebra mussels, quagga mussels, etc.), hazardous waste, hazardous materials, infrastructure, transportation, and utilities. Therefore, the cumulative effects analysis is deficient and doesn't analyze all important issues. 9) Page 5-12, 5.4.3.1 Sedimentation and Erosion, DEIS, the Corps ignores high turbidity in Brazos River and Oyster Creek and how this will be exacerbated by cumulative actions and their effects.	
30	NEPA/DEIS	Cumulative Impacts	9	44	10) Page 5-12, 5.4.3.1 Sedimentation and Erosion, DEIS, the Corps doesn't discuss how well BMPs are complied with and how efficient and effective the enforcement/compliance efforts are for BMPs. The Corps doesn't document whether inspections are frequent enough and rigorous enough to make BMPs work, inspections don't reduce sediment, there needs to be more monitoring and more enforcement. 11) Page-5-13, 5.4.3.1 Sedimentation and Erosion, DEIS, the Corps doesn't discuss that Dow's O&M plan doesn't take dredging and disposal of dredge material from a reservoir into account and there is no environmental analysis, including cumulative effects, for this concern/issue. 12) Pages 5-13 and 5-14, 5.4.3.2 Prime Farmland Soils/Agriculture, DEIS, the Corps doesn't discuss that prime farmland isn't protected and that its' protection appears to muted because it's considered uneconomic to save it. 13) Page 5-14, 5.4.3.3 Land Subsidence, DEIS, the Corps ignores that land subsidence also occurs due to oil, gas and water associated with oil/gas withdrawal and doesn't analyze the environmental impacts of this and cumulative effects	NA
31	NEPA/DEIS	Cumulative Impacts	9	45	14) Pages 5-15, 5.4.3.3 Land Subsidence, 5.4.3.3.2 Cumulative Effects Summary, 5-16, 5.4.3.4 System Flows/Environmental Flows, 5.4.3.4.2 Cumulative Effects Summary, 5-17, 5.4.3.5 Floodplains/Flood Hazards, 5.4.3.5.2 Cumulative Effects Summary, 5-20, 5.4.3.8 Aquatic Vegetation, 5.4.3.8.2 Cumulative Effects Summary, 5-21, 5.4.3.10 Federal and State Threatened and Endangered Species, 5.4.3.10.2 Cumulative Effects Summary, and 5-24, 5.4.3.11 Visual Resources, 5.4.3.11.2 Cumulative Effects Summary, DEIS, the Corps fails to define "localized", "substantial", "incremental contribution to cumulative effects", "substantively contribute", and "consistent with the existing landscape" for specific concerns/issues.	NA
32	NEPA/DEIS	Cumulative Impacts	9	46	15) Page 5-18, 5.4.3.6 Waters of the United States, Including Wetlands, DEIS, Oyster Creek mitigation is not a wetlands restoration project but a flood control project. 16) Page 5-18, 5.4.3.6 Waters of the United States, Including Wetlands, DEIS, the Corps states that Alternative 3 has more wetlands impacts than other alternatives, but the data is not available to say this since a wetland delineation was not done and compared to the wetland delineation of the proposed project. In addition, the NWI isn't as exact as a wetland delineation and often includes non-jurisdictional wetlands. 17) Page 5-19, 5.4.3.7 Terrestrial Vegetation, DEIS, the Corps fails to estimate how much conversion of undeveloped land for other uses (residential, commercial, and industrial) and loss of terrestrial vegetation will occur. 18) Page 5-20, 5.4.3.8 Aquatic Vegetation, DEIS, the Corps says, "not likely to introduce invasive aquatic plants", with no documentation on why this is so and fails to discuss aquatic invasive animals like the Zebra and Quagga mussels. 19) Page 5-22, 5.4.3.10 Federal and State Threatened and Endangered Species, DEIS, Corps cannot say, "would result in a may affect, not likely to adversely affect", when several alternatives have not had surveys conducted on their project sites to determine if there are species on the sites and to compare the results to the proposed alternative. 20) Pages 5-19, 5.4.3.7 Terrestrial Vegetation, 5-22, 5.4.3.9 Terrestrial and Aquatic Wildlife, 5-23, 5.4.3.10 Federal and State Threatened and Endangered Species and Monarch Butterfly, and 5-24, 5.4.3.10.3 State-Listed Species, are all affected by Corps permits but the Corps doesn't list their permit program on Tables 5.4-8 Potential Contribution to Terrestrial Vegetation Impacts for CEA Projects; 5.4-10 Potential Contribution to Terrestrial and Aquatic Wildlife Impacts for CEA Projects; and 5.4-13 Potential Contribution to Monarch Butterfly Impacts for CEA Projects. Therefore, the summary of potential contributions to cumulative impacts is inaccurate and incomplete.	Comment 32 and 33.
33	NEPA/DEIS	Cumulative Impacts	9	60-62	zz. Page 5-5, Table 5.2-1 Spatial Boundaries for Specific Resources and Page 5-3, 5.2.1 Spatial Boundaries, DEIS, Land Subsidence and Socioeconomic Resources, the spatial boundaries should include Matagorda and Wharton Counties since these are part of the Columbia Bottomlands Area, Ecosystem, and Vegetation and are part of the CEA study area of the Lower Brazos River Watershed. aaa. Page 5-6, 5.2.2 Temporal Limits, DEIS, the temporal limits should not be 5 years before and 5 years after but should be the life of the project. Then a true cumulative effects analysis will be conducted. bbb. Pages 5-6 through 5-9, 5.3 Past, Present, and Reasonably Foreseeable Activities and Table 5.3-1 Past, Present, and Reasonably Foreseeable Projects Included in the Cumulative Effects Analysis, DEIS, the Corps doesn't include many past and reasonably foreseeable activities like Texas Department of Transportation projects, county, city, and federal government transportation projects, county, city, and State government projects, institutional project, commercial and residential projects which can be determined via discussions with developers, industrial projects which can be determined by discussions with industrial companies, two DOW Corps permit projects, Permit Application Nos. SWG-1999-02548 and SWG-1999-02549, listed in 1. of this comment letter, other past and foreseeable Dow expansion projects, Gulf Intracoastal Waterway projects, Coastal Study of Texas projects (seawalls, levees, etc.), Corps permit projects of 2021, rebuilding of the Bluewater Highway, etc. The Corps has done an incomplete and thus flawed cumulative effectives analysis which is inaccurate and underestimates cumulative effects. ccc. Pages 5-10 through 5-12, 5.4.2 Key Resources Retained for Cumulative Effects analysis and Table 5.4-1 Key Resources Retained for the CEA, DEIS, the Corps doesn't include key resources that have impacts due to this proposed project and thus underestimates cumulative impacts. This includes groundwater, which will be used and which will be pumped out to construct the reservoir, invasive wildlife, which does not include feral hogs, Zebra and Quagga Mussels, population and housing which will increase (not minor and localized) due to the full or increased use of Dow water rights, industry and employment which will be significant due to expansions that have just occurred and planned for in the future due to more water use, environmental justice and protection of children which will be worse due to more air pollution from industrial expansions and transportation increases, climate and air quality which will be worse for people due to more fossil fuel energy use and increased air pollution due to industrial and transportation expansions, noise which will be worse due to more urbanization and industrialization, historic and	NA

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					archeological resources, which will be affected by the expansion of development, population growth, and urbanization due to the full or increased use of Dow water rights, hazardous waste/hazardous materials, which will be increased via more industrial expansion and urbanization, infrastructure, which will increase greatly via government and private industry public health and safety, transportation, and utilities projects. ddd. Pages 5-12 through 5-13, 5.4.3.1 Sedimentation and Erosion, DEIS, the Corps ignores that water quality will decrease as more runoff occurs and turbidity increases. The Corps doesn't address how well compliance is for BMP use. The Corps talks about inspections as part of the Dow O&M plan, but these inspections and monitoring don't in themselves reduce water pollution. The Dow O&M plan doesn't address dredging out reservoirs and placement of dredged materials and the cumulative environmental impacts these have. ee. Pages 5-1-5-25, 5 Cumulative Effects, DEIS, the Corps ignores the cumulative effects that full or increased use of Dow water rights will have, as a purpose of this proposed project, on population growth, development (industrial, commercial, residential, etc.), and urbanization which has cumulative effects on topography, geology, soils/prime farmland, sedimentation and erosion, land subsidence, surface water/water quality, groundwater, hydrology, floodplains/flood hazards, water rights, WOUS, including wetlands, terrestrial vegetation, aquatic vegetation, terrestrial wildlife, aquatic wildlife, migratory birds, commercial game animals, invasive wildlife, Whooping Crane, Texas Fawnsfoot, Monarch Butterfly, State-listed Species, pasture, agriculture, population and housing, community facilities and services, industry and employment, environmental justice, visual and aesthetic , navigation, creation, climate, air quality, noise, historic and archeological resources, hazardous waste/hazardous materials, public health and safety, transportation, and utilities. The Corps uses words or phrases that have no definition such as "localized", "substantial", and "incremental contribution" to describe cumulative impacts. The Corps leaves the public blind as to the range, quantitative level of impacts, what methodology was used, and the reason for use of a certain methodology to make such a determination. age 5-19, Terrestrial Vegetation, DEIS, the Corps doesn't provide any indication of the magnitude (quantity) of the conversion of undeveloped land to developed land due to projected growth in the region. Page 5-22, Terrestrial and Aquatic Wildlife, DEIS, the Corps admits that the proposed action, "may adversely affect Oyster Creek downstream of the reservoir outfall" but doesn't discuss what his means and gives no quantitative analysis about this cumulative impact. Page 5-17, Floodplains/Flood Hazards, Page 5-19, Terrestrial Vegetation, Page 5-22, Terrestrial and Aquatic Wildlife, Page 5-23, Federal and State Threatened and Endangered Species, Monarch Butterfly, and Page 5-24, State-Listed Species, DEIS, the Corps fails to include its' own Section 10/404 permit program as a cause of significant cumulative impacts in these affected environment areas. Page 5-25, 5.44 Potential Mitigation Opportunities, DEIS, the Corps refers to mitigation programs which are, "potential" and voluntary only and are not required or mandatory like the Farmland Protection Policy Act; programs with compliance and enforcement problems like the Clean Water Act and Texas solid and hazardous waste regulations; programs that are little use like the NRCS Wetland Reserve Program; county no-rise certification program which has failed miserably to stop or prevent flooding; and state regulations for sensitive species and habitats which don't stop development to justify this "ghost mitigation" for cumulative impacts that will occur but won't be mitigated. This is not acceptable. Therefore, the Corps underestimates significantly the cumulative environmental impacts of this proposed project.	
34	NEPA/DEIS	Scope of Analysis	1	15	There are several deficiencies in the DEIS's analysis. For one, it fails to estimate indirect or cumulative pollution impacts. By only considering direct construction and operational emissions, the DEIS grossly underestimates the project's effects. The DEIS should quantify the reasonably foreseeable, indirect impacts its project will have on communities surrounding the project site. Indirect effects would include all Dow projects that would be enabled by the reservoir's water, including the raw materials and finished products it creates and uses, plus all its emissions from those products and processes. Dow's planned expansion will increase its own production capabilities, but it will also increase the production capacity of other chemical, industrial, and municipal users its new water source will supply. Each user will create its own emissions, pollution, and impacts. This translates to more transportation emissions, more land used for development, more water, air, solid, and hazardous waste pollution, and more flooding risks. Indirect impacts would also include any future expansions, all development, population growth, urbanization, and climate change impacts that result from the increased water supply furnished by the project. The DEIS also fails to take into account the project's past, present, and future reasonably foreseeable activities and their cumulative impacts. Dow's own anticipated emissions and impacts should be analyzed together with those from the operation of nearby facilities, to more comprehensively estimate climate change impacts. Project impacts related to the Brazos River Floodplain and Oyster Creek floodplain should also be considered as cumulative impacts on floodplains, air, water, and land in the region.	Comments 27, 28, 34, 35, 36, 38, 44, 45, and 57.
35	NEPA/DEIS	Scope of Analysis	9	14-15	Dow attempted to hide greenhouse gas emissions in a scoping document, Pages 17 and 18, Attachment D, Alternatives Analysis. Dow failed to mention that indirect greenhouse gas emissions will be very large since this includes all raw materials, intermediate products, and final products that Dow's Freeport Works uses or produces in a year, for instance, and all the carbon dioxide (CO_2) and methane (CH_4) that is emitted during that year that is made possible from the water that this dam/impoundment proposal uses or that allows Dow to fully or in increased amounts use its' water rights. This includes water used for expansion of the Dow Freeport Works since construction of the expanded Harris Reservoir will help Dow use its' water rights. This increase also includes all population growth, development, and urbanization that Dow's water system allows via the Brazosport Water Authority and others that use Dow water or that Dow helps to distribute and use their water rights.	Comments 27, 28, 34, 35, 36, 38, 44, 45, and 57.
36	NEPA/DEIS	Scope of Analysis	9	38-41	Climate Change as an Issue in the DEIS is not adequately addressed. Dow attempted to hide greenhouse gas emissions in a scoping document, Pages 17 and 18, Attachment D, Alternatives Analysis. Dow failed to mention that indirect greenhouse gas air pollution will be very large since this includes all raw materials, intermediate products, and final products that Dow's Freeport Works uses or produces in a year, for instance, and all the CO_2 and CH_4 that is emitted during that year that is made possible from the water that this dam/impoundment uses	Comments 27, 28, 34, 35, 36, 38, 44, 45, and 57.
37	NEPA/DEIS	Scope of Analysis	9	48	Page 5-25, 5.4.4 Potential Mitigation Opportunities, DEIS, this list is virtually meaningless for protection of concerns/issues because: a. The Sierra Club has never seen any prime/unique farmland protected by the Farmland Protection Policy Act; b. There are compliance and enforcement problems with the Clean Water Act regulations so that many streams are not fishable swimmable; c. There are solid/hazardous waste regulations that allow landfills to be placed in communities and next to protected federal lands; d. The Natural Resources Conservation Service (NRCS) has done little with the Wetland Reserve and Conservation Reserve Programs in Texas; e. There is little Endangered Species Act (ESA) critical habitat protected in Texas: f. The no-rise certifications haven't worked, and more flooding has occurred; g. The conservation projects in the area are failing to keep up with conservation protection and the loss of landscapes due to development and population growth which the Corps does not analyze in this cumulative impact section; h. Use of information from the Lower Brazos Floodplain Protection Planning Study is voluntary, the political will is not there to implement most suggestions, and many good suggestions are not mentioned or pushed.	Comment 33, 37.
38	NEPA/DEIS	Scope of Analysis	9	55	Page 3-126, 3.12.2 Alternative 3, DEIS, the Corps doesn't state the impacts that roads currently have on noise levels and how this will increase in the future as traffic levels, road inventory and expansion, development, population growth, and urbanization increases.	Comments 27, 28, 34, 35, 36, 38, 44, 45, and 57.

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39	NEPA/DEIS	Impact Thresholds	9	44-45	This DEIS doesn't provide metes and bounds for environmental analysis levels. This methodology is inadequate, arbitrary, and capricious….The Corps hasn't quantified in the DEIS many of the impacts and the methodology it used hasn't removed "conclusory statements" that Judge Bates ruled against in the NPS lawsuit. Judge Bates stated in his decision that the descriptors "negligible", "minor", "moderate", and "major" are largely undefined or are defined in a manner that includes few objective bounds. These impact level descriptors remain largely undefined and with few objective bounds. The Corps doesn't explain the basis for its' conclusion that potentially "moderate" impacts could not be significant under NEPA.	Comments 39, 40.
40	NEPA/DEIS	Impact Thresholds	9	55-56	d. Page 4-2, 4.1.2 Determining the Level of Impact, DEIS, the Corps refers to "temporary, short-term impacts". However, compaction, sedimentation, and erosion, aren't short-term, temporary impacts and would take decades or centuries to stop, if they ever would. The Crops should rephrase this statement to acknowledge long-term and permanent impacts due to the proposal. e. Page 4-3 through 4-5, 4.1.3.1 Impact Levels for Biological and Physical Resources, 4.1.3.2 Impact Levels for Socioeconomic Issues, and 4.1.4 Impact Types and Durations, DEIS, the Corps impact levels are not quantitative and have no metes or bounds that clearly define where they begin or end. For instance, for biological and physical resources: "Negligible" depends on "measurable impacts", but doesn't answer the question by what or how often; "Minor" refers to words that are general like "Most" "could be avoided", "proper", and "recover completely"; "Moderate" depends on "viability" which is not defined, "would recover completely", Proper mitigation", and "proper remedial action"; "Major" depends on "unavoidable", viability, which is not defined, "would not fully recover", "during the life of the Project". For socioeconomic issues: "Negligible" depends on "measurable impacts" but doesn't answer the question by what or how often; "Minor", refers to "could be avoided", "proper mitigation", "would not disrupt the normal or routine functions", and "would return to a condition with no measurable effects without any mitigation"; Moderate" refers to "unavoidable", "Proper mitigation", "substantially" "some adjustments", and "no measurable effects if proper remedial action is taken"; "Major" refers to "unavoidable", "Proper mitigation" "would reduce impacts", "somewhat", "unavoidable disruptions to a degree beyond what is normally acceptable", and "may retain measurable effects indefinitely". For impact types and durations, the Sierra Club has already pointed out that "temporary" and short-term" are used by the Corps incorrectly since some impacts like compaction, erosion, and sedimentation will last decades, centuries, or perhaps forever due to the proposed project. These impact levels, types, and durations are bereft of any definitions which would tell the public exactly what is acceptable or not accepted at the impact level, type, and duration of impacts. These general words can be used by anyone to mean anything by anyone have no range which doesn't tell the public what the impacts are and aren't and what is acceptable. The Corps should either define these words clearly or use quantification that clearly states what is and isn't acceptable.	Comments 39, 40.
41	NEPA/DEIS	Incomplete Information	9	42	The DEIS doesn't address CEQ Section 1502.22 incomplete or unavailable information. There are many places in the DEIS where information is incomplete and obtainable or is unavailable but has not been addressed by the Corps as required by CEQ Section 1502.22(b)(1-4). The Sierra Club has not listed all places in this DEIS where this regulation applies. There are other places in the DEIS that must use Section 1502.22 as well as other places in these comments where the Sierra Club points out where Section 1502.22 should be used. Some of the incomplete and obtainable or unavailable information in the DEIS include: 1) Pages 3-33 and 3-34, 3.3.1.5 Environmental Flows, DEIS, significant gaps in environmental flow standards remain for Oyster Creek; a full evaluation of Oyster Creek that is similar to that on the Brazos River doesn't exist; and physical flow date for Oyster Creek are limited. 2) Pages 3-48 and 3-49, 3.3.4.1.2 Alternative 3 and 3.3.4.1.3 Alternative 4, DEIS, no wetland delineations were conducted on these two sites. A desktop review is insufficient to determine the number and amount of jurisdictional versus non-jurisdictional wetlands and other waterbodies on the sites. 3) Page 3-69, 3.4.1 Terrestrial, DEIS, Alternatives 3, no field surveys have been done and biological surveys have not been completed; for Alternative 4, no field surveys have been done. 4) Page 3-73, 3.5 Wildlife, Proposed Action, Alternative 2A, and Alternative 2B, DEIS, there is no information about how feral hogs and nutria will be dealt with at the Big Slough mitigation site and on proposed project site. 5) Page 3-79, 3.5.3 Migratory Birds, DEIS, Alternatives 3 and 4, no surveys for birds and commercial game animals have been done. The Corps calls feral hogs a commercial game animal but according to TPWD feral hogs are not game animals but are invasive animal species (and can be hunted at any time) 6) Page 3-91, 3.6.2.5 Mollusks, DEIS, additional mussel surveys have not been done (planned for 2022). 7) Pages 3-131 and 3-133, 3.13.3.2 Alternative 3 and 3.13.3.3 Alternative 4 and Pages 4-61 and 4-63, Alternatives 3 and 4, DEIS, systematic cultural resources investigations have not been done for the sites for these two alternatives. Desktop reviews are not good enough for cultural resources environmental impact analysis.	NA
42	NEPA/DEIS	Incomplete Information	9	43	Page 3-137, 3.14.2.2 Alternatives 3 and 3.14.2.3 Alternative 4, DEIS, in-the-field surveys have not been done for these two alternatives, only database searches have been done. b. Page 4-51, 4.10.6.4 Alternative 4, Visual and Aesthetic Resources, DEIS, the Corps biases alternative comparisons when it states, "The construction-related impacts … within the immediate foreground area and range from negligible to moderate … Overall, there would be temporary, negligible to moderate impacts to visual resources as a result of construction activities". The public is left with no definitive statement about environmental impacts since the Corps has allowed a large range of impact levels, three of the four used for impact levels, (Page 4-4, 4.1. 3.1 Impact Levels for Socioeconomic Issues, DEIS), that could be negligible, minor, or moderate. There is no delineation of which of these impact levels applies to which construction steps or sequence of steps.	NA
43	NEPA/DEIS	Scope of Analysis	9	5	Throughout these DEIS comments the Sierra Club documents why a supplemental DEIS for the proposed expanded Harris Reservoir is needed to cover issues that currently are not covered or that need further discussion and analysis in the DEIS	Comments 43, 44, 45
44	NEPA/DEIS	Supplemental EIS, Scope of analysis	9	25	The supplemental DEIS must compare between the alternatives the direct, indirect, connected, and cumulative effects due to full or increased use of Dow water rights over the life of the proposed project and compares the features, potential environmental impacts, mitigation and monitoring measures, and all biological, physical, socioeconomic, climate and air quality, noise, historic and archeological, hazardous waste and materials management, and infrastructure resources that the DEIS lists.	Comments 27, 28, 34, 35, 36, 38, 44, 45, and 57.
45	NEPA/DEIS	Supplemental EIS, Scope of analysis	9	62	The Sierra Club requests that the Corps prepare a supplemental DEIS for this proposal. This supplemental DEIS will provide for public review, analysis, and comment, which fully provides for NEPA public participation and transparency. The supplemental DEIS should address all the "Other DEIS inadequacies and deficiencies" pointed out in this Sierra Club comment letter. Because of the inadequacies, deficiencies, and questions that this DEIS has, the Sierra Club requests that the Corps hold a public meeting and hearing on this proposed	Comments 27, 28, 34, 35, 36, 38, 44, 45, and 57.

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					project (permit application). In addition, the Sierra Club requests that the Corps conduct extensive public outreach to alert the public in Brazoria County about this proposal and the public meeting and hearing	
46	NEPA/DEIS	Interagency Consultation	1	10	Interagency Consultation – FEMA and Flooding BCWK reiterates a comment of the Brazos River Club: A key part of the NEPA process in interagency consultation, as other state and federal agencies provide comments to the lead agency (here the Corps of Engineers) about the proposed project. The U.S. Fish and Wildlife Service, Texas Parks and Wildlife, the National Marine Fisheries Service and additional agencies typically are involved in the process. Flooding impacts consistently have been at the top of the list of concerns about Dow's proposed Reservoir. In looking the DEIS and the agency scoping meeting report, it appears that the Federal Emergency Management Administration (FEMA), which typically is considered the federal agency most involved with respect to flooding issues, was not consulted. As the Supplemental DEIS and EIS are prepared for this project, we strongly encourage consulting with FEMA at various levels – regional as well as local.	Comments 46, 47, 49, and 50.
47	NEPA/DEIS	Interagency Consultation	2	18	A key part of the NEPA process in interagency consultation, as other state and federal agencies provide comments to the lead agency (here the Corps of Engineers) about the proposed project. The U.S. Fish and Wildlife Service, Texas Parks and Wildlife, the National Marine Fisheries Service and additional agencies typically are involved in the process. Flooding impacts consistently have been at the top of the list of concerns about Dow's proposed reservoir. In looking the DEIS and the agency scoping meeting report, it appears that the Federal Emergency Management Administration (FEMA), which typically is considered the federal agency most involved with respect to flooding issues, was not consulted. As the Supplemental DEIS and EIS are prepared for this project, we strongly encourage consulting with FEMA at various levels – regional as well as local.	Comments 46, 47, 49, and 50.
48	NEPA/DEIS	Interagency Consultation	6	2	Disturbance of streambed materials below the gradient boundary elevation within state-owned streams, navigable streams subject to Small Bill restrictions, or certain perennial streams within land grants originally made under Spanish or Mexican law prior to Texas Independence may necessitate a TPWD sand and gravel permit (Parks and Wildlife Code, Chapter 86). The applicant should coordinate with TPWD's Sand and Gravel Permitting coordinator, Mr. Tom Heger (tom.heger@tpwd.texas.gov), to determine the status of sand and gravel jurisdiction and the potential need for a sand and gravel permit for any work proposed within the Brazos River, Oyster Creek and its unnamed tributary (29.291531 °, -95.560108°), and Big Slough.	NA
49	NEPA/DEIS	Interagency Consultation	10	4	In spite of the fact that it is clear that the most significant potential environmental impacts of the proposed project are loss of floodplain storage, the DEIS does not appear to include any evidence of consultation by either the USACE, or the applicant, with the County Floodplain Administrator or FEMA. This seems contrary to expectations, if not regulations or law, based on NEPA. It may also reflect that the USACE may not be meeting its obligations under EO 11988- Floodplain Management. It is not possible to tell, but it may also reflect the County Floodplain Administrator not meeting its responsibilities. The DEIS does not include any documentation of consultation between either USACE and the Floodplain Administrator, or between the project applicant and the Floodplain Administrator. For a project such as this, which clearly raises questions regarding its potential effects on the floodplain, in a floodplain that experienced massive flooding from the Brazos River recently, it seems obvious that the DEIS should include documentation of consultations with the Floodplain Administrator. I asked the Floodplain Administrator whether such consultation occurred, and I requested documentation. He asserted that such consultation had occurred, but he stated that it had been done by the county engineer. He referred me to the Public Affairs Director of Dow Chemical, the applicant, to request evidence of this consultation. I do not consider it appropriate for an interested citizen to have to request such documentation from the applicant, however, and I did not do so. The Floodplain Administrator stated that the County Engineer actually conducts the floodplain consultations, but he did not actually refer me to them. I did attempt to discuss my questions with the County Engineer though, but after repeated attempts to do so, I gave up.	Comments 46, 47, 49, and 50.
50	NEPA/DEIS	Interagency Consultation	Verbal 2	0	My major concerns about this project relate to its potential impacts on flooding profiles downstream, and the agency scoping the consultant process, it seems that no agencies primarily or directly involved with flooding impacts were brought into this process. A quick search finds no indication of consultation with FEMA or other agencies directly addressing flooding. I urge that FEMA and other agencies involved with flooding issues be brought directly into this process.	Comments 46, 47, 49, and 50.
51	NEPA/DEIS	Lead Agency Review	1	22	9. The Corps must independently verify all information provided by the applicant The CWA requires that the Corps independently evaluate and verify the information supplied by the applicant in determining whether to issue a Section 404 permit. 40 C.F.R. § 1506.5(b). When information is prepared by the applicant, "the district engineer is responsible for independent verification and use of the data, evaluation of the environmental issues, and for the scope and content." Friends of the Earth v. Hintz, 800 F.2d 822, 835 (9th Cir. 1986). Thus, 3 "while the Corps could, and did, base its permit decision exclusively on the information provided by [the applicant], the Corps nonetheless has an obligation to independently verify the information supplied to it." Id.; see also Sierra Club v. Van Antwerp, 526 F.3d 1353, 1368 (11th Cir. 2009) (Kravitch, J, concurring part and dissenting in part) ("when information submitted by an interested party is 'specifically and credibly challenged as inaccurate, the Corps has an independent duty to investigate.'") (citing Van Abbema v. Fornell, 807 F.2d 633, 642 (7th Cir. 1986)); Greater Yellowstone Coalition, 359 F.3d 1257, 1269 (10th Cir. 2004). The Corps must not take the applicant's analysis of impacts and possible alternatives at face value. The Corps must independently determine the scope and extent of impacts to aquatic ecosystems and the environment, and determine whether there are any other less damaging alternatives to the proposed project. The Corps' failure to do so violates its own regulations. 40 C.F.R. § 1506.5(a). The Corps should verify all information supplied by the applicant concerning this project--specifically, information in the wetland delineation and surveys, conclusions about the project's effects on Columbia bottomlands in particular, and information regarding environmental impacts. It must also demonstrate to the public that it has completed this independent analysis to ensure meaningful public participation. See 33 U.S.C. § 1344(a).	NA
52	Water Resources	Surface Water Quality, Sedimentation, Erosion	2	16	Visual observations of the river and the riverbed from our property confirm that erosion has occurred along the Brazos River during the recent flood events. Observations at the Highway 35 bridge downstream from the proposed reservoir also confirm the erosion impacts along the river from recent floods. The greater the volume of water heading downstream during a flood event, and the greater its velocity, the greater its erosive power. The modelling in Appendix B to the DEIS purports to show that velocities, elevations and flow rates in the river remain unchanged due to the project. Yet the overflows that the project would block during actual flood events were not changed as they were brought into that modelling. The discussion above should dispel any trust in these modelling results as accurately representing what changes might be occurring in the Brazos River conditions as a result of the proposed project. This issue needs to be re-addressed, and the likely increased velocities and erosive impacts considered more accurately and directly.	NA
53	Water Resources	Surface Water Quality, Sedimentation, Erosion	7	6	Sediment management is not discussed in any detail in the DEIS. The need for maintenance dredging, and the loss of reservoir volume due to sedimentation is acknowledged in the DEIS and as noted in our comments on the Alternative Analysis, it is given variously as 15 percent, or nearly half of the original design volume of the	NA

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					Harris Reservoir. Sediment management needs to be evaluated in detail in a supplemental EIS. The USACE needs to identify sediment disposal sites, and fully account for the environmental impacts of their use. These are directly attributable impacts to the current proposed project and should not be segmented and deferred for future analysis, since they directly affect the public's ability to meaningfully evaluate the environmental impacts of the project. In the past, Dow has indicated that they would dispose of accumulated sediment in Harris Reservoir by discharging via suction dredge to the Brazos. Lower Brazos Riverwatch believes this to be an unacceptable means of dealing with sediment. If, however, this course of action were to be considered the USACE needs to fully consider the timing of such discharges, the river flow levels at which such discharges could occur, the potential for contaminated sediments from agricultural chemicals, and the down river effects of the additional sediment load, particularly in the vicinity of the mouth of the Brazos, the Gulf Intracoastal Water Way, and the mouth of the San Bernard River. In addition, a detailed analysis of potentially impacted aquatic and benthic habitats in the Brazos below the discharge should be undertaken. Lower Brazos Riverwatch suggests that a supplemental EIS be prepared addressing sediment management as an integral part of the proposed project. Dredge disposal sites should be identified and evaluated. Impacts to the Brazos and Oyster Creek from sediment disposal should be fully considered. Alternatives for sediment management need to be fully developed and analyzed before the environmental impacts of the proposed project can be understood.	
54	Water Resources	Groundwater	9	33	Page 2-39, 2.8.1.3 Sedimentation and Erosion, the only place where the Corps mentions environmental impacts is when it says, "minimize stormwater pollution resulting from erosion and sediment migration from the construction, borrow, and staging areas."	Comment 54 and 55.
55	Water Resources	Groundwater	9	32	Page 3-56, 3.3.5 Groundwater, 3.3.5.1 Proposed Action, Alternative 2A, and Alternative 2B and Page 4-25, 4.3.5 Groundwater, 4.3.5.2 Proposed Action, alternative 2A, Alternative 2B, Alternative 3, and Alternative 4, DEIS, the Corps says that geotechnical borings encountered groundwater at depths ranging from 8 feet and that, "Shallow groundwater depths between 8 and 14 feet were encountered in the central to southern-central portion of the proposed reservoir". How will the applicant get rid of this groundwater? How will shallow water aquifers or water tables be affected? How will the loss of this water affect vegetation and animal life? How will the applicant work around the water found? How will this water be filtered so water pollution does not occur? These are some of the questions that the DEIS should answer but doesn't. The Corps doesn't discuss mitigation measures that could reduce these environmental impacts. Page 2-39, 2.8.1.3 Sedimentation and Erosion, the only place where the Corps mentions environmental impacts is when it says, "minimize stormwater pollution resulting from erosion and sediment migration from the construction, borrow, and staging areas." The Sierra Club requests that the Corps prepare a supplemental DEIS for this proposal. This supplemental DEIS will provide for public review, analysis, and comment, which fully provides for NEPA public participation and transparency.	Comment 54 and 55.
56	Water Resources	Groundwater	9	57	ii. Page 4-9, 4.2.2.6, Land Subsidence, DEIS, the Corps doesn't define and delineate what "Natural land subsidence" is and what is human caused. It's a long-term, major issue and not moderate since climate change, which is human caused, affects how much sea level rises and subsidence occurs and this proposed project will drive additional development, urbanization, and population growth and thus increase subsidence in Brazoria County where the alternative sites are.	NA
57	Water Resources	Water Use, Water Rights	2	18	The DEIS states: "Long-term effects to Brazos River system flows would not be anticipated as Dow is not proposing to increase its water right withdrawal." (DEIS at p. v and p. 4-12) While Dow's RIGHT to withdraw water is not increasing, its ACTUAL WITHDRAWALS of water from the Brazos River would increase if its proposed project is approved. This is an interesting parsing of words, and the withdrawal increases that actually would result from the proposed project and their impacts should be evaluated as part of the NEPA process. The DEIS states: "The proposed reservoir would not be expected to cause a change to the river hydrology due to the large natural flows through the Project vicinity except possibly at the lowest of river flows during drought." (DEIS at p. 4-28). As noted above, the withdrawal rate for the project will be up to 334 cfs. In checking the USGS data for the Rosharon gauge while preparing these comments, the current flow in the river was below 900 cfs, rising from about 800 cfs earlier in the day, and in looking at past data, these are not unusual flow rates. 334 cfs is not a tiny proportion of 900 cfs. The flow in the Brazos at Rosharon can be below 200 cfs during drought conditions. The potential flow impacts should be considered in more detail.	Comments 27, 28, 34, 35, 36, 38, 44, 45, and 57.
58	Water Resources	Flood Hazards	2	2-5	The BRC's greatest environmental impact concern is that the reservoir embankments will block considerable existing floodwater overflows from the Brazos River at the project location that currently go into Oyster Creek and the broader river system floodplain. How does this proposed project impact flood patterns and the damages that result? While extensive modelling has been provided as part of this DEIS, this modelling has not directly addressed this major concern. As a considerable amount of Brazos River floodwater is blocked by the reservoir embankments from overflowing at the locations where it has done so for many years, where will this floodwater go? What new areas might be flooded? What areas might have higher flooding elevations, or higher velocities and hence more erosion, when compared to the existing situation? The DEIS had not accurately addressed these critical issues, and the significant environmental, human, and economic impacts that are likely to result. In both BRC's 2018 comments requesting an EIS for this project and in our 2020 scoping comments, we clearly raised concerns about how the project effectively plugs overflows in this area, and alters the flow between the Brazos River and Oyster Creek and the broader floodplain during flood events. The DEIS confirms that "Under existing conditions, three interbasin flows are occurring between the Brazos River Basin and the Oyster Creek Basin during both the 50- and 100-year storm events within the location of the proposed Harris Reservoir. The removal of these flow paths (Proposed Action, Alternative 2A, and Alternative 2B) results in a shift of the interbasin flows downstream of the existing Harris Reservoir." (DEIS at p. v. See also p. 4-14). Yet there appears to be no real data or calculations in the DEIS or its Appendices to indicate the amount of these interbasin flows that would be blocked or the impact of the "removal of these flow paths" as more water is directed downstream. So we go elsewhere for information. In 2019, the Brazos River Authority published the Lower Brazos Floodplain Protection Planning Study, prepared by Halff Associates (Halff Study). Among other things, this study developed and applied a HEC-RAC model for the Lower Brazos River that evaluates flows, water levels, and floodplains in the Lower Brazos River and discussed the results. This study is referenced in the DEIS, but much of its most critical data seems to be ignored. Maps in the Halff Study show that during a 1% ACE (Annual Chance Exceedance) storm event on the Brazos River, often called the 100 year storm, "Approximately 28,600 CFS leaves from the Brazos River to Lower Oyster Creek" in the area between the Rosharon river gauge south of FM1462 and the current Harris Reservoir. (Halff Study at p. 22 and p. E-50) (CFS is "cubic feet per second" of floodwater.) The maps on pages 1-2 and 1-3 of the DEIS show that the embankments for the proposed project effectively create levees or vertical walls surrounding the land / floodplain between the Brazos River and Oyster Creek for almost a third of the north / south distance between FM1462 and the current Harris Reservoir, blocking the current overflow of floodwater (interbasin flows) in that area. Flow generally trends southeasterly in this region, and the overall embankments surrounding this reservoir also could disrupt the southerly transit of overflows occurring north of the site, not just the water overflowing from the river directly at the site location. As much of this overflow into Oyster Creek and the broader floodplain would be blocked, the Brazos River floodwaters that previously overflowed there likely would be directed westward and downstream, where the Brazos River Club is located. The redirected floodwater also could impact the City of West Columbia, Columbia Lakes and other downstream locations. Yet the modelling done as part of the DEIS purporting to evaluate changes to the Brazos River flows and levels by this project does not incorporate these major changes in	Comments 58, 59, 61, 62, 63, 64, 68, 71, 75, 76

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					interbasin flow patterns into its "existing" v "proposed" flow model for the Brazos River contained in the DEIS. Appendices A and B to the DEIS explain that the HEC-RAC model from the Halff Study was used in the modelling for this project. Dow's contractor made changes to the model by (1) truncating the model at the Rosharon gauge (arguably the upper end of the study area), (2) making minor changes to the boundary conditions, and (3) adding the intake into Dow's propose reservoir. (DEIS App. A at p. 72 and App. B at p. 75) This new intake of 150,000 gpm (334 cfs) would pump water from the Brazos River that will then would be stored and moved through the proposed reservoir and eventually into Oyster Creek as this project operates to store and move water for Dow. These Appendices simply state that "any backwater effects associated with the existing and proposed reservoir are expected to be isolated to the area in the closer vicinity to the existing Brazoria and Harris reservoirs and proposed Harris reservoir expansion." (DEIS App. A at 72 and App. B at 75) This is a conclusory and unsubstantiated statement. Backwater effects are increases in the elevation of the water level in a river or hydraulic system due to obstructions or blockages. As an example, backwater effects can occur upstream of a bridge, where the piers and the related structure of the bridge redirect some of the water, somewhat increasing the water level. This is the type of impact that the BRC has consistently raised concerns about. Compare this conclusory quote from the DEIS to the more detailed discussion in the Halff Study, quoted below, which address the importance and impact of these overflows in this stretch of the Brazos River in minimizing increases in water elevation during flood events. The modelling runs in the DEIS trying to demonstrate the river flow, height, and velocity AFTER the project is in place, documented in Appendices A and B of the DEIS, seem to have LEFT IN WITHOUT CHANGES these large overflows near and at the project location that in reality would no longer occur or would be substantially disrupted. (See the more detailed discussion below.) The modelling as part of the DEIS incorporated the 334 cfc intake, but ignored the much greater impact of the blocked / diverted overflows. The DEIS does not address what portion of the approximately 28,600 cfs (56,727 acre-ft/day)\ of overflows in this area are impacted by proposed project, while it clearly recognizes that at least some of these interbasin "flow paths" are "removed." (DEIS at p. v and 4-13) To bring some perspective, at the 28,600 cfs rate, the DAILY overflow from the Brazos River into Oyster Creek and the associated floodplain in this stretch of the river downstream of the Rosharon FM1462 bridge and north of the current Harris Reservoir during a 1% ACE storm event – much of which will be blocked by the proposed embankments -- is slightly greater than the total amount of water that would be stored in the proposed reservoir when filled. Hurricane Harvey was somewhat smaller than such an event. During Harvey and some other flood events, high river flows and elevations continued for several days. While overflows might not be at the peak 1% ACE storm rate for the full time, in this stretch of the river, high but somewhat lower levels might occur for days before the water recedes, which represents a huge volume of overflowing floodwater. The Brazos River Club owns property in Brazoria County that is immediately adjacent to the Brazos River and is located just a few miles downstream and west of Dow Chemical Company's proposed reservoir. The BRC is a likely destination for this diverted overflow floodwater. The approach used in the DEIS failed in addressing the major concerns raised in the BRC's comments to both the 2018 proposed permit and the 2020 scoping. The modelling focused on the fly sitting quietly in the corner while ignoring the elephant stomping around the room. According to NEPA, a federal statute, an Environmental Impact Statement (EIS) is to look at "the environmental impacts of the proposed action." 42 U.S.C. 4332(1)(C)(i). Under NEPA's regulations, the EIS "shall provide full and fair discussion of significant environmental impacts." 40 C.F.R. 1502.1 This DEIS does not take an accurate and hard look at the impacts of the blocked overflows between the Brazos River and Oyster Creek and the associated joint floodplain, a major concern raised in our prior comments and also by others during the scoping comments. The DEIS also does not accurately analyze the amount of lost flood plain storage. This issue should be considered in addition to the hydraulics issues raised by the blocked overflows. The BRC requests that to satisfy the requirements of NEPA, the Corps of Engineers prepare a Supplemental DEIS addressing the significant impacts from the proposed project as it blocks overflows into Oyster Creek and the surrounding floodplain and other issues raised in these comments. The Corps should allow for full transparency and public participation as this additional information is made available for an additional comment period.	
59	Water Resources	Flood Hazards	2	5-6	Between June 2015 and May 2019, there were five river floods that impacted our property and the adjacent homes of our members. Prior to that, it had been over 20 years since we experienced a river flood. These homes have flooded, or been left stranded with water under and surrounding them, during each of these floods. BRC and its members incurred expenses and significant effort and inconvenience relating to these floods and their aftermath. As flood height or duration increases, so do the damages and lost use. Based on the observations of multiple shareholders of the BRC – some of whom have more than 60 years of experience observing multiple local floods – there is an indisputable interconnection between the Brazos River and Oyster Creek during flooding events. Also, major rainfall far north of our area generally impacts flooding from the Brazos River more than local rainfall. Often floods reach our area long after the rains have left, when the sun is shining. Our flooding occurs when water overflows the western bank of the Brazos River north of our property and works its way southward through the floodplain. During these inundation events, our property and homes can be flooded for a few weeks before the water eventually recedes. The proposed reservoir is a short distance upstream on the Brazos River, north and east of our property. Again, as the current large overflow at the proposed project is blocked, then localized water levels can rise and floodwaters be diverted. These likely would be forced our direction.	Comments 58, 59, 61, 62, 63, 64, 68, 71, 75, 76
60	Water Resources	Flood Hazards	2	7	The experience of our BRC members, confirmed by the DEIS, is that flow from upstream of the Rosharon gauge is the major factor for flooding on the Brazos River. It is a major river…There is plenty of confirmation that most flooding incidents near the proposed project are driven by flow from upstream rather than local rainfall. There is a long history of flooding along the Brazos River that we will not repeat here. The initial permit application identified the proposed site as part of only the Oyster Creek floodplain, and not the larger Brazos River floodplain. During relatively dry and low-flow times, this arguably is the case. In 2018, the BRC, along with others, pointed out that this floodplain merged with the Brazos River floodplain during flood events. This was confirmed as the Corps of Engineers determined that an EIS was needed for Dow's proposed project. Yet much of the discussion of flooding and related mitigation in the DEIS still seems to be focused primarily on the Oyster Creek watershed during storm events, while not really considering the impacts and needed mitigation to address what happens when there is major flooding on the Brazos from upstream that dominates over the localized rainfall.	NA
61	Water Resources	Flood Hazards	2	7-10	The Halff Study, referenced above, and its Appendices can be found at: https://brazos.org/Project-Updates/Lower-Brazos-Floodplain-Protection-Planning-Study The Halff Study was prepared for the Brazos River Authority under a grant funded by the Texas Water Development Board. Several other stakeholders providing funding and information to support the study. The first paragraph of the Halff Study includes the following: The Lower Brazos River is an integrated system in which the entire basin must be considered including the interaction of reservoirs, levees, overflows, diversions, bridges, etc. to accurately assess flood impacts and the complex interaction of these elements. The basin-wide based floodplain protection planning study was necessary to more accurately determine the overall existing flood hazards and determine the feasibility of flood reduction alternatives. (Halff Study at p.1; p. 15 in the pdf document) The quotes above and below show (1) that this was an extensive study, (2) the importance and impacts of the overflows into Oyster Creek on flooding and water elevations in this area of Brazoria County, and (3) that the modelling resulting from the Halff study was calibrated to confirm it reached results that were fairly consistent with levels	Comments 58, 59, 61, 62, 63, 64, 68, 71, 75, 76

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					during prior storm events. In addition to the Brazos River, other river systems in Fort Bend and Brazoria counties were included to account for the overflow conditions that exist within the Lower Brazos River Basin during large rainfall events. . . .In addition to the Lower Brazos River, cross sections in overflow river reaches were created to simulate the interaction between both the Lower Brazos River and the overflow river reaches. The calibration storms consisted of the June-July 2007, the May-June 2016 and the August-September 2017 events. (Halff Study at p. 11) The Rosharon USGS gauge is located downstream of FM 1462 in Brazoria County and has . . . been in service for 49 years. The Brazos River in this area overflows into Oyster Creek resulting in a very wide floodplain. (Halff Study at p. 20) At the Rosharon Gauge: The water surface elevations were comparable to each other between the storm events [10%, 2%, 1% and .2% ACE storms] because much of the discharge upstream in the Lower Brazos River overflows into Oyster Creek. This overflow widens the floodplain. (Halff Study at p. 21) From Appendix E – Hydraulic Analysis. Beyond 70,000 cfs, [at the Rosharon gauge] the water surface elevations plateaued and rose very little even with significantly higher flows due to the overflow conditions between the Brazos River and Oyster Creek. . . . In B Brazoria County, overflow occurred between the Brazos River and Oyster Creek creating a very wide floodplain during the 1% ACE event. (Halff Study at E-54) Based on the unsteady hydraulics analyses, the Lower Brazos River and tributaries are a complex system of flow transfers that were not considered in previous modeling efforts of the Brazos River. These areas of interaction include transferring flow to other river systems or storing volume to be released back in to the Lower Brazos River. High flow events greater than 60,000 cfs can trigger these overflows and create a vast network of impacted streams and areas. (Halff Study at E-60) As noted in these quotations, during flood events the elevations in the river at the Rosharon gauge location generally do not increase drastically once a certain level of flow is reached BECAUSE these overflows occur. Summarizing some additional information contained in tables the study, at the Rosharon gauge, between the modelled 10% to .02% ACE storm events (often considered the “10 year” and “500 year” storms), the river elevation changes by about a foot. In contrast, at the upstream Richmond gauge, which does not have this degree of nearby overflows, between the 10% and .02% storm events, the river elevation changes by over 10 feet. This helps confirm the discussion in the quoted content above that these major overflows can make a real difference in reducing increases in flood elevation in this area of the river. We encourage reviewing the Halff Study and its Appendix E, attached. Looking at the Halff Study, the flow within the Brazos River at the Rosharon gauge during a 1% ACE flood event is about 145,000 cfs, with about 28,600 cfs, or almost 20% of this amount, overflowing into Oyster Creek in the stretch just downstream of the gauge that includes the project. In other storm profiles, the relative percentage might be higher or lower. The DEIS confirms that overflows would be blocked by the project (DEIS at p. v) but, as previously noted, does not seem quantify the amount or bring these impacts into its modelling of the Brazos River system. Again, in the DEIS modelling of the Brazos River, the only real changes made to the model and data used in the Halff Study is truncating the model to set the upper limit at the Rosharon gauge, some apparently minor revisions some boundary conditions, and adding the intake from the river into the new reservoir, with no change to the overflow values. (DEIS App. B at 75-76) Also see the discussion below on the DEIS modelling. There do not appear to be additional major overflow areas from the Brazos River into Oyster Creek of a such a great magnitude “downstream” of the proposed site. In looking at the maps in the Halff study, there is a smaller overflow area into Oyster Creek around and north of SH35, of about 18,000 cfs during a 1% event. The BRC is located between the proposed reservoir and that location, so water elevation rises in that stretch may impact the BRC and others. Moving farther downstream, some of the water then gradually starts flowing back into the Brazos River from the Oyster Creek side of the floodplain. We generally understand that some of this floodwater continues downstream in Oyster Creek, while some may overflow into other watersheds and could make its way to Bastrop Bayou and Christmas Bay. So what happens to the flooding patterns and the water elevations in the area around and downstream of the proposed project as these current eastward overflows are blocked – and it may be some distance to other overflow locations into Oyster Creek? Consider that the current Harris Reservoir blocks eastern overflows in the area immediately downstream of the proposed project. There already is some westward overflow that impacts the BRC. How much of this “blocked” water might be redirected westward – into our club, West Columbia, Columbia Lakes, and other places west and downstream? As this redirected floodwater moves “downstream” through the floodplain, what new areas might be impacted that generally have avoided flooding in the past? What areas might be impacted more severely than they would otherwise? These critical issues and associated impacts have not been directly addressed in the DEIS. Also consider that these overflows can continue for some time, so overall a very large quantity of water can be involved. During Hurricane Harvey, the 1991/1992 flood and the later of the 2016 floods, the discharge and water elevations at the Rosharon gauge remained high for days. It seems the proposed Dow Harris Reservoir Expansion is creating a great experiment with respect to flooding changes on the Brazos River, and the BRC could very likely be among the victims.	
62	Water Resources	Flood Hazards	2	10-14	Different types of flooding impacts are implicated by the proposed project. There are basically three types of flooding impacts that can occur: (1) the impacts on the hydraulics / dynamics of the Brazos River floodwater as major floods come from upstream and flow into the greater floodplain, focusing on the changes with the overflow / movement of the blocked water, (2) the impacts from the removal of floodplain storage from the Brazos River’s floodplain as major floods come from upstream and flow into the greater integrated floodplains, and (3) the impacts on the floodplain and floodplain storage as rainfall occurs in the immediate area around the project during events such as a localized 10%, 2%, 1% or .02% ACE storm. These three factors integrate with each other, and one or all could be occurring to some degree at the same time. Yet as discussed above, “the river discharge on the Brazos River is significantly dominated by upstream riverine processes rather than precipitation-induced discharges in the coastal plain” and usually “precipitation processes can be ignored in the analysis” of “the long-term hydrodynamics.” (DEIS App. B at p. 20) Flooding from upstream is the driving factor in defining the impacts from Dow’s proposed reservoir. Yet in determining impacts and floodplain storage losses to be mitigated, much of the focus in the DEIS seems to have been based on rainfall driven events in the Oyster Creek watershed. There is a disconnect occurring here. The DEIS states that the “Project is estimated to result in a 1,028 AF (1%) lo ss of floodplain storage during a 100-year storm event.” (DEIS at v and p. 4-17) Where did this value for 1,028 AF of lost floodplain storage come from? How was it derived? From Appendix B: “There would be a net loss of 1,028 ac-ft Oyster Creek floodplain storage when the proposed Harris Reservoir is constructed.” (DEIS App. B at p. ii, emphasis added) In determining where the 1,028 ac-ft loss comes from, this analysis is primarily discussed in Appendix C to the DEIS. This attempts to model the flood impacts in the Oyster Creek portion of the watershed during various rainfall events. A major input in this “model” is localized rainfall data from the “1999 Fort Bend County Drainage Criteria Manual.” (DEIS App. C at p. 5) “The Brazoria County, Texas, and incorporated areas FIS (revised 9-22-1999) was reviewed for this analysis.” (DEIS App. C at p. 6). This model in Appendix C also assumed Dow would be making no operational releases to Oyster Creek during a storm event “[s]o only natural rainfall and runoff from the contributing drainage area will have to be considered in the modelling of the 50- and 100 – year storm event on Oyster Creek.” (DEIS App. C at p. 9, emphasis added) Under the heading “Considerations for Proposed Oyster Creek Improvements and Oxbow Storage”: “The proposed project reservoir will prevent Oyster Creek overflow into the west floodplain of Oyster Creek for approximately 12,000 feet of the creek. The Dow proposed Oyster Creek improvement projects do not fully mitigate for this storage loss.” (DEIS App. C at p. 9.) So according to this DIES, apparently it is the loss of “overflow into the west floodplain of Oyster Creek” FROM Oyster Creek (as contrasted with from the Brazos River)	Comments 58, 59, 61, 62, 63, 64, 68, 71, 75, 76

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					that represents this 1,028 acre-feet to be mitigated. During very localized storms, this mechanism may accurately describe the lost floodwater storage capacity within the isolated Oyster Creek floodplain. In looking very generally at the three proposed mitigation projects in the DEIS, this is the type of flow and storage that might be mitigated by them. These projects are all on the eastern side of Dow's proposed reservoir. To emphasize again, the flood events of greater concern are large floods coming from upstream on the Brazos River. During these events, this "floodplain storage" area identified for localized Oyster Creek rainfall – what arguably is the floodplain storage being "lost" and mitigated for -- would already be overwhelmed by the water overflowing eastward from the Brazos. The area analyzed as lost "west floodplain of Oyster Creek" already effectively would be unavailable. What is the relevance of these calculated Oyster Creek Floodplain losses during such major Brazos River flood events that overwhelm this area with water overflowing in the opposite direction? The situation of concern to be modelled for floodplain storage loss and mitigation should be a major flood coming from upstream on the Brazos River, where the sun might even be shining locally. Again, this clearly was acknowledged in the DEIS, as quoted earlier. "[P]precipitation processes can be ignored in the analysis. Such behavior is expected due to a large drainage area. It is possible that heavy local rainfall between the Rosharon gage and the Harris Reservoir project intersection could influence hydrodynamics at the project site. However, long-term trends indicate it is an infrequent event, which would not likely alter the long-term hydrodynamics." (DEIS App. B at p. 20) There may be arguments that the overflows from the Brazos River are considered as "sources and sinks" in this "Oyster Creek" model in Appendix C used to determine the lost floodplain storage, so this addresses that issue. Let's look at that consideration in more detail. The Brazos/Oyster interbasin flows are represented in the HEC-HMS model as sources and sinks. The sources are considered positive inflows entering Oyster Creek and the sinks are considered negative outflows leaving Oyster Creek, which return to the Brazos River. After a thorough review of the Lower Brazos Flood Protection Planning Study, the flow hydrographs were adjusted to generate peak flow results at the same nodes/river mile stations similar to the Brazoria County FIS study. The lateral structure hydrographs from the Lower Brazos Flood Protection Planning Study were used to represent the interbasin flows; however the flow hydrographs were decreased by 75% to 80% to better match the results found in the Brazoria County FIS study. The lateral structure hydrographs from the Lower Brazos Flood Protection Planning Study HEC- RAS model were entered at the centroid of the lateral structure weir length and transferred across to Oyster Creek. This method was used to place the interbasin flow sources and sinks into the appropriate locations in the HEC-HMS node diagram. (DEIS App. C at ii) There has not yet been a hydraulic analysis to determine where the blocked and redirected overflow waters would go. How would a modeler know the "appropriate locations" to include these as returns into the Oyster Creek model? In reality, would they all return into Oyster Creek, or rather head westward? Additionally, this quotation from the Oyster Creek study notes that the "hydrographs" taken from the Halff study "to represent the interbasin flows" were "decreased by 75% to 80% to better match the results found in the Brazoria County FIS study." So how accurate and reliable are the results of this localized Oyster Creek model expected to be when the data taken from the more recent and thorough 2019 Halff Study for the overflow values is adjusted downward about 75 to 80% to make it more consistent with what appears to be the older and less accurate 1999 floodplain study for the county? Might there be other reasons to go with a localized rainfall model rather than evaluating the situation where major flooding is coming from upstream while the sun is shining locally? Let's look at some of the other considerations related to rainfall brought into Oyster Creek model and discussed in the DEIS. The DEIS states that "[b]between May 15 and December 1, Dow would monitor weather events, and in the event of a hurricane making landfall, would drawdown the reservoir to allow 1.7 feet of capacity, which would capture up to 19 inches of rainfall." (DEIS at p. ix) The DEIS and related studies look at 8 different operating scenarios, six of which include "[D]drawdown 18 inches prior to a storm event" to hold 6, 9, or 12 inches of rainfall as "floodplain storage in the reservoir before spillway discharge for" either the 50-year or 100-year "24-hour design storm event" (DEIS at p. 4-17 and App. C at p. vii-viii. See also the DEIS at p. 4-16 to 4-19.) It seems an assumption in the modelling in Appendix C, incorporated into the DEIS, is that the drawdown in the reservoir will be able to absorb the rainfall that will fall on it during the modelled localized storm event and this is credited as "floodplain storage" in the model, effectively removing that area within the reservoir from needing to be accounted for as floodplain storage losses that need to be mitigated. This might be appropriate if localized rainfall represents the greatest flooding concerns for the project. This is not the case. During Brazos River flooding coming from upstream, with the peak river elevations possibly reaching the project and BRC while the sun is shining, this proposed drawdown and its ability to capture rainfall is irrelevant in determining the actual floodplain storage losses as a result of this project. There would be no local rainfall to mitigate, only flow from upstream. This floodwater not only would be obstructed hydraulically by the project, but the project's footprint. including its embankments removes 2000+ acres from the floodplain where these floodwaters can no longer be stored. The DEIS states: The lowest elevation in the Project site is 2 feet MSL at the Brazos River near the proposed pump station, and the highest elevation is 45 feet MSL along the existing Harris Reservoir's northern embankment. (DEIS at p. 3-2) During flood events, this project site is likely covered in several feet of water as the overflows occur toward Oyster Creek and beyond. Considering some of the discussion below, the average flooding depths across the site during a 1% ACE storm might be several feet deep. The floodplain storage losses in this more likely situation -- flooding coming primarily or exclusively from upstream on the Brazos -- do not seem to have been addressed in the DEIS. The modelling in Appendix C seems to be an exercise to find various values that have little relevance to the reality on the ground during a major flood coming from upstream. See also the discussion in the Modelling area below. Again, of greatest concern to the BRC is the impact on the hydraulics of the river system during major flood events from upstream rainfall. How are the dynamics of the flow of water in the Brazos River and its greater integrated floodplain impacted by the large embankments of the proposed project, as well as the large area where flow and storage of floodwaters would no longer occur? The Halff Study did a credible job of looking at the current hydraulics / dynamics of the Lower Brazos River during flood events. With the information from the Halff study and above, look again at the maps on pages 1-2 and 1-3 of the DEIS that show the location of Dow's proposed reservoir and consider its proposed high embankments. Is a conclusory statement that "any backwater effects associated with the existing and proposed reservoir are expected to be isolated to the area in the closer vicinity to the existing Brazoria and Harris reservoirs and proposed Harris reservoir expansion" (DEIS App. A at 72 and App. B at 75) sufficient analysis of our concern about the project's impact on river hydraulics? We don't think so. A supplemental DEIS addressing the impacts of Dow's proposed reservoir on the hydraulics of the Brazos River system during major flood events is needed to meet the requirements of NEPA to look at "the environmental impacts of the proposed action" (42 U.S.C. 4332(1)(C)(i)). The current DEIS fails to "provide full and fair discussion of significant environmental impacts" required in a DEIS. (40 C.F.R. 1502.1)	
63	Water Resources	Flood Hazards	2	14-16	Appendix A to the DEIS, the Preliminary Hydrology and Hydraulics Report, was completed in January of 2020, before the public scoping timeframe for this DEIS, but was not made available to the public until the recent release of the DEIS. It would have been helpful to have this information as part of the scoping process. Appendix B includes similar information, with some updates. Appendix C, discussed above, focusses on a localized rainfall situation. Of particular concern is the 10.5 year time frame chosen for these studies. It is January 1, 2009 through May 6, 2019. (See DEIS App. B at p. 56-57) Why stop at May 6, 2019? Why not use June 30, 2019, and make and a full 10.5 years? Consider that beginning on May 7, 2019, the Brazos River entered flood stage elevations at the Rosharon gauge. The water levels continued to rise until May 11, 2019, the peak at the Rosharon gauge for that flood event. The crest reached that day of 50.36 feet at the	Comments 58, 59, 61, 62, 63, 64, 68, 71, 75, 76

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					Rosharon gauge is listed as the seventh highest historic crest for that gauge since 1965, the earliest date in that list. The flow at that time was 78,000 cubic feet per second, the highest levels reached since Hurricane Harvey. The "10.5 year" time frame used excluded this flood event. Why was this time frame selected? The DEIS does not seem to address this issue. This omission is concerning to us, as the BRC and its members experienced significant flooding during that 2019 event. The model in Appendix B ran from the Rosharon gauge at the north (River Station 308,583.5 in the model), past the proposed reservoir inflow where water is pumped into Dow's proposed reservoir near the southern part of the project (River Station 283,920.7 per App. B at p. 76), and southward to an area closer to Freeport and the Gulf of Mexico, where there are notable tidal effects (River Station 9,604.0) As quoted above, "[t]he lowest elevation in the Project site is 2 feet MSL at the Brazos River near the proposed pump station, and the highest elevation is 45 feet MSL along the existing Harris Reservoir's northern embankment." (DEIS at 3.2) The current Harris Reservoir's northern embankment is the southern end of the proposed project. The Harris Reservoir embankment clearly is elevated above the surrounding area, and apparently has not been overtopped in recent flooding events. All the rest of the site must be well below 45 feet MSL, with some areas as low as 2 feet. We encourage review of the calculated Water Surface Elevation (WSEL) in Appendix B during the modelled 120,000 cfs event at "existing condition", with the river water elevation going from 53.84 feet at the Rosharon gauge (308,583.5) to 40.62 feet the intake site (253,920.7). This intake is north of the southern boundary of the proposed site and the current Harris Reservoir's embankment. (See DEIS App. B at 85 to 86). These land elevations and the calculated water elevations appear to additionally confirm that much of the property almost certainly would be under at least a few feet of flowing water during the modelled storm event. So how much floodplain storage really is displaced by the proposed reservoir during major upstream flood events? Again, the DEIS does not seem to address even the basic "footprint" floodplain storage loss issue, as the modelling completed as part of the DEIS rather seemed to assume that much of the reservoir's area would absorb falling rainfall to be stored within the reservoir. This assumption is not valid during the more likely flood events, when considerable rainfall is not occurring at the same time that the peak flooding occurs and overflows that are blocked by this large area removed from the floodplain. Again, the skies might even be sunny. Also look at Figures 60 and 61 in Appendix B showing the "existing" and "proposed" stream flows in the main channel and also the left and right overbank flow during the modelled flood event. (DEIS App. B at p. 84) These graphs also confirm (1) that there currently are considerable overflows between the proposed project inlet (at 253,920.7, near the southern end of the project site) and the Rosharon gauge (at 308,583.5), and (2) that these overflows were left in unchanged for the model runs arguably finding the "after" flows within the main stream of the Brazos River. Obstruction of at least some of these overflows represent the biggest actual changes in the "existing" and "current" conditions, and these changes were ignored in the modelling. Again, the BRC is much more concerned about the impacts of Dow's proposed reservoir during major floodwaters come from upstream than during localized rainfall events. Ignoring the impacts of the blocking of these overflows during the analysis of the flood elevations in the Brazos River, and rather modelling them as sources and sinks at drastically lower rates into localized Oyster Creek model during a localized rainfall event, fails to address the BRC's flooding concerns. We could provide more detailed criticism of the model in Appendix C focusing on storm events in the Oyster Creek watershed, but do not believe that is needed at this point. While modelling has been done, it avoids addressing the issues of concern that present the most significant potential for major environmental impacts resulting from Dow's proposed reservoir. A supplemental DEIS addressing the impacts of Dow's proposed reservoir on the hydraulics of the Brazos River during major flood events is needed to meet the requirements of NEPA to identify and determine "the environmental impacts of the proposed action" (42 U.S.C. 4332(1)(C)(i)). The current DEIS fails to "provide full and fair discussion of significant environmental impacts" required in a DEIS. (40 C.F.R. 1502.1)	
64	Water Resources	Flood Hazards	5	1-2	The Corps' September 4, 2018 significance determination for this project confirms that "[t]he proposed Reservoir is located . . . within both the Brazos River and Oyster Creek 100-year Federal Emergency Management Agency (FEMA) regulatory floodplains." (at p. 1). It found that "the proposed project would result in the removal of approximately 2000 acres of wide floodplains with significant storage effects on the hydrograph in a region currently vulnerable to flooding. If the proposed Reservoir significantly alters the flooding on the Brazos River or Oyster Creek, the impacts to local citizens and stakeholders may be significant . . . To be able to evaluate the significance of the direct, indirect (i.e. the causal secondary effects), and the cumulative effects in the Lower Brazos River basin from the proposed water supply project and/or its alternatives, the development of current hydrologic conditions without and then with the project is needed as well as the ability to predict future hydrologic conditions." (at p. 7, emphasis added) As noted in the comments of the Brazos River Club, these flooding concerns and impacts have not been directly and accurately addressed as part of this DEIS process. The inputs for the main issues of concern with respect to this project – the blocking of existing overflows during flood events – were left unchanged between the model runs "with" and "without" the project used to evaluate changes in elevation and flow in the main channel of the Brazos River. The significance determination quoted above clearly expected accurate "with" and "without" modelling of the flood impacts. While the DEIS includes Appendices that contain a considerable amount of documentation related to flooding on the Brazos, these fail to address the flooding scenarios that create the greatest concern and are most likely to cause significant impacts. I discussed Project Brays in my 2020 scoping comments. Tom and I are very familiar with some of the detention basins that have been built in the Houston area in recent years, most notably the Willow Waterhole and Art Storey Park, but also many more. The Corps of Engineers has been very involved with, and has spent considerable funds on, Projects Brays and other overflow and detention projects. In watching how these overflows and detention basins have worked over the years, we can see the important role of overflows in reducing flooding in new or unexpected places. These projects are designed with long and shallow notches in the side of the main bayou or other gravity-driven control structures. Once the water level in the bayou reaches a certain elevation, water overflows into a planned or constructed detention area. As the water overflows, it slows the increase in water elevation of the main bayou, and hence the elevation of the flooding, until the detention area is filled. Should these overflows be blocked, the floodwaters are redirected elsewhere. Personally, we are very grateful for how these projects have helped minimize flooding elevations in past events such as the Memorial and Tax Day floods (when our Houston home did not flood) and Hurricane Harvey (when the flood elevation was minimized). The proposed Dow project effectively is an anti-detention project. It not only removes space from the floodplain with its large footprint, but also blocks existing natural overflows. This consequence of the project, and the resulting damages that may occur, should be considered by the Corps of Engineers as it reviews the proposed project. The areas impacted by the current overflows already are known to be in the floodplain, with adjustments already made to structures and uses in those areas. If these overflows are blocked, new areas could flood or other areas could experience increased flooding. The DEIS does not accurately address these critical flood-related issues and impacts. A supplemental DEIS is needed to take a hard look at the flooding scenarios that are of actual concern. A flood caused by water flowing from upstream on the Brazos River – which had the greatest annual average flow of any river in Texas – is of much greater concern than flooding primarily driven by a localized rainfall event in the area of the proposed project. I use Project Brays in Harris County as an example. Again, the Corps of Engineers should be very familiar with this project. This long-term project includes several large detention basins have been built to partially mitigate flood impacts.	Comments 58, 59, 61, 62, 63, 64, 68, 71, 75, 76
65	Water Resources	Flood Hazards	5	3	In my 2020 scoping comments, I shared how slight changes in flood elevations can have increased and unfortunate additional impacts. Sometimes there is an elevation which, if exceeded slightly, results in considerably more and costly damages. One or two more inches during Harvey, and we would have lost considerably more irreplaceable family photographs and memorabilia.	NA

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					We are at that point in our home at the Brazos River Club where slight increases in floodwater elevation can make a big difference in our damages. Each flood is a very messy, time-consuming, and frustrating event. (This is an understatement.) We have had to spend funds on clean-up, have lost furniture and more as a result of these floods, and had to replace doors and make other repairs. In recent flood events, the peaks have ended up being fairly close to each other in depth, with all of the five recent floods being much higher than the 1994 flood of over 20 years earlier. However, if the water rises just a couple of more inches, the amount of our damages could increase drastically and some of the more expensive infrastructure at our house becomes impacted. Our region of the Texas coast is replete with many examples in recent decades where development has impacted the flood plains, and dumped flood waters in new areas or in increased amounts. In Harris County, construction of large obstructions in the flood plain arguably requires mitigation, typically in the form of detention capacity. Many neighborhoods in Houston have increased flooding due to upstream development and more rapid conveyance of storm water from those areas. There seems to be a requirement now for demonstrating “no rise” conditions for major projects or new subdivisions, yet there does not seem to be a hard look or independent review to confirm that such calculations are accurate. As a result of reviewing this DEIS, I now have insights into how a “no rise” condition might be modeled for permitting purposes, but impacts still can result once the project is built.	
66	Water Resources	Flood Hazards	5	4	A supplemental DEIS is needed to take a hard look at the flooding scenarios that are of actual concern. A flood caused by water flowing from upstream on the Brazos River – which had the greatest annual average flow of any river in Texas – is of much greater concern than flooding primarily driven by a localized rainfall event in the area of the proposed project. These and additional issues raised in these comments and those of the Brazos River Club and others should be considered as a Supplemental DEIS is prepared and made available for public comments.	Comment 66, 67
67	Water Resources	Flood Hazards	7	7-8	Lower Brazos Riverwatch concurs with the detailed discussions of floodplain impacts provided in the comments from the Sierra Club and the Brazos River Club. A review of the flood modeling provided in Appendices A, B, and C indicates that the flood modeling focuses almost entirely on the effects of the local 50 and 100 year storm events. As all of us who live in Brazos River communities are all too aware, the local storm events are not the critical flood events in need of consideration. Most of our major flood events in recent years have resulted from down-river flooding, with crests moving from below Lake Whitney to the Gulf over a period of days to weeks. Often the flood crests we experience occur long after the rainfall events that trigger them. Modeling the effects of the insertion of the reservoir expansion footprint based on local rainfall flood events will inevitably underestimate the effects of this interference with inter-basin flows between the Brazos, Oyster Creek, and Bastrop Bayou. In addition to this, the constant modification of the floodplain and addition of impervious cover in Fort Bend County need to be consider as cumulative impacts on Brazos River flood flows in Brazoria County. A supplemental EIS needs to consider the totality of the Brazos Basin below Waco when evaluating cumulative impacts on flood flows in the project area, and the potential for the project to result in increased flood elevations downstream. Given the topography of the area, and the changes in flood flow elevations observed in recent years, even very small percentage changes in flood elevation should be considered significant. While the modeling of flood flows resulting from local rainfall events is useful, it is insufficient, given the source of the highest flows on the Brazos.	Comment 66, 67
68	Water Resources	Flood Hazards	8	1	No one has mentioned the affect this construction will have on the downstream west side of the river once this flood water will not longer be able to relieve into Oyster Creek. The NOAA river gage web site used to state that the river would flow into Oyster Creek at a county road at the Ramsey unit. This has been removed. I am very concerned how holding all this water in the Brazos river channel along with all the levee systems being installed up stream is going to hurt the land owners down stream and on the west side of the river that is never mentioned.	Comments 58, 59, 61, 62, 63, 64, 68, 71, 75, 76
69	Water Resources	Flood Hazards	9	1-4	Corps should require an analysis, using the most recent flood and other data, about the flood potential and safety of construction in floodplains/floodways. The Corps used 19 inches of rain as the limit of water received by the reservoirs, river, and streams when a more realistic amount of rainfall is 40-60 inches (as occurred in Harvey). life of the project should be 100 years and should be used in the effects analysis along with long-term mitigation which takes not 15-20 years, but 80-100 years to mature for bottomland hardwood forests. b. The Corps did not model a worst-case scenario with the dam breached and affecting both floodplains/floodways. c. The Corps does not provide detail about its’ definition for adaptive management and what its’ adaptive management plan will consist of including how often inspections will occur, what other monitoring will occur, and what triggers will be used to initiate action. d. The impacts of emergency releases of water to the downstream environment and people are not modeled and the public hasn’t been told in the DEIS what the results are for such actions for their particular property. The Corps should require a 500-year floodplain study because climate change has altered the 100-year flood so that it’s now the same as a 500-year flood The Corps says nothing about waves kicked up during storms and hurricanes and how they impact dam proposals. The Corps proposes to allow this so-called off-channel reservoir that would be built in multiple 100-year floodplains/floodways for both the Brazos River and Oyster Creek. Massive amounts of floodwaters will be rerouted to flow over people’s property who either don’t flood, flood less, or flood in a different manner. This dam/impoundment blockage includes distributaries that normally connect the Brazos River with Oyster Creek. Where Dow plans to block the Brazos River and the Oyster Creek Floodplains/Floodways via the dam/impoundment, floods occurred in 1991, 1994, 2016, and 2017 The Brazos River and Oyster Creek Channels/Floodplains/Floodways that this proposal blocks at the proposed location are located where major overflows occurs (12 overflow locations) during flood events on the Lower Brazos River. The removal of over 1,900 acres from the floodplains/floodways and the blockage of at least three overflows at this site could result in extreme impacts via rerouting of water during flood events or during river rerouting events. At least three of these overflow areas (overland flow) will be blocked by the proposal. The water that overflows at this location goes down Oyster Creek and via overland flow to Bastrop Bayou, Christmas Bay (a state coastal preserve), and the Gulf of Mexico, 25 miles away. The volume of water that goes down Oyster Creek at this location is tremendous during flood events. The Corps must require a study which determines where that water will go, what properties will be flooded, what downstream and upstream impacts will occur when the proposed project blocks flow down Oyster Creek, and what mitigation measures must be required to ameliorate the changes. The environmental impacts to the Christmas Bay Coastal Preserve must be studied, evaluated, and revealed. The Corps fails to assess these impacts in the DEIS. The Corps has not provided an analysis of how the Christmas Bay Coastal Preserve and Bastrop Bayou will be affected in the DEIS. It’s of great concern that the proposed project has the potential to block and reroute the Brazos River during a flood event. This would increase flooding in other places and possibly cause flooding in West Columbia, Lake Jackson, or cause flood waters to overtop levees at Dow. The Corps has not analyzed these possible events or conditions.	Comments 69, 70, and 140
70	Water Resources	Flood Hazards	9	15	This proposal sets a precedent for other future off-channel reservoirs (Sections 1508.27(4) and (5)) since it allows large parts of the floodplain to be walled off and blocks flood waters from the flow travel corridors that exist. The precedent is that an off-channel reservoir, which should be on an upland site, will be in a floodplain/floodway where disruption of flows may occur tens of miles away and perhaps even affect Bastrop Bayou and the Christmas Bay Coastal Preserve on the Texas Coast	Comments 69, 70, and 140

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71	Water Resources	Flood Hazards	9	27-28	Pages 3-24, 3.3.1.1 Regulatory Setting, 3-37, 3.3.2 Flood Hazards and Flood Hazard Values, 3.3.2.1 Regulatory Setting, and 3-108, 3.10.3 Population and Housing, 3.10.3.1 Proposed Action, Alternative 2A, Alternative 2B, and Alternative 3, DEIS, despite the Brazoria County No-Rise Certification and demonstration that properties upstream will not flood, due to Hurricane Harvey or other storms flooding that is significant to people and their environment has occurred in the Lower Brazos River Watershed (74 flood events between 1996 and 2019, between 1,500 to 9,000 homes damaged in another flood event in 2016 and Hurricane Harvey). The present flood control efforts in Brazoria County are not working and interbasin areas (overland flows) and other areas between the Brazos River and Oyster Creek with soils mentioned above are flooding at greater rates than the Corps description suggests. This is important for the proposed project because, Page 3-22, 3.3 Water Resources, DEIS, states, “Oyster Creek receives water from the Brazos River via a diversion dam at Flat Bank Creek and Harris Reservoir and from overland sheet flow”.	Comments 58, 59, 61, 62, 63, 64, 68, 71, 75, 76
72	Water Resources	Flood Hazards	9	42	Page 4-16, 4.3.2 Flood Hazards and Flood Hazard Values, 4.3.2.2 Proposed Action, Alternative 2A, and Alternative 2B, DEIS, if combined operation is considered then the combined impacts need to be revealed and analyzed.	NA
73	Water Resources	Flood Hazards	9	54	Page 3-40, 3.3.3 Water Rights, DEIS, the Corps ignores that higher rainfall intensity levels are expected and greater than 1-2 feet of sea level rise in the next 50 years is expected due to climate change.	NA
74	Water Resources	Flood Hazards	9	57-58	Pages 4-9 and 4-10, 4.2.3 Sedimentation and Erosion, DEIS, since there are two existing reservoirs, the Corps should be able to state how sedimentation and erosion have affected the Harris and Brazoria Reservoirs and provide modeling that takes these real-world examples into account for the proposed project. kk. Page 4-11, 4.3.1.1 Water Quality, DEIS, the assumption that a flood control project will reduce water quality problems is not documented in the DEIS with any studies that show this to be the case over the short or long-term. ll. Page 4-12, 4.3.1.2 Brazos River System Flows, DEIS, the Corps doesn’t address how loss of over 2,000 acres in the floodplains of two major streams won’t have an effect on flows particularly since the Corps has not conducted a worst-case modeling scenario with 50-60 inches of rainfall instead of 19 inches. The Corps doesn’t state what happens when storms of this magnitude affect all three reservoirs, both Oyster Creek and the Brazos River, additional water flows due to more urbanization, population growth, and development. The impact analysis is woefully deficient and needs additional documentation. mm. Pages 4-12 and 4-13, 4.3.1.4 Environmental Flows and 4.3.1.3 Oyster Creek System Flows, DEIS, the Corps doesn’t use the 500-year floodplain as the new 100-year floodplain due to climate change alteration of rainfall intensities and frequencies. The Corps doesn’t use a 50-60-inch rainfall and overland flow increases to model what flows will occur during storms. The Corps also doesn’t state what the environmental impacts are of decreased water temperatures in Oyster Creek. nn. Pages 4-16 through 4-20, 4.3.2 Flood Hazards and Flood Hazard Values, DEIS, the Corps admits that the Harris Reservoirs act together via peak flows. Therefore, the synergistic effects of these two reservoirs and the Brazoria Reservoir, which are a system and operated by Dow as such for water use, must be examined for environmental impacts together. This includes interbasin flows or the blocking of these, use of the 500-year floodplain as the new 100-year floodplain due to climate change alteration of rainfall intensities and frequencies, and the use of a 50-60 inch rainfall to model what flows will occur during storms. The Corps ignores important flood hazards and flood values and its’ documentation is incomplete and faulty. The Corps statement that these flood flows could “create temporary minor to moderate hazards for local residents” hide what impacts will occur to people on their property up and downstream.	NA
75	Water Resources	Flood Hazards	10	2-3	After quickly reviewing the DEIS, and the appendices, it appears the main concern for the proposed project, is the potential for this structure to change the movement and spatial distribution of floodwaters from the Brazos River, in the local floodplain, and to reduce floodplain storage. While the appendices include much information regarding hydrology and hydraulics, I could find nothing that addresses the potential risk of the proposed project changing the pattern of movement of floodwaters from the Brazos River, and changing the spatial distribution of these floodwaters in the local floodplain. The DEIS (Appendix C) acknowledges the proposed project will block floodwaters from the Brazos River. From: Oyster Creek Downstream Hydrologic and Hydraulic Impacts Final Report, DCC Harris Reservoir Expansion EIS (Watearth, December 2021). • The proposed Harris Reservoir causes blockage to interbasin flows from the Brazos River into Oyster Creek. This causes increases in peak flows following 50- and 100-year storm events. To address this, the design of the proposed reservoir can be modified to keep the natural overflow paths, or a conveyance route can be established for interbasin basin flows that are blocked by the proposed Harris Reservoir (especially B11 and B12 in the HEC-HMS model). • Another measure to address the blockage of interbasin flows from the proposed Harris Reservoir would be to have an additional detention storage to store 50- and 100-year storm events and mimic the current timing of overflows from the Brazos River into Oyster Creek. This would also help decrease the potential water surface elevation increases due to peak flow increases. However, note that the only benefit of providing additional storage in the reservoir in advance of storm events, is to offset the effect of eliminating the floodplain storage for direct precipitation over the reservoir site. Reservoir storage cannot mitigate for the effect of the reservoir blocking floodwater movement from the Brazos River.	Comments 58, 59, 61, 62, 63, 64, 68, 71, 75, 76
76	Water Resources	Flood Hazards	Verbal 2	0	The appendices of the Draft EIS include separate hydrology reports for the Brazos River and Oyster Creek.· My main concerns are not just with the 200 acres that this project takes out of what I call the static floodplains.· Our concerns are what happens in actual major flooding events when the Brazos River and Oyster Creek floodplains combine and clearly interact, there is considerable water overflow between these two water ways, and this could effectively create a plug that could redirect large amounts of water.	Comments 58, 59, 61, 62, 63, 64, 68, 71, 75, 76
77	Water Resources	Wetlands, WOTUS	7	10	Based on the DEIS, it appears that the only alternative for which an actual on-site wetland delineation was conducted was the applicant preferred alternative (Alternative 1). Lower Brazos Riverwatch suggests that a supplemental EIS include a comparable field delineation for all of the alternative sites. Since only the preferred alternative was actually field delineated and the other alternatives were delineated using a desktop review of National Wetland Inventory maps, which tend to provide a substantially different outcome, there is no way to compare the impacts between the various alternatives. The fact that only one alternative was actually fully studied also makes it appear that the entire EIS process was conclusory, in bad faith and contrary to the intent of NEPA. Lower Brazos Riverwatch also objects to the empty appendices stating that data sheets and other information are “Available on Request”. As we have noted the time and resource disparity between the applicant and the commenting entities is already unreasonable without having to chase information necessary to do a thorough review of the DEIS.	Comments 77 and 78.
78	Water Resources	404(b)(1)/CWA Issues	10	3	Alternative 3 would eliminate concern for potentially unacceptable floodplain effects (e.g. potential increased flood risks to people and infrastructure) of the proposed alternative. However, wetland and other aquatic habitat impacts would be greater, and so would cost. It seems doubtful Alternative 3 would ever be the Least Environmentally Damaging Practicable Alternative, so if this alternative were selected, the Clean Water Act Section 404(b)(1) Guidelines almost certainly would not be met.	Comments 77 and 78.

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79	Water Resources	404(b)(1)/CWA Issues	1	1-3	As currently proposed, the Corps must deny the permit because the proposed discharge does not comply with Section 404(b)(1) guidelines… Several specific requirements under the Section 404(b)(1) guidelines are particularly relevant here, for the reasons described throughout this comment letter. First, the Corps may not issue a permit under Section 404 if there is any "practicable alternative" to the project with less impact on the aquatic ecosystem. 40 C.F.R. § 230.10(a). Second, the Corps cannot issue the permit unless there is a demonstration that any discharge from the project "will not have an unacceptable adverse impact either individually or in combination with known and/or probable impacts of other activities affecting the ecosystems of concern," or if any discharge will result in significant adverse effects to water quality. Id. § 230.1(c). Third, the Corps cannot allow discharges unless "appropriate and practicable steps have been taken which will minimize potential adverse impacts of the discharge on the aquatic ecosystem." Id. § 230.10(d). Finally, the Corps must determine that the project is in the "public interest" by weighing all relevant" considerations and balancing all probable impacts of the proposed action against its alleged benefits. 33 C.F.R. § 320.4(a). Moreover, the Corps must independently verify all the information in the application. See, e.g., Greater Yellowstone Coalition v. Flowers, 359 F.3d 1257, 1269 (10th Cir. 2004); see also 40 C.F.R. §1506.5(b). Taken together, these requirements create a "very strong" presumption "'that the unnecessary alteration or destruction of [wetlands] should be discouraged as contrary to the public interest.'" Buttrey v. United States, 690 F.2d 1170, 1180 (5th Cir. 1982) (quoting 33 C.F.R. § 320.4(b)(1)).	Comments 79, 80, 81, 82, 83, 84.
80	Water Resources	404(b)(1)/CWA Issues	1	4-5	Appropriate and practicable steps have not been taken to minimize the Project's impacts The Corps cannot allow discharges unless "appropriate and practicable steps have been taken which will minimize potential adverse impacts of the discharge on the aquatic ecosystem." 40 C.F.R. § 230.10(d). As further guidance, the Section 404(b)(1) guidelines recognize that "[t]he discharge of dredged or fill material in wetlands is likely to damage or destroy habitat and adversely affect the biological productivity of wetland ecosystems by smothering, by dewatering, by permanently flooding, or by altering substrate elevation or periodicity of water movement." 40 C.F.R. § 230.41(b) (emphasis added). The guidelines also state that a 404 permit should only be issued if the applicant takes "all appropriate and practicable steps to avoid and minimize adverse impacts to waters of the United States." 40 C.F.R. § 230.91(c)(2). Subpart H of the guidelines provides examples of actions the Corps might take to minimize adverse effects, see id., which courts have viewed as the "correct factors" for the Corps to consider when making its determination as to whether these steps have been taken. Sierra Club v. U.S. Army Corps of Eng'rs, No. Civ.A. 05-1724JAP, 2005 WL 2090028, at *17 (D.N.J. Aug. 29, 2005). These measures include avoiding sites having unique habitat or other value. Id. § 230.75(c). By failing to take a hard look at the impacts of this project, from the perspective of the environment, flooding, environmental justice, and climate change, as described further in this letter, the Army Corps' review falls short of these requirements. The proposed project will cause both temporary and permanent impacts to sensitive and critical ecosystems, including Columbia Bottomlands habitat, which have not yet been adequately studied. BCWK requests that the Corps prepare a supplemental DEIS to address this missing information. At a minimum, the supplemental DEIS must acknowledge that Columbia Bottomlands as an area, ecosystem, and vegetation exist on the proposed project sites and is affected by each alternative and includes an analysis of remnant Columbia Bottomlands via the NEPA which compares the features, potential environmental impacts, and Columbia Bottomland restoration mitigation measures (biological, ecological, and climate change) between the alternatives.	Comments 79, 80, 81, 82, 83, 84.
81	Water Resources	404(b)(1)/CWA Issues	1	5-6	The Corps must select the least damaging alternative and has not: The application does not demonstrate that the Project is the least environmentally damaging practicable alternative. The Corps is required to conduct an alternative analysis and determine what projects are "available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes." 40 C.F.R. § 230.10(a)(2). The process for undertaking this analysis is clearly set out in the Corps' guidelines implementing the CWA. First, the Corps must define the project's "overall project purpose." Id. Second, the Corps must determine whether a project is "water dependent." Id. § 230.10(a)(3). If the project is not water dependent, "the Corps apply a presumption that a practicable alternative that has a less adverse environmental impact on the wetland[s] is available." Sierra Club v. Van Antwerp,362 F. App'x 100, 106 (11th Cir. 2010) (citing 40 C.F.R. § 230.10(a)(3)). If the presumption applies, "the applicant must then rebut the presumption by 'clearly demonstrate[ing]' that a practicable alternative is not available." Id. In addition, when a discharge involves a "special aquatic site," the Corps must presume that all practicable alternatives that do not involve a discharge into that site would have less adverse impact on the aquatic ecosystem, unless the applicant can clearly demonstrate otherwise. 40 C.F.R. § 230.10(a)(3). "Special aquatic sites" include wetlands. Id. §§ 230.40–230.45.	Comments 79, 80, 81, 82, 83, 84.
82	Water Resources	404(b)(1)/CWA Issues	1	10	The Project must not cause or contribute to significant degradation of waters of the United States Under the Section 404(b)(1) guidelines, the Corps may not permit discharges of fill material that will "cause or contribute to significant degradation" of wetlands. 40 C.F.R. § 230.10(c). Examples of effects contributing to significant degradation include adverse effects on life stages of aquatic life and other wildlife dependent on aquatic ecosystems, as well as the loss of fish and wildlife habitat or the loss of the capacity of a wetland. See id. § 230.10(c)(2), (3). It also includes significant adverse effects of discharges on recreational, aesthetic, and economic values. Id. § 230.10(c)(4). The extent and duration of the impacts, as well as the habitats' uniqueness, are relevant considerations. See id. § 230.10(c); Bering Strait Citizens for Responsible Res. Dev. v. U.S. Army Corps of Eng'rs, 524 F.3d 938, 949 (9th Cir. 2008). The Corps should explain how the proposed mitigation would avoid significant degradation of aquatic ecosystems. Cf. Sierra Club v. U.S. Army Corps of Eng'rs, 614 F. Supp. 1475, 1495–96, 1517 (S.D.N.Y. 1985) (holding arbitrary the Corps' decision to issue a landfill permit where its conclusions about impacts on a fishery differed dramatically from those in a draft EIS), aff'd in part, rev'd in part on other grounds, 772 F.2d 1043 (2d Cir. 1985). Failure to show that the Project actually will comply with water quality standards, that it will not contribute to further degradation of impaired waters, and that it will be sufficiently protective of waterways and ecosystems to comply with the CWA's requirements render a project ineligible for a permit under Section 404. See 40 C.F.R. § 230.10(b)(1), (c).	Comments 79, 80, 81, 82, 83, 84.
83	Water Resources	404(b)(1)/CWA Issues	1	4-5	As a preliminary manner, the Corps must verify all information received from the applicant and evaluate the scope of impacts, including both the size and extent of impacts to determine permanent impacts caused by the Project that have not yet been disclosed, whether conversion of various types of wetlands will result in a loss of wetland function and/or a change of use of the waterbody, which constitute significant adverse impacts. 40 C.F.R. § 230.11. The Corps must also analyze the interconnections between streams, ponds, and the recharge of groundwater as well as how each wetland supports the existing habitat, wildlife, and plants. Id. § 230.11(a), (b), (c), (e). Finally, the Corps must evaluate whether the existing wetlands provide flood protection or relief and how those functional services would be impacted. 40 C.F.R. § 230.41(b) ("Discharging fill material in wetlands... may modify the capacity of wetlands to retain and store floodwaters and to serve as a buffer zone shielding upland areas from wave actions, storm damage and erosion.").	Comments 79, 80, 81, 82, 83, 84.
84	Water Resources	404(b)(1)/CWA Issues	1	6-10	The plan for mitigation is inadequate If the Corps finds that the Project would significantly degrade wetlands, it may issue a permit conditioned on minimization of, or compensation for, impacts. See City of Olmsted Falls, Ohio v.EPA, 435 F.3d 632, 637–38 (6th Cir. 2006); Ohio Valley Env't. Coal. v. U.S. Army Corps of Eng'rs, 674 F. Supp. 2d 783, 790 (S.D. W. Va. 2009). However, inadequacies in plans for minimization or compensation may invalidate the decision to allow discharge. See All. to Save the Mattaponi v. U.S. Army Corps of Eng'rs, 606 F. Supp. 2d 121, 133–34 (D.D.C. 2009). According to the Section 404(b)(1) guidelines, "[t]he fundamental objective of compensatory mitigation is to offset environmental losses resulting from unavoidable impacts to waters of the United States authorized by... permits." 40 C.F.R. § 230.93(a)(1). Thus, the Corps "must determine the compensatory mitigation to be required in a… permit, based on what is practicable and capable of compensating for the aquatic resource functions that will be lost as a result of the permitted activity." Id. (emphasis added). Compensatory mitigation may include restoration, enhancement, establishment, and preservation of aquatic ecosystems. Id. § 230.93(a)(2). In general, it should take place within the same watershed where unavoidable impacts occur. Id. § 230.93(c)(1). In general, it should take place within the same watershed where unavoidable impacts	Comments 79, 80, 81, 82, 83, 84.

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					occur. Id. § 230.93(c)(1). A permittee's compensatory mitigation requirements may be met only when a bank has the appropriate number and resource type of credits available and those credits are secured by the sponsor. See id. § 230.93(b)(2). Letter 1 (page 21-22). 8. The Corps must complete a public interest review The Corps must determine that the project is in the "public interest" by weighing all "relevant" considerations and balancing all probable impacts of the proposed action against its alleged benefits. 33 C.F.R. § 320.4(a)(1). Determining that the Project is in the public interest requires weighing its benefits against its costs. Nat'l Parks Conservation Ass'n v. Semonite, 311 F. Supp. 3d 350, 377 (D.D.C. 2018).	
85	Water Resources	404(b)(1)/CWA Issues	1	21-22	The Corps must complete a public interest review The Corps must determine that the project is in the "public interest" by weighing all "relevant" considerations and balancing all probable impacts of the proposed action against its alleged benefits. 33 C.F.R. § 320.4(a)(1). Determining that the Project is in the public interest requires weighing its benefits against its costs. Nat'l Parks Conservation Ass'n v. Semonite, 311 F. Supp.3d 350, 377 (D.D.C. 2018). The public interest review is intentionally broad and should include all relevant issues that could impact the environment, human health, and natural resources. The Corps' regulation instructs: Evaluation of the probable impact which the proposed activity may have on the public interest requires a careful weighing of all those factors which become relevant in each particular case. The benefits which reasonably may be expected to accrue from the proposal must be balanced against its reasonably foreseeable detriments. The decision whether to authorize a proposal, and if so, the conditions under which it will be allowed to occur, are therefore determined by the outcome of this general balancing process. That decision should reflect the national concern for both protection and utilization of important resources. 33 C.F.R. § 320.4(a)(1). The Corps' regulations include a non-exhaustive list of factors that may be relevant for each individual project. 33 C.F.R. § 320.4(a)(1) states in part: All factors which may be relevant to the proposal must be considered including the cumulative effects thereof: among those are conservation, economics, aesthetics, general environmental concerns, wetlands, historic properties, fish and wildlife values, flood hazards, floodplain values, land use, navigation, shore erosion and accretion, recreation, water supply and conservation, water quality, energy needs, safety, food and fiber production, mineral needs, considerations of property ownership and, in general, the needs and welfare of the people. Environmental justice and climate change impacts must be considered as part of this review. See Vecinos para el Bienestar de la Comunidad Costera v. FERC, Nos. 20-1045, 20-1093, 20-1094, 2021 U.S. App. LEXIS 22881, at *18-19 (D.C. Cir. 2021) (explaining that consideration of climate change and environmental justice factors forms part of public interest review under the Natural Gas Act); Friends of the Earth v. Haaland, No. CV 21-2317 (RC), 2022 WL 254526 (D.D.C. Jan. 27, 2022) (government violates NEPA when underestimates climate impacts of federal action); see also Exec. Order No. 12,898, § 1-101, 59 Fed. Reg. 7,629 (Feb. 11, 1994); id. § 3-302(b). Consistent with the mandate that the Corps consider "all those factors that become relevant," this non-exhaustive list of factors includes issues beyond those directly related to the impacts of in-water work. Id. In other words, by requiring an analysis of "cumulative impacts" and by including a non-exhaustive, far-reaching list of factors, the Corps is clearly required to conduct a broad analysis of the public interest that captures all relevant impacts associated with the project and not just those that result directly from the permitted activities. At a minimum, by not evaluating whether this project is in the public interest, specifically by addressing the flooding concerns, environmental justice impacts, and climate impacts of the project raised in this and other commenters' letters, the Corps has not met this requirement	Comment 1, 85.
86	Water Resources	Columbia Bottomlands	7	6-7	Lower Brazos Riverwatch disagrees with the conclusion that the remnant forested habitats at the project site are not Columbia Bottomlands. This reflects a very narrow conclusory view of what this habitat is and a lack of understanding of the habitat. This view is reflected in several places throughout the DEIS and appendices. No scientific rationale for why these habitats are not Columbia Bottomlands, despite being entirely within the area mapped as historic Columbia Bottomlands, is advanced by the USACE. This is conclusory statement, unsupported by evidence and largely disputed by other agencies (USFWS, TPWD) that work in the Columbia Bottomlands. The Columbia Bottomlands is a geographic concept. It is a coined term used to refer to bottomland forested habitats in the lower Colorado, San Bernard, and Brazos corridors, and along adjacent creeks and bayous, including Oyster Creek. It is not a rigidly defined aggregation of species that is invariable throughout the area. TPWD notes that the Columbia Bottomlands is comprised of several different vegetation communities as follows: • Columbia Bottomlands Live Oak Forest and Woodland • Columbia Bottomlands Mixed Evergreen/Hardwood Forest and Woodland • Columbia Bottomlands Hardwood Forest and Woodland • Columbia Bottomlands Evergreen Shrubland • Columbia Bottomlands Deciduous Shrubland • Columbia Bottomlands Grassland • Columbia Bottomlands Herbaceous Wetlands • Columbia Bottomlands Riparian Live Oak Forest and Woodland • Columbia Bottomlands Riparian Mixed Evergreen/Hardwood Forest and Woodland • Columbia Bottomlands Hardwood Forest and Woodland • Columbia Bottomlands Evergreen Shrubland • Columbia Bottomlands Deciduous Shrubland • Columbia Bottomlands Riparian Grassland • Columbia Bottomlands Herbaceous Wetland All of the species identified as occurring in the remnant impacted habitats are species that occur in the Columbia Bottomlands. These habitats should not be misclassified due to anthropogenic impacts that result in certain species being missing from the remnant communities. Lower Brazos Riverwatch suggests that a supplemental EIS be conducted that evaluates the loss of forested habitats due to the project as losses of Columbia Bottomlands. The cumulative impacts from all sources to the Columbia Bottomlands need to be evaluated when determining the significance of these impacts. In addition, mitigation for impacts to forested habitats should focus on the restoration of healthy Columbia Bottomlands.	Comments 86 and 87.
87	Water Resources	Columbia Bottomlands	9	6-14	The proposal (Proposed Alternative and Alternatives 2, 2B, and 3) impact the Columbia Bottomlands area, ecosystem, and vegetation as well as Alternative 4. The Corps states repeatedly in the DEIS (the Sierra Club realizes that this may be the applicant and its' consultant's view, but the Corps legally is required to make the DEIS its' own and take a "hard look" at environmental impacts) that the proposal, except for Alternative 4, doesn't impact the Columbia Bottomlands. Below are some examples of this erroneous idea:	Comments 86 and 87.
88	Water Resources	Columbia Bottomlands	9	16	The diversion of flood waters from Oyster Creek and other current flow travel corridors will impact Columbia Bottomlands habitat (Section 1508.27(3)), which the Corps has recognized as unique, other wetlands, other watersheds like Bastrop Bayou, park lands on the coast, prime farmlands, and ecologically critical areas (Christmas Bay Coastal Preserve and Columbia Bottomlands).	NA
89	Water Resources	Mitigation and Monitoring	4	2	33 CFR 332.3(h) identifies specific requirements for preservation when used to provide compensatory mitigation. Most of the buffer areas viewed during an April 22, 2022, agency site visit would require at least some level of enhancement or maintenance activity and may not be currently suitable as a preservation component. EPA recommends the Final EIS have the potential preservation components clearly identified. The Final EIS should also discuss the suitability of the buffer areas as	Comments 89, 90, 91, 92, 93, 94, 97, 98, 102.

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					preservation, and detail what actions are necessary to utilize the areas as preservation. For the off-site mitigation option at Big Slough, there is reference to numerous studies, including a watershed analysis estimating peak flows through regression modeling and a hydraulic assessment that estimates bankfull flow, shear stress, and stream power. However, the provided Conceptual Compensatory Mitigation Plan in Appendix G does not appear to include those references. Without additional design details, it is difficult to assess the future likelihood of success as a stream mitigation feature. Please include links or complete references to any studies or other documents that are mentioned within the Draft EIS. Any proposed mitigation planned for the Big Slough feature should include complete removal of all hydrologic obstructions within the proposed project area. Losses to aquatic habitat associated with any proposed Big Slough restoration activities should also be accounted for. Based upon the agency site visit on April 22, 2022, it is uncertain if the conceptual stream restoration plan is the most effective use of the proposed Big Slough mitigation site. Mitigation components heavily include riparian buffer improvements which will require significant long-term efforts to manage invasive species. More appropriate stream mitigation opportunities beyond Dow owned properties may exist, and it is recommended other mitigation alternatives within the watershed be evaluated to provide the compensatory mitigation necessary to replace stream losses.	
90	Water Resources	Mitigation and Monitoring	4	2-3	EPA recommends the Final EIS include a more robust project monitoring plan. Specific details, such as frequency, duration, and location, should be included in the description of how the project impacts will be measured and monitored. The Final EIS should also include the potential corrective actions that will be taken to address common or anticipated issues that could occur. EPA appreciates the USACE commitment to coordinate with the resource agencies on the development of a final compensatory mitigation plan prior to the Final EIS. EPA reiterates the importance of including well developed monitoring requirements, performance standards, success criteria, planting plans, and adaptive management given the heavy reliance on monitoring and adaptive management to address the unknown project impacts associated with project discharges to Oyster Creek. The O&M Plan also refers to monitoring per the Oyster Creek monitoring and adaptive management plan. It remains unclear how the compensatory mitigation monitoring and adaptive management, based on ecological performance standards, will be managed congruent with O&M floodplain enhancement adaptive management and monitoring, based on separate hydromodification and floodplain management criteria. EPA recommends the Final EIS include a discussion on how the resources using ecological performance-based standards will coexist and interact with the resources using hydromodification and floodplain management criteria.	Comments 89, 90, 91, 92, 93, 94, 97, 98, 102.
91	Water Resources	Mitigation and Monitoring	6	1-2	The conceptual compensatory mitigation plan (Appendix G) lacks sufficient details for TPWD to fully evaluate the proposed compensation for unavoidable wetland and stream impacts. For example, the conceptual plan proposes the purchase of mitigation bank credits as compensatory mitigation for wetland impacts. However, the DEIS did not specifically identify the name of the proposed mitigation bank(s), and so the suitability of the proposed mitigation cannot be properly assessed. As another example, the permittee-responsible mitigation (PRM) proposed as compensation for stream impacts did not include a mitigation work plan incorporating detailed specifications and descriptions for construction methods, timing, and sequence; plans to control invasive plant species; proposed grading plan (including elevations and slopes of the substrate); stream channel geometry (plan form, channel cross-sections); and methods and species list for streambank and riparian buffer planting. Prior to issuance of a final EIS, TPWD recommends a draft compensatory mitigation plan, including all of the items described in 33 CFR 332.4(c)(2) through (c)(14), be coordinated through a supplement to the draft EIS for review and comment by resources agencies and the public. TPWD believes a supplement to the draft EIS is warranted under 33 CFR 230.13 and 40 CFR 1502.9(d)(l)(i) and (ii) because the additional information from the items in 33 CFR 332.4(c)(2) through (c)(14) would be substantial changes and significant new information relevant to the Project's environmental concerns (i.e., compensatory mitigation for unavoidable impacts).	NA
92	Water Resources	Mitigation and Monitoring	7	11	The mitigation plan proposed does not seem to be focused on providing compensation for functional values actually lost, or in providing for the restoration of Columbia Bottomlands habitats that were on the site historically. Instead it appears to be a flood control project posing as mitigation. The focus appears to be on flood flow or water supply conveyance rather than on habitat restoration or replacement. While we certainly have no objection to getting more bang for the buck in mitigation, the first objective should be mitigating for the values actually lost and it does not appear to be what is happening here. We are particularly concerned with the modifications to Oyster Creek that take a functional riparian corridor, lay back the banks to increase channel capacity and then revegetate what was already an appropriately vegetated corridor. It is unclear why any increase in flow on Oyster Creek is necessary in any case, since the purpose of the project is to increase storage capacity as a buffer against drought, not increase the delivery capacity of the system. Lower Brazos Riverwatch suggests that a supplemental EIS be prepared that includes a mitigation plan focused on restoring the former Columbia Bottomlands habitats that were present on the site. The supplemental EIS should also provide means for minimizing the impacts of the project on functional riparian corridors that already exist at the site.	Comment 92 and 95.
93	Water Resources	Mitigation and Monitoring	9	24-25	The Corps should ensure that the appropriate mitigation and monitoring, the right amount of mitigation and monitoring, and documentation of mitigation and monitoring is done for the proposed project using the CEQ NEPA regulations. The Corps hasn't released to the public in the DEIS a comprehensive mitigation and monitoring plan which informs the public of their effectiveness and whether more is needed over the lifetime of the proposed project as it ages. The Sierra Club requests that the Corps prepare a supplemental DEIS for this proposal. This supplemental DEIS will provide for public review, analysis, and comment, which fully provides for NEPA public participation and transparency.	Comments 89, 90, 91, 92, 93, 94, 97, 98, 102.
94	Water Resources	Mitigation and Monitoring	9	28-29	The conceptual mitigation plan submitted with the DA permit application in 2018 has been revised to address compensation of unavoidable impacts to WOUS based on the updated delineation and new studies. The revised mitigation plan is provided in Appendix G."	Comments 89, 90, 91, 92, 93, 94, 97, 98, 102.
95	Water Resources	Mitigation and Monitoring	9	30-32	Oyster Creek Mitigation Projects 1 and 2 are listed on Page 6, Harris Reservoir Expansion EIS CMP, Brazoria County, Texas. Figure 1.1-2 Proposed Harris Reservoir Expansion Project, shows Mitigation Project 3 which is another significant flood control project that is treated in a section that is supposed to cover only wetland mitigation in the CMP. Page 1-8, 1.3.4 Proposed Action and Page 2-5, 2.3.3 Project Components, DEIS, the Corps states, "The proposed Project … also includes floodplain enhancements in Oyster Creek". This statement documents that the so-called mitigation projects are really flood control projects. This is documented on Page 2-7, 2.3.3 Project Components, DEIS, when the Corps states, "227-acre Oyster Creek floodplain enhancement/stream restoration area".	Comment 92 and 95.
96	Water Resources	Mitigation and Monitoring	9	35-38	The wetlands mitigation plan has numerous problems. See 11., above in this comment letter. The Sierra Club asks the question, is the wetland mitigation proposed really a regional mitigation bank posing as a permittee responsible program? The magnitude and design of this proposal gives one pause about its' intent. The Corps should clearly answer this question.	NA
97	Water Resources	Mitigation and Monitoring	9	48	i. Page 6-1, 6 Mitigation, is extremely underprepared. Little mitigation is provided in the DEIS and what is proposed doesn't: 1) Mitigate for Columbia Bottomlands ecosystem and vegetation that is destroyed; 2) Destroys more wetlands and riparian habitat in the name of mitigation but really the goal is flood control; 3) The best management practices listed under Section 2.8 are too few, not detailed, and are not required to be use. The CMP is poorly done and the fact that it doesn't	Comments 89, 90, 91, 92, 93, 94, 97, 98, 102.

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					include performance standards now in the DEIS keeps the public from review, analysis, and comment on the adequacy of the mitigation measures proposed. j. The Corps must prepare a supplemental EIS with a complete mitigation plan not just for wetlands losses but for mitigation for all natural resources that may be impacted. The CEQ's NEPA regulations emphasize the need for mitigation and monitoring as shown in these quotes:	
98	Water Resources	Mitigation and Monitoring	9	51	k. The Corps must ensure that the appropriate mitigation and monitoring, the right amount of mitigation and monitoring, and documentation of mitigation and monitoring is done for the proposed project using the CEQ NEPA regulations. The Corps hasn't released to the public in the DEIS a comprehensive mitigation and monitoring plan which informs the public of their effectiveness and whether more is needed over the lifetime of the proposed project as it ages.	Comments 89, 90, 91, 92, 93, 94, 97, 98, 102.
99	Water Resources	Mitigation and Monitoring	9	52	Page 2-1, 2.3.3.7 Oyster Creek Floodplain Enhancement, DEIS, the Corps doesn't allow the creek to meander which is a natural condition that allows erosion and sedimentation to approximately equal each other so that there is a way for the creek to move and produce habitats that wildlife need. The Corps must discuss how mitigation measures can be implemented which allow Oyster Creek to meander to allow erosion/sedimentation processes to operate to allow wildlife habitats to be created.	NA
100	Water Resources	Mitigation and Monitoring	9	59	The Corps underestimates the length of time that mitigation will take for trees planted in the Oyster Creek drainage to grow, mature, and provide full ecological benefits. It will take 80-100 years for these trees to reach the ecological benefits that mature trees. This includes biological legacies like snags, downed wood, and wood that has fallen into water. The Corps overestimates the ecological benefits when it does not use the 80-100-year timeframe that it takes for trees, a forest, to reach ecological maturity and provide full ecological benefits.	NA
101	Water Resources	Mitigation and Monitoring	10	4	The proposed off-site, out-of-kind stream mitigation, is unacceptable as mitigation for impacts to streams at the project site. The types of streams impacted at the project site are very different than Big Slough (smaller, higher in the watershed, less perennial, not tidal). While I do not think that it is necessary to propose stream mitigation that matches the impacted streams perfectly, Big Slough is simply too different from the streams to be impacted by the proposed project, to be considered a legitimate candidate for mitigation for impacts from this proposed project. Perhaps it would be more appropriate to consider additional stream restoration and enhancement for Oyster Creek and tributaries, close to the proposed project site? The USACE should require the applicant to consider other, more in-kind stream mitigation alternatives, include them in a Supplemental Draft EIS, for review and comment by the public.	NA
102	Water Resources	Mitigation and Monitoring	10	4	The Corp's own consultants repeatedly recommended that the applicant be required to create maintenance plans for the proposed stream enhancement on Oyster Creek, which are apparently required to reduce peak flows and reduce erosion. The USACE should require the applicant to commit to an appropriate O&M program for the proposed stream enhancements on Oyster Creek, and should revise the DEIS to show these commitments.	Comments 89, 90, 91, 92, 93, 94, 97, 98, 102.
103	Water Resources	O&M	4	2	The Operation & Maintenance Plan (O&M) states water release from DOW's water storage reservoirs will be in a manner that maximizes the benefit of the storage and yields the highest probability to refill storage during sustained drought. Since the reservoir operations will also play in a role in managing impacts to Oyster Creek, EPA recommends including an additional goal in the O&M plan to limit adverse impacts to Oyster Creek.	NA
104	Biological Resources	General Wildlife, Wildlife habitat, Avian	9	1	Page 4-33, 4.5.3 Migratory Birds, in the No Action Alternative and Page 4-39, 4.7 State-Listed Wildlife, DEIS, the Corps states, "existing and reasonably foreseeable trends and actions would continue to affect migratory birds in the analysis areas." The Sierra Club asks the Corps why this statement is only found in the No Action Alternative and is not found for all other alternatives. This statement applies to all alternatives and should be stated as such under each alternative.	Comments 104 and 105.
105	Biological Resources	General Wildlife, Wildlife habitat, Avian	9	43	). Page 4-29, 4.5 Wildlife, No Action, DEIS, the Corps states "However, existing and reasonably foreseeable trends and actions would continue to affect wildlife in the analysis areas." The Corps does not make this statement for other alternatives thus giving the reader the idea that the No Action Alternative is unique in this way. This same statement applies to all other alternatives and must be applied to them and not just the No Action Alternative. Otherwise, the Corps biases the assessment, analysis, and evaluation of environmental impacts against the No Action Alternative and misleads the public about which alternatives have what impacts.	Comments 104 and 105.
106	Biological Resources	General Wildlife, Wildlife habitat, Avian	11	1	The DEIS for the above referenced project found that moderate potential impact may occur to state-listed bird species including bald eagle, wood stork, and white-faced ibis. We encourage Dow Chemical develop and follow a vegetation management plan that includes avoiding vegetation disturbance or removal during peak nesting season. Activities that must occur during this timeframe should include a survey for nests prior to the activity start and provide a wide buffer around any nests identified. A vegetation management plan should also include strategies to minimize to the maximum extent possible the amount of native vegetation that is disturbed or removed throughout the projects' activities, and if native vegetation is affected, the same amount of habitat or more should be restored with appropriate native vegetation prescribed by native plant experts. Birds are influenced by impacts on vegetation and prey species like fish, and Houston Audubon subsequently encourages actions to minimize the impacts on habitats affecting birds and their food sources.	NA
107	Biological Resources	General Wildlife, Wildlife habitat, Avian	Verbal 1	0	Third (indiscernible) is that I'm -- I'm wondering if the Texas Water Code, Section 11.152 impacts this project and, if so, whether the EIS either already includes some consideration of this or will in the future.· And this deals with the (indiscernible) of permits -- water rights permits on fish and wildlife (indiscernible).	NA
108	Biological Resources	Federal and State T&E Species	6	2	TPWD is concerned that streambed and streambank disturbance from construction of the Brazos River pump station and Oyster Creek outfall, as well as in-channel compensatory mitigation activities in Oyster Creek, may impact state listed freshwater mussels. Freshwater mussels are among the most long-lived animals in the world, and many species may live for decades, if not centuries (Strayer et al. 2004). Because they are relatively sedentary filter-feeders and long-lived, these animals are important indicators of water quality. Freshwater mussels are considered to be the most imperiled group of all aquatic animals in North America (Williams et al. 1993, Strayer et al. .2004, Haag and Williams 2014) and are a high conservation priority (NNMCC 1998, FMCS 2016). Section 3.6.2 of the DEIS states that potentially suitable habitat for Texas fawnsfoot (Truncilla. macrodon) is present within the Project site. This species is state-listed as threatened and is proposed to be federally listed as threatened under the Endangered Species Act (86 FR 47916). The applicant has received a TPWD permit to· introduce fish, shellfish or aquatic plants into public waters (Permit Number INT 22 04-27d) associated with their freshwater mussel survey. This permit is valid until June 30, 2022. If the survey finds Texas fawnsfoot (or any other state-listed freshwater mussel species) or the permit expires, then TPWD recommends the applicant continue consulting with a TPWD Aquatic Resource Relocation Plan coordinator and utilize methodologies outlined in the Texas Freshwater Mussel Survey Protocol developed by TPWD and the U.S. Fish and Wildlife Service.	Comments 108, 109.
109	Biological Resources	Federal and State T&E Species	7	8	Lower Brazos Riverwatch suggests that a supplemental EIS address several concerns and data gaps in the Biological Assessment and Aquatic Assessment. The Biological assessment, in its discussion of the Texas Fawnsfoot Mussel (Truncilla macrodon) acknowledges that it is a potential presence in the project area and that the project may affect the species. They do not however present any survey information concerning the presence or absence of the species in the project area. The project is within the known historic range of the species. While official reports of the species place it up river near the confluence of the Brazos and Cow Bayou, in Fort Bend County, Lower Brazos Riverwatch has identified both live individuals and recently dead valves immediately north of FM 1462 and in bank and point bar habitat in Brazoria County approximately 10 river miles above the project area. We believe that the areas of project on the Brazos should be surveyed for this species and that identified individuals/populations be considered for relocation prior to construction.	Comments 108, 109.

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					We are also concerned with the levels of impact to Oyster Creek and the potential to affect this species. Water interchange between the Brazos and Oyster Creek occurs at multiple locations above and below the project area. There is significant flow diversion from one stream to the other in the Sienna Plantation area in Fort Bend County, well above the lowest identified populations of the Texas Fawnsfoot. We believe that his mixing of the two relevant streams, plus the documented occurrence of the Texas Fawnsfoot in rice canals in Fort Bend County are evidence of its potential occurrence in Oyster Creek in the Project area. Lower Brazos Riverwatch believes that a supplemental EIS should be prepared to include surveys for this species on those portions of Oyster Creek to be impacted by the project construction, and those portions downstream that will experience modified stream flows as a result of the project.	
110	Biological Resources	Federal and State T&E Species	9	58	Pages 4-39 through 4-42, 4.7 State-Listed Wildlife and Pages 4-42 through 4-69, DEIS, the Corps ignores the impacts that decreased or low water temperatures will have on aquatic organisms in the summer or the rest of the year. The large range of impacts that the Corps uses for alternatives, negligible to moderate, cover three impact levels. This inexact impact level presentation doesn't allow the public to know what the environmental impacts are and hinders its' ability to review, analyze, and comment on the proposed project.	NA
111	Biological Resources	Federal and State T&E Species	9	54	Page 3-99, Table 3.8-1 State-Listed Species and their Potential to Occur, DEIS, the Alligator Snapping Turtle should have a high potential, not low potential, to occur in the Brazos River and Oyster Creek because it lives in large bodies of water in Texas. The Corps should change this potential to occur in analysis area rating.	NA
112	Biological Resources	Aquatic Species	7	9	The Aquatic Assessment report does not mention the freshwater drum (Aplodinotus grunniens) as an observed or potential fish species occurrence in either the Brazos River or Oyster Creek. Ordinarily the omission of a species from generalized lists is not concerning, but this species is common in both Oyster Creek and the Brazos River and is the presumed host species for glochidia of the Texas Fawnsfoot. The species should be included as a potential occurrence in both waters, if it is not actually encountered during sampling, since it is a necessary element in the likelihood of the Texas Fawnsfoot occurring in either stream. The Aquatic Assessment report contains a number of tables of data purported to be for Oyster Creek, Allens Creek, and the Brazos River. The data for Allens Creek appears to be erroneous. It contains entries for fairly large numbers of a mussel identified as Texas hornshell (Popenaias popeii). This species is a Federally listed Endangered Species and is endemic to the Rio Grande watershed, in the Rio Grande, Pecos and Devils Rivers in Texas and tributaries of the Rio Grande in Mexico. It is not clear if this is a location error or a species identification error, but it is highly unlikely that the Texas Hornshell is an occurrence in the Allens Creek that is a tributary to the Brazos. It is also not clear why data for Allens Creek is included in this report, unless it is a relic from considering the Allens Creek Reservoir as an alternative to the proposed project. None of the reports on biological resources discuss the newly described Brazos heelsplitter mussel (Potamilus streckersoni). This species was described in 2019. It is the genetically distinct Brazos population, formerly considered to be pink papershell (Potamilus ohiensis). This species has been listed by the state of Texas as threatened and is a likely candidate for Federal review for listing. The Texas Natural Resource Database shows it as occurring on the entire lower Brazos including Brazoria County. Lower Brazos Riverwatch field observations have identified it in backwater and point bar habitats within four river miles of the project area. Again, the host for glochidia is freshwater drum and also white crappie. Lower Brazos Riverwatch suggests that a supplemental EIS address the presence of this species in the project area, and potential impacts. This species is considered a Brazos River endemic, but given the exchange of water between the Brazos and Oyster Creek, and the presence of appropriate fish hosts in both watersheds, we believe that it should be surveyed for in areas of appropriate habitat in Oyster Creek also.	NA
113	Biological Resources	Aquatic Species	9	58	p. Page 4-32, 4.5.2 Aquatic, DEIS, the Corps doesn't require mitigation measures that should be required as a matter of course. The Corps states, "but it is anticipated that the intake would be properly screened to avoid entrainment … would not be anticipated to impact aquatic wildlife in the Brazos River during normal operations." The Sierra Club asks the Corps why screens to avoid entrainment of aquatic life aren't required but are only "anticipated". The Sierra Club requests that the Corps require the installation and operation and maintenance of intake screens to avoid entrainment of aquatic organisms.	NA
114	Biological Resources	Invasive Species	9	25	The Corps in the DEIS fails to assess, analyze, and evaluate the impacts of invasive Zebra and Quagga Mussels for the proposed expanded Harris Reservoir, Harris Reservoir, Brazoria Reservoir, Brazos River, Oyster Creek, tributaries of these rivers and streams, downstream due to overland flow to Bastrop Bayou and the Christmas Bay Coastal Preserve which could move these invasive mussels to other waterbodies in the Lower Brazos River Watershed.	NA
115	Physical Resources	Geology	9	26-29	There are overlooked channels which influence water flow, flooding, and flood modeling for the proposed project. Page 3-1, 3.2 Geology and Soils, 3.2.1 Topography, DEIS, states, "Most of the terrain features in this sub-province are nearly flat grasslands with imperceptible slopes to the southeastern portion of the Coastal Prairies."	NA
116	Physical Resources	Geology	9	28	The presence of faults on the proposed alternatives is not eliminated. Page 3-3, 3.2.1 Geology, 3.2.1.1 Proposed Action, Alternative 2A, Alternative 2B, DEIS, the Corps states, "There are no faults mapped in or near the Project stie". The Corps also states on Page 3-7, 3.2.1.3 Alternative 4, DEIS, "There are no faults mapped in or near the Alternative 4 site."	NA
117	Physical Resources	Geology	9	42	Environmental impacts of borrow pits (areas) are ignored and not covered in the DEIS. The Corps mentions borrow areas (pits) in only a few places in the DEIS. Pages 1-14 and 1-15, 1.6 Areas of Known Controversy, DEIS, the Corps states, "Commenters also requested the inclusion of the following topics: … the impact of removing materials from borrow areas". list the environmental impacts of borrow pits and what mitigation measures will be required for these impacts.	NA
118	Physical Resources	Geology	9	33	Environmental impacts of laydown areas, workspace areas, and construction staging areas are ignored or not covered sufficiently in the DEIS. The Corps fails to discuss the environmental impacts of temporary construction laydown areas, staging areas, and workspace areas. This includes a 22-acre staging area that is southeast of the reservoir; a second staging area that is 5 acres on the southwest side of the reservoir; an optional temporary 4-acre laydown area for staging on the southwest side of the project site; and a 32-acre temporary workspace near the southwest corner of the embankment. This is a total of 63-acres of staging and workspaces that will have environmental impacts.	NA
119	Physical Resources	Geology	9	53	Page 3-17, 3.2.2.3 Land Subsidence, 3.2.2.3.1 Proposed Action, Alternative 2A, Alternative 2B, Alternative 3, and Alternative 4, DEIS, the Corps fails to discuss what causes subsidence at alternative sites and how subsidence will affect the proposed alternatives in the 50-year future. The Corps must do this.	Comments 119 and 121.
120	Physical Resources	Geology	9	54	Page 3-19, 3.2.3.2, Erosion and Sedimentation Potential, 3.2.3.2.1 Proposed Action, Alternative 2A, and Alternative 2B, DEIS, the Crops oversimplifies how different soils erode and ignores that the Brazos River has many natural clay particles due to the formations it moves through. That is why the Brazos is a rusty color.	NA
121	Physical Resources	Geology	9	57	i. Page 4-9, 4.2.2.6, Land Subsidence, DEIS, the Corps doesn't define and delineate what "Natural land subsidence" is and what is human caused. It's a long-term, major issue and not moderate since climate change, which is human caused, affects how much sea level rises and subsidence occurs and this proposed project will drive additional development, urbanization, and population growth and thus increase subsidence in Brazoria County where the alternative sites are.	Comments 119 and 121.

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122	Physical Resources	Visual/Aesthetics	9	54	Page 3-115, 3.10.8 Visual and Aesthetic Resources, 3.10.8.1.1 Characteristic Landscape, DEIS, the Brazos River and Oyster Creek are distinctive visual resources. This should be stated in the first sentence.	NA
123	Physical Resources	Recreation	7	3	The DEIS, in section 4.10.5 discusses recreational navigation in a very conclusory manner and with absolutely no basis cited for the conclusions. It displays little understanding of the types of recreational navigation conducted in the area. In section 4.10.5.2.2 it states as follows: "Recreational activities in the Brazos River under the Proposed Action, Alternative 2A, and Alternative 2B near the intake structure would be prevented during construction for public safety. However, adjacent fishing, boating, and other in-water recreational uses would not be impeded during construction, which suggests in-water recreational users would experience short-term, minor, and localized impacts." The implication is that recreational users would be free to use the river up to and on either side of a construction exclusion zone. The actual pattern of use in this area is for recreational users to put into the river at FM 1462, approximately 12.5 river miles above the project area and paddle through to Brazoria County Brazos River Park, about 5.0 miles below the project area. What they describe as a minor inconvenience would, in effect take approximately 17.5 river miles out of public use. They do not define the duration of impacts other than "short term", which could mean anything from weeks to years in the context of major construction. The DEIS should quantify this loss of public use, both geographic and temporal, in a manner that is reflective of actual public use patterns. The DEIS should look at opportunities to provide portage access on the west bank of the Brazos during construction, as is frequently done in projects on navigable waters. In addition, the DEIS should explain clearly how river closures are to be communicated to the user public in a manner that would prevent inadvertent navigation by members of the user public during periods of closure. The DEIS is similarly conclusory and inaccurate in its discussion of long term operational impacts to recreational users. In section 4.10.5.2.2 it states as follows: "Long term operations that could affect in-water recreation would be the existence of the new intake structure in the Brazos River and occasional intake cleaning activities. Operational impacts on in-water recreation in the Brazos River would (be) long term, but infrequent and therefore negligible." Currently, the existing facilities and operations have no effect on recreational users of the Brazos or Oyster Creek. The quoted section appears to state that there will be periodic impacts to users of the river resulting from the new facilities. Again, with no basis for the conclusion, these impacts are stated to be "infrequent and therefore negligible". The DEIS needs to fully describe the nature of these activities, the level of disruption in terms of both time and geography, how the potential for navigation disruption would be communicated to the user public and what mitigation measures (portage ways at the location) would be undertaken to allow continuous use of the river during construction. Lower Brazos Riverwatch does not consider the impacts to navigation and recreational use to be short term, minor or localized, nor do we consider that they have been accurately represented in the DEIS. A supplemental EIS should include an accurate quantification of these impacts and a realistic review of mitigation measures to minimize the disruption of public use on this river segment.	NA
124	Physical Resources	Air Quality, Climate Change, GHG	1	13-15	The DEIS does not adequately analyze climate impacts associated with the project The DEIS fails to adequately consider climate change impacts, in violation of Executive Orders 13,990 and 14,008. See Exec. Order 13,990, Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis, 86 Fed. Reg. 7037 (Jan. 20, 2021) ("Extreme weather events and other climate-related effects have harmed the health, safety, and security of the American people and have increased the urgency for combating climate change..."); see also Exec. Order 14,008, Executive Order on Tackling the Climate Crisis at Home and Abroad, 86 Fed. Reg. 7,619, (Jan. 27, 2021) ("United States international engagement to address climate change — which has become a climate crisis — is more necessary and urgent than ever.") (There is little time left to avoid setting the world on a dangerous, potentially catastrophic, climate trajectory.... we face a climate crisis that threatens our people and communities, public health and economy, and, starkly, our ability to live on planet Earth.... We must listen to science — and act.... It is the policy of my Administration to organize and deploy the full capacity of its agencies to combat the climate crisis to implement a Government-wide approach that reduces climate pollution in every sector of the economy…"). As mentioned in the previous subsection, the NEPA requires an environmental impact assessment to examine all potential impacts of a project, including "ecological . . . aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative." 40 C.F.R. § 1508.8. As part of its climate change analysis, the DEIS should consider both the project's direct impacts and its "reasonably foreseeable" indirect impacts, with those "later in time or farther removed in distance" a part of that assessment. 40 C.F.R. § 1508.8. According to the D.C. Circuit Court of Appeals, "[r]easonable forecasting and speculation is ... implicit in NEPA, and we must reject any attempt by agencies to shirk their responsibilities under NEPA by labeling any and all discussion of future environmental effects as 'crystal ball inquiry.'" Scientists' Inst. For Pub. Info. v. Atomic Energy Comm'n, 481 F.2d 1079, 1092 (D.C. Cir. 1973). Indeed, "when the nature of the effect is reasonably foreseeable but its extent is not, [an] agency may not simply ignore the effect." Mid States Coal. for Progress v. Surface Transp. Bd., 345 F.3d 520, 549 (8th Cir. 2003). The CEQ prescribes guidance for taking a hard look at climate change impacts, which "[r]ecommends that agencies use projected GHG emissions…as a proxy for assessing potential climate change effects when preparing a NEPA analysis for a proposed agency action…"2 GHG emissions such as those created by this project lead to climate change impacts such as ocean warming, ocean acidification, sea-level rise, increased severity and frequency of storm events, flooding, heatwaves, coastal erosion, food and water insecurity, and damage to ecosystems. See "Climate Change 2021," IPCC (2021), available at: https://www.ipcc.ch/report/ r6/wg1/downloads/report/IPCC_AR6_WGI_SPM_final.pdf. According to scientific assessments, without a major and immediate reduction of GHG emissions, there will be more than 1.5 degrees Celsius, and possibly even 2 degrees Celsius, of warming globally. See "Special Report: Global Warming of 1.5°C," IPCC (2018), available at: https://www.ipcc.ch/sr15/. Any contribution, however minor, accelerates this trend. See id. ("Every tonne of CO2 emissions adds to global warming"). The project is already located in a nonattainment area for ozone and, according to the National Research Council, "emission reduction choices made today matter in determining impacts that will be experienced not just over the next few decades, but also into 2 See "Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews," Council on Environmental Quality (Aug. 1, 2016), available at: https://ceq.doe.gov/docs/ceq-regulations-and-guidance/nepa_final_ghg_guidance.pdf. the coming centuries and Millennia." National Research Council, Climate Stabilization Targets (2011).Despite this context, the DEIS lists greenhouse gas emissions data for its planned project construction activities and ongoing operations, concluding that, because the project's emissions are so small, its "contribution to climate change is considered negligible (no measurable impact)." DEIS 4-52.	Comments 124 and 129.
125	Physical Resources	Air Quality, Climate Change, GHG	1	15	For example, it does not analyze the impacts of "fugitive equipment leaks from switchgear and circuit boards containing SF6," instead assuring that best management practices would be applied. This is especially concerning, given the project's development in a floodplain. Its location makes it especially vulnerable to storm surges and flooding, which is only expected to increase as climate change increases the frequency and severity of storm events.	NA
126	Physical Resources	Air Quality, Climate Change, GHG	1	15-16	Neither does the DEIS analyze how the project's direct, indirect, and cumulative contributions to climate change will impact threatened, endangered, or candidate species and their habitats. The project could contribute to climate change impacts such as sea level rise, coastal erosion, loss of coral reefs, habitat loss, reduced food source availability, changes in wildfire intensity and frequency, the spread of disease, severe weather events such as droughts, floods, and heatwaves, and the release of contaminants, all of which could harm species in the region.	NA

Comment ID #	Issue ID	Subcategory	Letter Number	Pages	Comment	Merged Comments
127	Physical Resources	Air Quality, Climate Change, GHG	1	16	The DEIS also does not adequately evaluate the project's impact on climate change through ecosystem health. It does not analyze the potential harms associated with the destruction of Columbia Bottomlands, based on the carbon storage capacity of these trees and their soils. Given their importance in the local ecology, restoring Columbia Bottomlands should be considered in each of the project's mitigation proposals. In addition, the DEIS should consider the climate change-related impacts of diverting flood waters, and the effect it will have on local ecology such as the Christmas Bay Coastal Preserve, Columbia Bottomlands, and Bastrop Bayou. The DEIS should have based its estimates on scenarios that better predict and mitigate for the effects of climate change caused by its project. Instead, the DEIS uses "conservative assumptions" of emissions when "sufficient detail regarding certain aspects of the construction, maintenance, and operation of the Project are not yet known." DEIS 4-52. The DEIS's use of conservative estimates for emissions, but also for sea level rise and rainfall levels, means that it has not adequately explained its plans for scenarios such as facility flooding or damage due to severe storm events that climate change exacerbates.	NA
128	Physical Resources	Air Quality, Climate Change, GHG	1	16	The DEIS also does not adequately assess the importance of project mitigation and potential alternatives. As for mitigation, it does not discuss ways to reduce pollution during the construction and operation of the project. Neither does it sufficiently address alternatives. Dow justifies this project in part based on its need to combat saltwater intrusion from the Gulf of Mexico, but the DEIS does not explain that saltwater intrusion itself can be a result of climate change. Instead, it assumes the expansion project is needed to provide additional water to Dow. It does not consider how this demand could change in the future, or how the project, by endangering local communities, harming ecosystems, and expediting climate change, might not be in the national interest.	NA
129	Physical Resources	Air Quality, Climate Change, GHG	1	16-17	Finally, the DEIS fails to discuss the most recent climate change models, reports, and scientific assessments. For example, it does not mention the 2021 IPCC report, which stresses the importance of acting immediately to reduce GHG emissions to avoid the climate change impacts that would be created with a warming of 1.5 to 2 degrees Celsius. See "Climate Change 2021," IPCC (2021), available at: https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WG I_SPM_final.pdf. It also does not employ readily available tools to estimate GHG emissions and their impact, such as the U.S. EPA's Carbon Equivalencies Calculator, the EPA's social cost of carbon calculator, and the World Resources Protocol Institute and World Business Council on Sustainable Development's Greenhouse Gas Protocol, the Coastal Study Texas, or the EPA's Environmental Justice Screen for the region that considers factors including wildlife hazard potential, drought, coastal flood hazard, and sea level rise (NOAA). Based on the above factors, all project impacts - direct, indirect, and cumulative - should be analyzed, with mitigation measures adopted accordingly. Unless it does so, the DEIS will not have adequately considered the project's impact on climate change.	Comments 124 and 129.
130	Physical Resources	Air Quality, Climate Change, GHG	9	54	). Page 3-121, 3.11.3 Air Quality, DEIS, the Corps states, "… criteria air pollutants …typically have localized air quality effects and relatively short atmospheric lifetimes." This statement is false. Ozone, as a criteria pollutant, can be created and or travel for 100's of miles and cause health effects and this can occur for days because the plume doesn't disappear but advances as the wind blows each day. In Brazoria County we have the ocean-sea breeze-land movement of ozone and its' precursors and HAPs inland and then over the Gulf of Mexico over scores of miles. The statement above should be changed. x. Page 3-123, 3.11.4.1 Greenhouse Gas Pollutants, DEIS, the Corps is incorrect when it states, "GHG … generally do not have direct impacts to human health." Since GHG can cause temperatures that create health emergencies where people overheat and die, GHGs do in fact have direct impacts on human health. These direct impacts are delayed due to the time it takes for climate change air pollution to drift up to the atmosphere and begin the process of increasing temperatures on the surface of the Earth. y. Page 3-124, 3.11.4.2 Greenhouse Gas Emissions, DEIS, the Corps should state that there are currently no air pollution controls for GHGs, so the public understands that little or nothing is being done to reduce these air pollutants.	NA
131	Physical Resources	Traffic	9	55	bb. Pages 3-143 and 3-144, 3.15.2.2 Traffic Volume and Accidents, 3.15.2.2.1 Proposed Action, Alternative 2A, Alternative 2B, and Alternative 3, Table 3.15-1 Annual Daily Traffic 2018 to 2015 and 3.15.2.2.2 Alternative 4, Table 3.15-2 Annual Daily Traffic 2018 to 2015, DEIS, the data used is 4-7 years old and is out-of-date. More current traffic data should be used for the best picture of what traffic volume and accidents are.	NA
132	Physical Resources	Agriculture	9	55	hh. Pages 4-8 through 4-9, 4.2.2.5 Prime Farmland Soils, 4.2.2.5.2 Proposed Action, Alternative 2A, and Alternative 2B, 4.2.2.5.3 Alternative 3, and 4.2.2.4.4 Alternative 4, DEIS, the Corps fails to state why the loss of 2,285.1 acres of prime, unique, and important farmland is only a moderate impact. The impact levels should be defined so the public understands the range of impacts for each impact level and how this range was determined	NA
133	Socioeconomics	Economy	9	14	Dow stated that shortages of water and thus production to the Dow Freeport Works "could impact the national and global economy … have severe negative socioeconomic consequences" in a scoping document (Page 14, Attachment D, Alternatives Analysis). If this is the case, the assumption is that provision of water will have an enormous productive and economic benefit for Dow and others. Since NEPA CEQ regulations/rules require that both beneficial and adverse impacts be considered (Section 1508.27(b)) it's obvious that the DEIS must discuss these beneficial impacts. The Corps doesn't do this.	NA
134	Socioeconomics	EJ	1	11-13	5. The DEIS does not adequately analyze environmental justice impacts associated with the project: The DEIS fails to adequately consider environmental justice impacts, including the human health, economic and social effects of the proposed project on minority and low-income communities in violation of Executive Order 12898. Executive Order 12,898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, 59 Fed. Reg. 7,629 (Feb. 11, 1994); see also Exec. Order 13,990, Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis, 86 Fed. Reg. 7037 (Jan. 20, 2021) ("Where the Federal Government has failed to meet that commitment in the past, it must advance environmental justice."); Exec. Order 14,008, Executive Order on Tackling the Climate Crisis at Home and Abroad, 86 Fed. Reg. 7,619, (Jan. 27, 2021) ("We must deliver environmental justice in communities all across America."). NEPA requires an environmental impact assessment to examine all potential impacts of a project, including "ecological. . . aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative." 40 C.F.R. § 1508.8. Agencies must consider the environmental justice ("EJ") impacts of their actions on low-income, minority communities in accordance with Executive Order 12898. Coliseum Square, Inc. v. Jackson, 465 F.3d 215, 232 (5th Cir. 2006). The socioeconomic costs of a project related to physical environmental impacts must also be analyzed. These analyses include examining "purely economic" impacts—for example, the loss of businesses in the project area—and effects that branch from economic inequality. Id. at	NA

Comment ID #	Issue ID	Subcategory	Letter Number	Pages	Comment	Merged Comments
					234.The analysis must also consider problems related to the displacement or relocation of people. Id. at 232. Taking a hard look at EJ impacts includes a two-step process prescribed by the CEQ. First, the agency must identify any minority or low-income populations in the project's affected area; and second, it must analyze whether those impacts will have disproportionately high and adverse effects on the applicable EJ populations. CEQ EJ Guidance at 9. To determine disproportionate impact, the agency should consider both the demographics of the affected areas and comparison populations and unique factors that may amplify a project's effects in EJ populations. Id. at 9. The DEIS concludes, "Environmental Justice Minority populations would not be displaced under all action alternatives. There are no environmental or human health impacts that would specifically or disproportionately occur within low income or minority populations or areas with concentrations of children under all action alternatives" (viii, page 13). It also claims, "There are no environmental or human health impacts that would specifically or disproportionately occur within low income or minority populations or areas with concentrations of children under all action alternatives." Despite making such assertions, the DEIS does not analyze factors that are critical for understanding the project's potential impact on environmental justice communities. To consider the human health impacts on environmental justice communities in the project area, the DEIS should compare existing rates of health conditions such as cancer, heart disease, asthma, and low life expectancy that could be further exacerbated by the project. Beyond disease rates themselves, the DEIS should also look at regional access to healthcare, including the presence of local hospitals and percentages of minority populations and low income individuals uninsured. It should also quantify the percentages of children and elderly in the project region, and recognize that these populations are more susceptible to ozone exposure, VOCs, hazardous air pollutants, and criteria pollutants. The DEIS should assess the project area and alternatives through the EPA's Environmental Justice Screening and Mapping Tool to identify vulnerable communities in the region and to consider potential impacts on them. Related to environmental justice indexes, including ozone, particulate matter, air toxics cancer risk, air toxics respiratory hazard index, traffic proximity, superfund proximity, lead paint, RMP facility proximity, hazardous waste proximity, underwater storage tanks, and wastewater discharge. "EJScreen," EPA (Apr. 2022), available at: https://ejscreen.epa.gov/mapper/. The project region has a higher percentage than the national average for all of these indexes except for wastewater discharge. See id. Related to socioeconomic indicators, as compared to the national average, the project area also has a higher than average population of people of color, unemployment rate, populations linguistically isolated, and people with less than a high school education. See id. The DEIS should recognize that its project will cause a higher level of pollutants in the air (regardless of compliance with NAAQS), water, and land, along with the associated increased threat of fires and industrial disasters, which will endanger public health, with disproportionate effect on environmental justice communities. The DEIS should also consider the economic impacts of the project and alternatives on environmental justice communities. It should evaluate the potential impacts on the region's industries, businesses, and employment rates during project construction but also during future operations. The project also has the potential to increase the risk of natural disasters and flooding in the region, which could damage the local economy and threaten livelihoods. The DEIS should also analyze in its report the potential housing impacts of the project and its alternatives as related to environmental justice communities. During project construction, there will likely be an associated influx of workers. Additionally, as reservoir capacity is expanded, industrial facilities using the new water source will be able to increase their production and hire more workers to maintain their expanded operations. This could affect housing demand, availability, and costs within minority and low-income populations living in the region. This analysis should take into account historic discriminatory housing policies such as redlining and restrictive zoning, and also consider that environmental justice communities make up a high percentage of renters, are evicted at higher rates than their counterparts, and are disproportionately impacted by natural disasters and associated property damage. The DEIS should evaluate the effects the project and its alternatives might have on Indigenous people and tribes, regardless of whether the Texas Historic Commission recognizes historic properties on site and regardless of whether these communities are federally recognized. The historic range of the Karankawa tribe lies within the project area. "Native Lands Digital" (2022), available at: https://native-land.ca/. The Karankawa's descendants, known as the Karankawa	

Comment ID #	Issue ID	Subcategory	Letter Number	Pages	Comment	Merged Comments
					Kadla, maintain a connection with the region and historic and cultural significance within it. The Corps and DEIS should specifically include consultation with its members. Finally, the DEIS should analyze the effects that the project and its alternatives have on environmental justice communities through climate change. It should do so, recognizing the disproportionate impacts that major storms, flooding events, chemical fires, and air pollution have on environmental justice communities. It should recognize that minority and low-income populations are less likely to get emergency assistance and post-disaster recovery aid compared to their non-minority, wealthier counterparts. Based on the above factors, all project impacts - direct, indirect, and cumulative - should be analyzed, with mitigation measures adopted accordingly. By failing to do so, the DEIS has not adequately considered the project's impact on environmental justice communities.	
135	Socioeconomics	EJ	4	3	According to Section 3.10.6.1.1 of the Draft EIS, Texas and Brazoria County have higher minority population percentages than the national average (39%). One of the three Census Tracts in the analysis area has a higher minority population percentage than the national, state, and county percentages (Census Tract 6619.01) (Census 2020d). Census Tract 6619.01 also has a minority population percentage greater than 50%, which is identified as an indicator for environmental justice analysis (Federal Interagency Working Group on Environmental Justice & NEPA Compliance Committee 2016). The EPA recommends the USACE include additional meaningful outreach to the impacted populations, such as, TV and radio announcements, placing notifications at school and religious establishments, and distributing flyers in the impacted communities. The USACE should include a description of the meaningful outreach effort to the Public (not just known interested parties and/or individuals) in the EIS.	NA
136	Public Health and Safety	Infrastructure Collapse	1	15	Additionally, the DEIS does not adequately assess the direct impacts the project will have, as it fails to evaluate the risk caused by a collapse of its infrastructure.	NA
137	Water Resources	Flood Hazards	9	1-4	The Corps must conduct the National Environmental Policy Act (NEPA) environmental impact statement (EIS) analysis as required by the President's Council on Environmental Quality (CEQ) regulations/rules and consider the effects on floodplains/floodways that are developed and or rerouted.	NA
138	NEPA	Alternatives	9	1-4	The Corps hasn't chosen to analyze alternatives that implement floodplain conservation, the conservation of open space, and consider the monetary impacts of ecosystems and the ecological services provided to people and the environment. The Federal Emergency Management Agency (FEMA) allows for and encourages the analysis of ecosystem services in projects. It's time that the Corps do the same for this proposal.	Comments 4, 5, 6, 7, 8, 9, 15, 17, 22, and 138.
139	Water Resources	Flood Hazards	9	1-4	A Hazard Mitigation Plan is needed for the entire area so that floods are dealt with comprehensively, including current wetlands, where wetlands can be restored, and not piecemeal analysis and plans where different projects may interfere and disrupt each other.	NA
140	NEPA	Cumulative	9	1-4	There is a proposed re-evaluation of the 1995 Upper Bastrop Bayou Flood Protection Plan Study that may impact or be impacted by the Dow proposal. This re-evaluation will look not only at diverting Brazos River overflow waters to Bastrop Bayou by a new diversion channel and Angleton Drainage District Ditch 22 but will determine if additional Brazos River overflows can be diverted to Oyster Creek. The City of Lake Jackson, Brazoria County, City of Richwood, Velasco Drainage District, Angleton Drainage District, and the City of Clute are involved in this re-evaluation and these entities along with the Texas Water Development Board have conducted studies or have data that may be of use for direct, indirect (secondary), connected, and cumulative impacts analysis (Sections 1508.7, 1508.8, 1508.14, 1508.18, and 1508.27). This project has been ignored by the Corps in this DEIS for cumulative effects analysis.	Comment 69, 70, and 140.

APPENDIX O

Biological Assessment and
U.S. Fish and Wildlife Service Concurrence

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Texas Coastal Ecological Services Field Office
17629 El Camino Real, Suite 211
Houston, Texas 77058
PHONE: 281/286-8282
FAX: 281/488-5882

In Reply Refer To:
2023-0002280

October 13, 2022

Colonel Rhett Blackmon
Galveston District, Corps of Engineers
Attn: Jayson Hudson
P.O. Box 1229
Galveston, Texas 77553-1229

Dear Colonel Blackmon:

Thank you for the final Biological Assessment (BA) dated August 2022 and your request for concurrence with the U.S. Army Corps of Engineers' (Corps) determination that the proposed Dow Chemical Harris Reservoir Expansion Project (Corps permit number SWG -2016-01027) may affect, but is not likely to adversely affect the endangered Whooping crane (*Grus americana*). The applicant, Dow Chemical Company, is proposing to construct an off-channel impoundment reservoir, pumped intake station, gravity outfall, and new bypass channel located 8 miles northwest of the City of Angleton, adjacent to Dow's existing Harris Reservoir in Brazoria County, Texas.

Dow Chemical and the Corps have determined that the proposed project will have no effect on: West Indian Manatee (*Trichechus manatus),* Attwater's greater prairie chicken (*Tympanuchus cupido attwateri),* eastern black rail (*Laterallus jamaicensis ssp. jamaicensis*), red knot (*Calidris canutus rufa)*, piping plover *(Charadrius melodus,* leatherback sea turtle (*Dermochelys coriace),* hawksbill sea turtle (*Eretmochelys imbricate)*, loggerhead sea turtle (*Caretta caretta)*, green sea turtle (*Chelonia mydas),* Kemp's ridley sea turtle (*Lepidochelys kempii)*, Texas fawnsfoot (*Truncilla macrodon*), and Texas Prairie dawn-flower (*Hymenoxys texana*). No additional coordination with the Service is necessary for these species.

The U.S. Fish and Wildlife Service (Service) concurs that the proposed project may affect, but is not likely to adversely affect the federally listed Whooping crane. This concurrence is based on a review of the final BA dated August 2022, Service files, e-mail correspondence, written correspondence, conference calls, and the implementation of the following avoidance and minimization measures.

AVOIDANCE AND MINIMIZATION MEASURES

- If a whooping crane is observed, all construction activities will be stopped within 1000 feet of the whooping crane observation. Construction activities will remain stopped until the whooping crane(s) leaves the area.
- All tall construction equipment will be lowered at night to reduce potential for collisions with whooping cranes and other avian species.

In the event the project changes or additional information on listed or proposed species becomes available, the project should be reanalyzed for effects not previously considered. If you have any questions, or need additional information, please contact staff biologist Moni Belton at 281-212-1512 or Moni_Belton@fws.gov.

Sincerely,

CHARLES ARDIZZONE
Digitally signed by CHARLES ARDIZZONE
Date: 2022.10.13 11:53:42 -05'00'

Charles Ardizzone
Field Supervisor

Biological Assessment for the Dow Chemical Harris Reservoir Expansion Project within the U.S. Army Corps of Engineers Galveston District

USACE Galveston District File No. SWG-2016-01027

AUGUST 2022

PREPARED FOR

U.S. Army Corps of Engineers
and
Dow Chemical Company

PREPARED BY

SWCA Environmental Consultants

BIOLOGICAL ASSESSMENT FOR THE DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT WITHIN THE U.S. ARMY CORPS OF ENGINEERS GALVESTON DISTRICT

USACE Galveston District File No. SWG-2016-01027

Prepared for

U.S. Army Corps of Engineers
Galveston District
2000 Fort Point Road
Galveston, Texas 77550

and

Dow Chemical Company
Texas Innovation Center
332 SH 332 E
Lake Jackson, Texas 77566

Prepared by

SWCA Environmental Consultants
10245 West Little York Road, Suite 600
Houston, Texas 77040
www.swca.com

SWCA Project No. 52872

August 2022

EXECUTIVE SUMMARY

Dow Chemical Company (Dow or Applicant) proposes to construct and operate an off-channel impoundment reservoir, pumped intake station, gravity outfall, and new bypass channel (proposed Project). The proposed Project site consists of 2,533 acres and would be located south of Houston, Texas, approximately 8 miles northwest of Angleton, adjacent to Dow's existing Harris Reservoir in Brazoria County, Texas. The purpose of the proposed Project is to expand Dow's water storage capacity at or near the existing Harris Reservoir to improve the long-term reliability of water supply during drought for facilities at Dow's Texas Operations (an integrated chemical manufacturing facility) in Freeport, Texas, as well as for other industrial, community, and potable water users that rely on Dow's water supply. The proposed Project is intended to allow more efficient use of Dow's existing Brazos River surface water rights.

The proposed Project would cause the discharge of dredge and fill material into waters of the United States for the purpose of constructing the proposed Project. Dow submitted an application to U.S. Army Corps of Engineers (USACE) for a Department of the Army permit pursuant to Section 10 of the Rivers and Harbors Act of 1899 (33 United States Code [USC] 403) and Section 404 of the Clean Water Act (33 USC 1344) (USACE Permit SWG–2016–01027). USACE determined that the proposed Project constitutes a major federal action that has the potential to significantly affect the quality of the human environment, which required the preparation of an environmental impact statement (EIS). The USACE Galveston District Regulatory Division is the lead federal agency that prepared the EIS. This biological assessment (BA) serves as an accompanying document to the EIS to support federal interagency consultation between the USACE and the U.S. Fish and Wildlife Service (USFWS) in accordance with Section 7(a) of the Endangered Species Act.

Eleven federally Listed Species, plus one species proposed for federal listing and one candidate species, may occur or are known to occur within Brazoria County (USFWS 2021b). Of these 13 species, three have the potential to occur in the Action Area: the endangered whooping crane (*Grus americana*), the proposed for federal listing Texas fawnsfoot (*Truncilla macrodon*), and the candidate species monarch butterfly (*Danaus plexippus*). The USACE is not required to consult with USFWS on candidate species per 50 Code of Federal Regulations 402.12. The assessment concludes that the proposed Project *may affect but is not likely to adversely affect* the whooping crane. There is no Designated Critical Habitat within the Action Area (USFWS 2021b). Dow would implement species-specific conservation measures and general construction conservation measures to avoid and minimize effects to federally listed, proposed, and candidate species.

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CONTENTS

Figures

Tables

1 INTRODUCTION

SWCA Environmental Consultants (SWCA) prepared this biological assessment (BA) on behalf of the U.S. Army Corps of Engineers (USACE) and Dow Chemical (Dow or Applicant). The Applicant proposes to construct and operate an off-channel impoundment reservoir, pumped intake station, gravity outfall, and new bypass channel (proposed Project). The proposed Project site consists of 2,533 acres, and would be located south of Houston, Texas, approximately 8 miles northwest of Angleton and approximately 5 miles west of State Highway (SH) 288, in Brazoria County (Figure 1). The proposed reservoir would be adjacent to Dow's existing Harris Reservoir. The purpose of the proposed Project is to expand Dow's water storage capacity at or near the existing Harris Reservoir to improve the long-term reliability of water supply during drought for facilities at Dow's Texas Operations (an integrated chemical manufacturing facility) in Freeport, Texas, as well as for other industrial, community, and potable water users that rely on Dow's water supply. The proposed Project is intended to allow more efficient use of Dow's existing Brazos River surface water rights.

The proposed Project would cause the discharge of dredge and fill material into waters of the U.S. (WOUS) for the purpose of constructing the proposed Project. These activities are regulated by the USACE under Section 404 of the Clean Water Act (CWA). Dow submitted an application to USACE for a Department of the Army permit pursuant to Section 10 of the Rivers and Harbors Act of 1899 (33 United States Code [USC] 403) and Section 404 of the CWA (33 USC 1344) (USACE Permit SWG–2016–01027). USACE determined that the proposed Project constitutes a major federal action that has the potential to significantly affect the quality of the human environment, which required the preparation of an environmental impact statement (EIS). The USACE Galveston District Regulatory Division is the lead federal agency that prepared the EIS.

If a federally Listed Species may be affected by a federal action, even if entirely beneficial, consultation (either formal or informal) with the U.S. Fish and Wildlife Service (USFWS) is necessary as required by Section 7(a) of the Endangered Species Act (ESA). This BA serves as an accompanying document to the EIS for use by the USACE in consultation with the USFWS. The BA evaluates the effects of the actions, as defined in 50 Code of Federal Regulations (CFR) 402.02, taken by the USACE to authorize discharges of dredged or fill material into WOUS associated with the proposed Project (i.e., the effects of the Proposed Action) on species listed as threatened or endangered under the ESA or species proposed for such listing (together, the "Listed Species") and on areas designated as critical habitat under the ESA or areas proposed for such designation (together, the "Designated Critical Habitats"). This BA also provides the USACE determination of effects for Listed Species and Designated Critical Habitats.

1.1 Description of the Proposed Project

The proposed Project is to construct a reservoir to expand Dow's water storage capacity adjacent to the existing Harris Reservoir to improve the long-term reliability of water supply during drought conditions. Dow's current effective storage capacity provides approximately 68 days or less of stored water, which is below the Texas Commission on Environmental Quality (TCEQ) recommendation for storage to meet drought preparedness and response standards of 180 days (30 Texas Administrative Code (TAC) 290.41 (b)(1)).

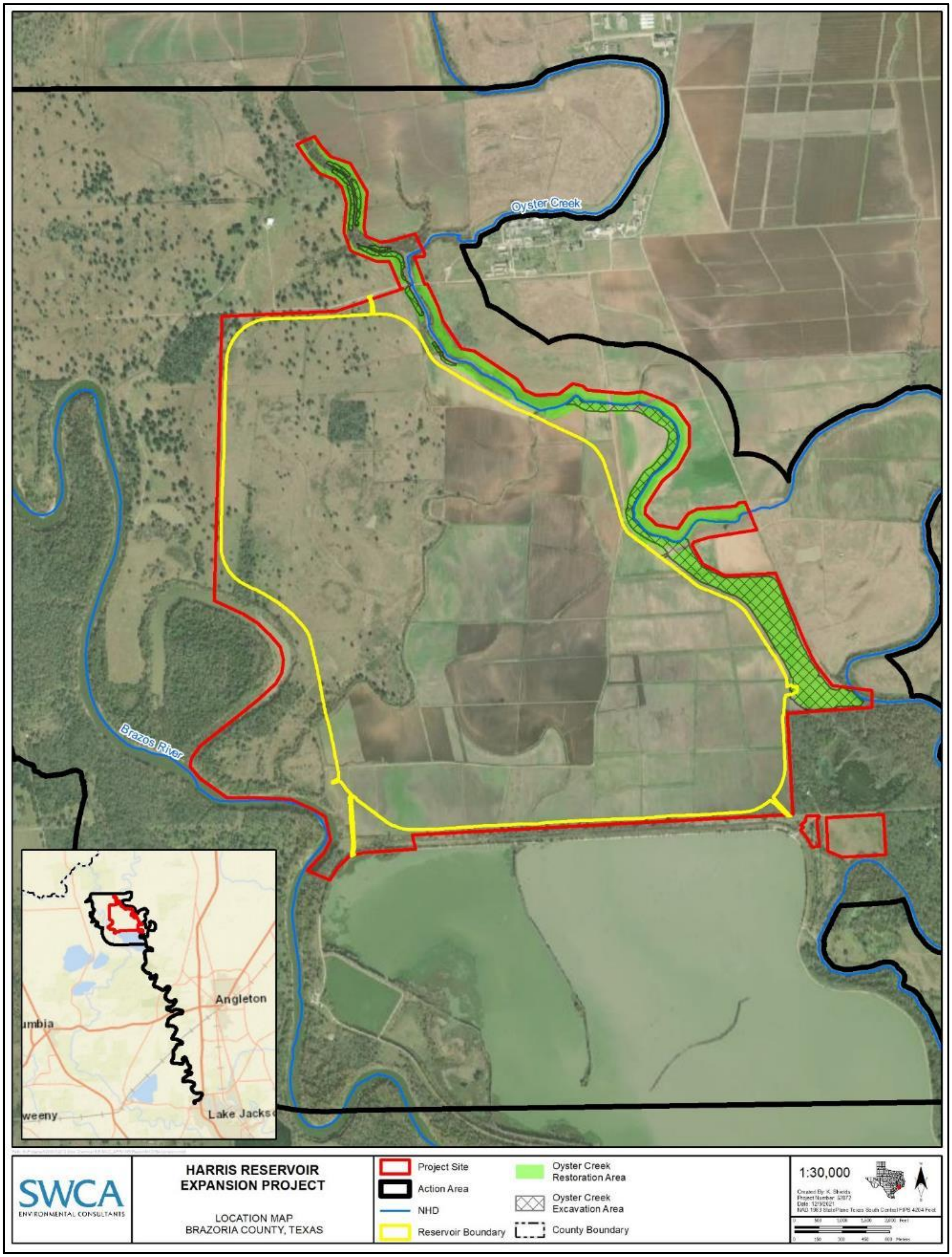

Figure 1. Project location.

The proposed Project site is 2,533 acres and located in rural Brazoria County, bordered by the Brazos River to the west, Oyster Creek to the east, the existing Harris Reservoir to the south, and Texas Department of Criminal Justice (TDCJ) Ramsey Prison Facility land to the north (see Figure 1). The southern boundary of the proposed Project site abuts Harris Reservoir Road (County Road [CR] 34). The northern portion of the proposed Project site can be accessed from a dirt road on the prison property to Ramsey Bridge. The proposed Project site is currently leased to the TDCJ Ramsey Unit for agricultural farming and cattle grazing. The surrounding area is mostly agricultural fields and grazing pastures with scattered residences and the TDCJ prison to the north. The proposed Project site is within the floodplain of the Brazos River and Oyster Creek.

1.1.1 Project Components

The proposed Project would include the following elements: an off-channel impoundment of approximately 1,929 acres with a 51,000-acre-foot (ac-ft) storage capacity, an intake and pump station to divert water from the Brazos River, an outlet and emergency spillway to Oyster Creek, temporary access roads and staging areas, and floodplain enhancements and stream restoration in Oyster Creek (Figure 2). Each element is discussed in detail below.

Within the 2,533-acre proposed Project site, approximately 77% of land would be permanently developed, 3% would be temporarily disturbed during construction, 11% would remain undeveloped, and 9% would be improved as part of mitigation (Table 1). Disturbances would include the following:

- 1,929 acres for the reservoir including the embankment.
- The 10 acres needed for construction of the river intake and pump station, including the intake pipeline. The permanent pump station (fenced area after construction) would be 2 acres.
- The reservoir outlet/spillway structure which would be mostly within the reservoir and embankment, except for 400 feet of 10-foot-wide conduit between the embankment and Oyster Creek totaling 0.1 acre.
- A 7-mile-long gravel perimeter road that would range from 12 to 20 feet wide (11 acres) plus a 4-foot shoulder (7 acres).

Table 1. Temporary and Permanent Disturbance Under the Proposed Action (Project Workspace)

Project Component	Temporary Acres	Permanent Acres	Total Acres
Reservoir	0.0	1,929.0	1,929.0
River intake and pump station	7.1	3.1	10.2
Spillway/outlet	0.0	0.1	0.1
Perimeter road	0.0	17.9	17.9
Temporary staging and work areas	63.0	0.0	63.0
Total disturbance	**70.1**	**1,950.1**	**2,020.2**
Total floodplain enhancement	**0.0**	**227.0**	**227.0**
Total undisturbed land			**285.8**
Total proposed Project site			**2,533.0**

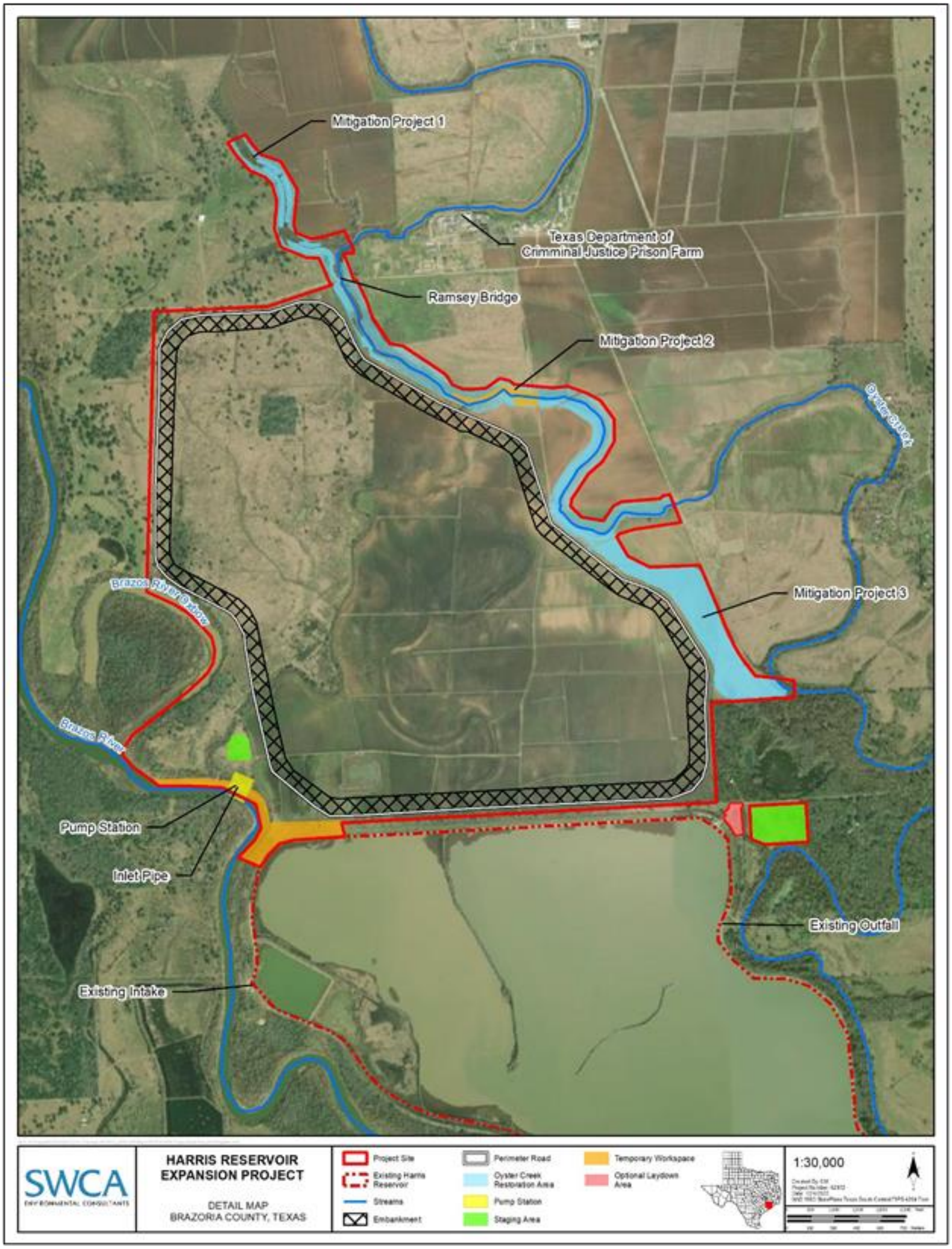

Figure 2. Project components.

1.1.2 Off-channel Impoundment

An approximately 40-foot-high × 36,200-foot-long earthen embankment would be constructed to form the reservoir impoundment. The embankment would be constructed of compacted soils obtained from borrow areas within the reservoir interior and the slope design is based on these soil conditions. The components of the embankment would include a stabilizing berm, soil-cement armoring, wave wall, main embankment, chimney and blanket filters and drains, perimeter toe ditch, seepage barrier wall, and a perimeter road embankment (see Appendix K of the environmental impact statement [EIS] for engineering and design drawings[1]). The stabilizing berm would be constructed of soils stripped from the embankment footprint and borrow areas and would mainly serve two purposes: 1) to stabilize the slope under a rapid drawdown loading condition during releases in drought conditions, and 2) to decrease the portion of the slope requiring armoring against erosion. Approximately 900,000 tons of sand and cement would be imported to the site for construction of internal filter/drains and soil-cement armoring. The exterior slope of the embankment would be seeded with native vegetation and maintained by mowing.

1.1.3 River Intake and Pump Station

The Brazos River in-channel intake structure (Figure 3; see Appendix K of the EIS) would include a sheet pile structure with a concrete head wall in the Brazos River, mechanically cleaned T-screens, and two 72-inch buried pipelines from the screens to the pump station building. The pump station would be partially underground with reinforced concrete walls and would be enclosed on three sides aboveground and have a roof. The pump station would contain two pumps capable of pumping 75,000 gallons per minute each from the river to the reservoir. An electrical power line would be constructed to convey power from the nearby CenterPoint Energy transmission line to the pump station. Water would be conveyed to the reservoir via approximately 1,200 linear feet of steel discharge pipeline. Streambank stabilization measures would be installed in the immediate vicinity of the intake structure, approximately 200 feet upstream and 100 feet downstream. Measures anticipated to stabilize the riverbank would include sheet piling, native backfill, and riprap (4,245 cubic yards [cy] within a 32,008-square-foot area) designed to reinforce the toe and a portion of the slope of the riverbank, preventing lateral migration of the Brazos River.

Other facilities associated with the pump station would include the operations building, electrical motor control center (MCC) building, and transformer area. The operations building would be an approximately 2,000-square-foot pre-engineered metal building supported by a concrete foundation. The transformer would be supported on a concrete foundation pad with a containment area.

1.1.4 Discharge Pipeline and Reservoir Inlet

Two 72-inch welded steel discharge pipelines from the pumps would run above grade to where they exit the pump station and combine into a common header and would remain above grade to immediately downstream of the flowmeter. Then, the discharge pipeline would be buried with minimum cover to where it meets the reservoir.

The reservoir inlet structure would be located inside the reservoir and would serve to transition the pump discharge from the pipe into the reservoir. A USACE-type (USACE 1963) stilling well would be placed at the end of the pipe and would be approximately 15 feet in diameter and in depth. Design plans are included in Appendix K of the EIS.

1 The Section 508 amendment of the Rehabilitation Act of 1973 requires that the information in federal documents be accessible to individuals with disabilities. The U.S. Army Corps of Engineers (Corps) has made every effort to ensure that the information in this appendix is accessible. However, Appendix K of the EIS is not fully compliant with Section 508, and readers with disabilities are encouraged to contact Mr. Jayson Hudson at the Corps at (409) 766-3108 or at SWG201601027@usace.army.mil if they would like access to the information.

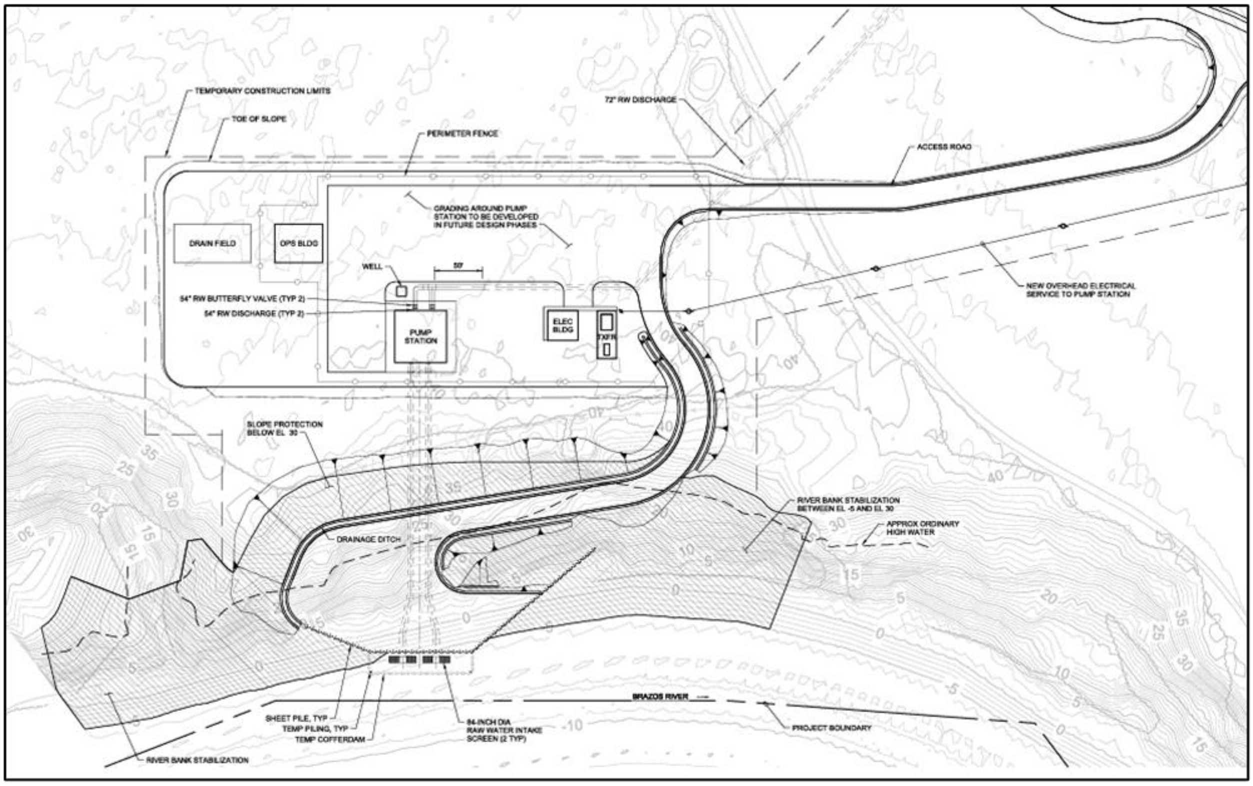

Figure 3. River intake and pump station.

1.1.5 Reservoir Outlet and Emergency Spillway

The reservoir outlet and emergency spillway comprise a concrete structure on the interior toe of the reservoir embankment and include a sluice gate outlet for controlled releases (Figure 4). The outlet consists of a spillway crest with a weir crest that controls flow entering the drop shaft and an outlet conduit that conveys water through the embankment to the stilling basin, which is near the flood mitigation channel for Oyster Creek. The outlet conduit is a box culvert 5 feet high × 10 feet wide.

1.1.6 Conveyance

Water would be released from the reservoir into Oyster Creek via the outlet described above and would supplement releases from the existing Harris Reservoir discharge facilities. Downstream, the existing pump stations and industrial canals at Lake Jackson and Freeport would convey the water to Dow’s Texas Operations facility for use. No new canals are proposed as part of the proposed Project.

1.1.7 Roads

Access to the embankment for maintenance and inspection would be provided by a new 8-foot-wide gravel road on the embankment crest and another 12-foot-wide gravel road around the perimeter of the embankment.

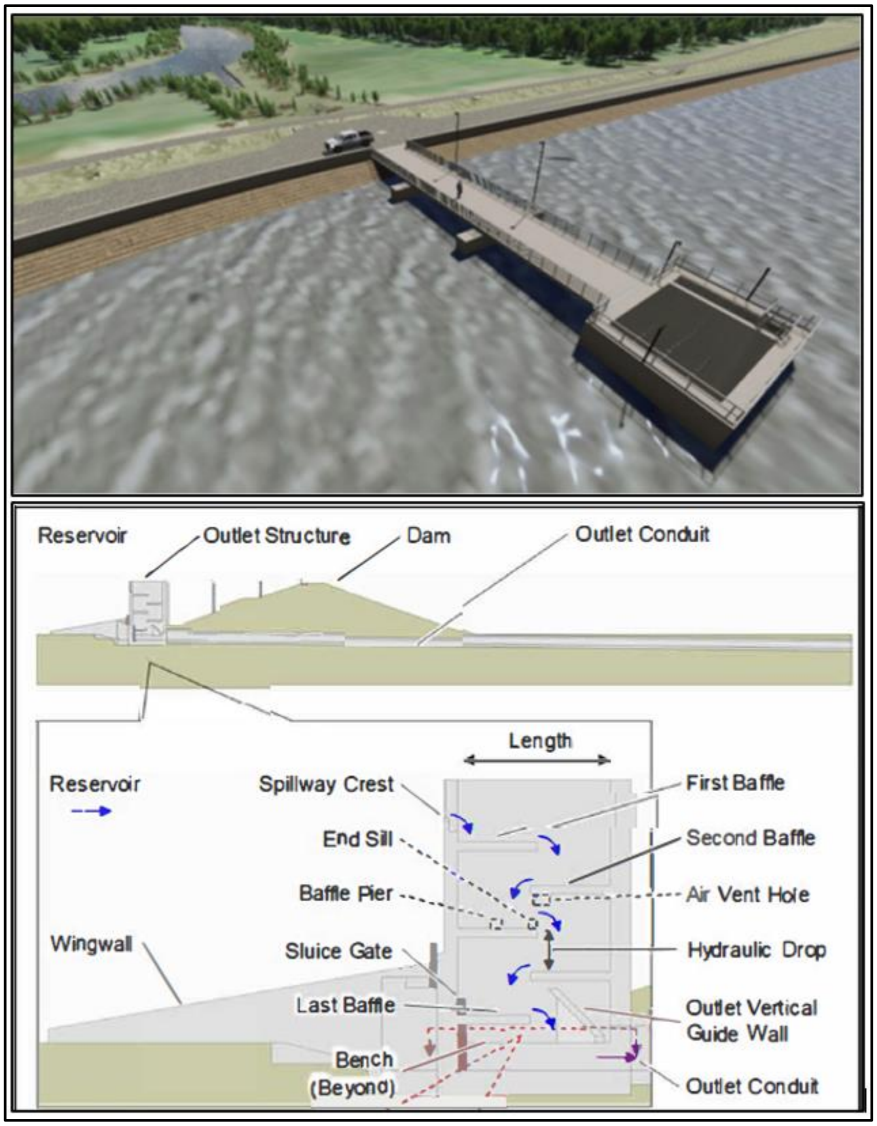

Figure 4. Reservoir outlet and emergency spillway.

1.1.8 Oyster Creek Floodplain Enhancement

The proposed Project would include three on-site floodplain enhancement projects along Oyster Creek, Oyster Creek Projects 1, 2, and 3 (see Figure 2). The Oyster Creek projects would include use of native vegetation planting, a monitoring plan, and an invasive plant species management plan. Projects 1 and 2 are detailed in the mitigation plan because these two areas include compensatory mitigation required for unavoidable impacts to wetlands and waterbodies (SWCA 2022).

Oyster Creek Project 1 would widen the unnamed tributary to Oyster Creek immediately north of the confluence of Oyster Creek and the unnamed tributary north of Farm-to-Market Road 655. Project 1 would include riparian buffer and riparian vegetation improvements. The project includes widening the channel at key locations and providing a floodplain bench to help convey water, and would preserve and enhance the riverine habitat.

Oyster Creek Project 2 would widen the main Oyster Creek channel starting just downstream of Project 1 to a point approximately 12,000 feet downstream. Widening of the Oyster Creek channel through this section would be predominantly on the west side of Oyster Creek and would include the development of a floodplain bench and bank slopeback where required to address the reduction in channel capacity that is the result of farming activities. Project 2 would restore the natural function of the channel through rehabilitation and enhancement by planting riparian vegetation and providing a riparian buffer in addition to the channel widening.

Oyster Creek Project 3 includes a new flood conveyance channel to improve the capacity and flow characteristics of the Oyster Creek channel and provide floodplain enhancement (Figure 5). The flood conveyance channel would be constructed from the end of Project 2 and flow 4,300 feet south, rejoining Oyster Creek 12,000 feet upstream of the existing Harris Reservoir Road (CR 34). This channel is designed to carry high flows during 25-year storms and above. Project 3 would establish new riparian functionality and provide additional channel capacity for Oyster Creek during high-flow events.

1.2 Construction

Construction of the proposed Project would involve the excavation, removal, and placement of more than 12 million cy of material. For the intake and streambed stabilization, 420 cy of dredge, and 8,075 cy of fill volume are proposed below the ordinary high water mark of the Brazos River (Table 2). The proposed Project site contains 21.38 acres of wetlands and 109,338 linear feet (74.10 acres) of waterbodies and would permanently impact 15.97 acres of wetlands and 78,038 linear feet (31.89 acres) of waterbodies.

Table 2. Brazos River Dredge and Fill Volumes Below Ordinary High Water Mark

Feature Name	Dredge Volume	Fill Volume
Intake	420 cy	3,830 cy
Streambank stabilization measures	0 cy	4,245 cy
Total	**420 cy**	**8,075 cy**

Construction would occur in three phases: 1) reservoir embankment construction, 2) intake structure and pump station construction, and 3) Oyster Creek projects floodplain enhancements. Construction would include use of temporary staging areas and workspaces, early site works (e.g., site grading, installation of temporary facilities to support construction activities), relocation of utilities, and road maintenance. These elements are summarized below. A detailed construction plan is described in Dow’s preliminary construction management plan for the proposed Project (Jacobs 2018).

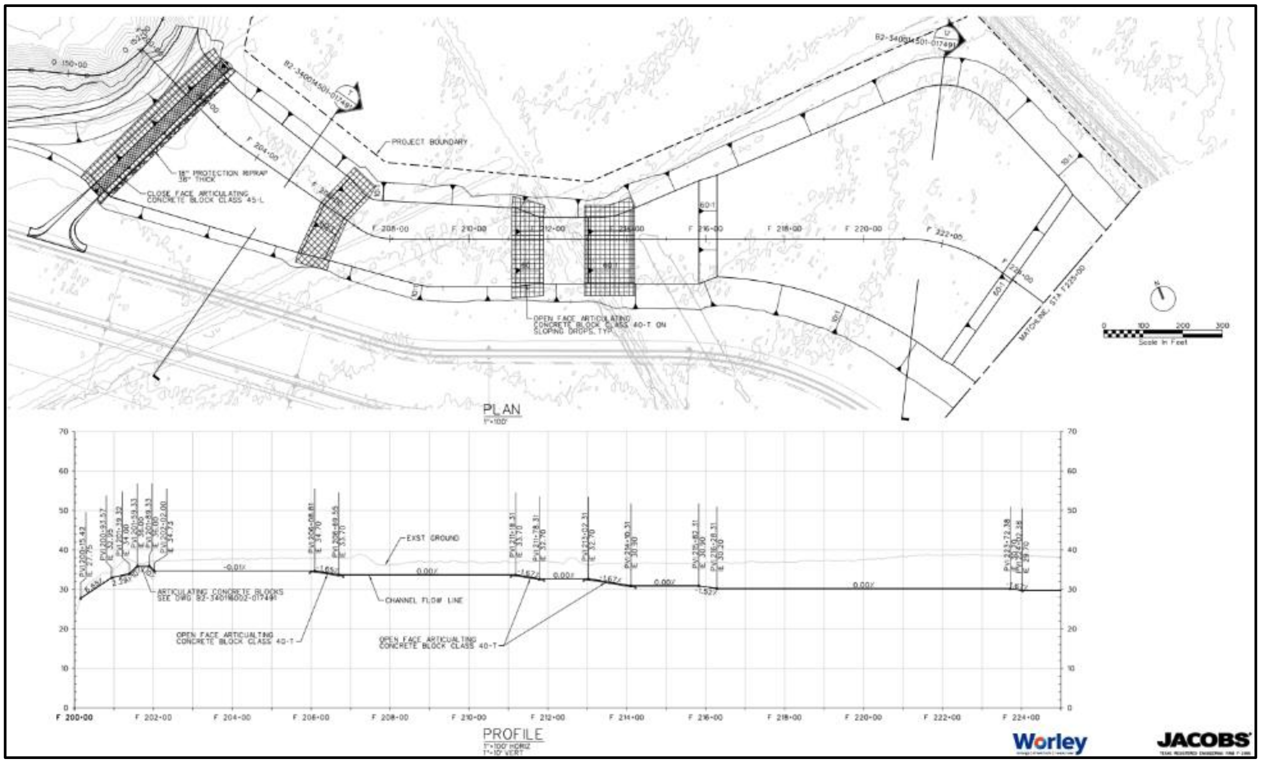

Figure 5. Oyster Creek Project 3.

1.2.1 Temporary Staging Areas and Workspace

Two temporary staging areas and one temporary workspace would be used during construction. An approximately 22-acre staging area southeast of the proposed reservoir would be used for temporary construction facilities, including construction offices, equipment and material storage, and work force parking. There is a 4-acre optional laydown area located west and adjacent to the 22-acre staging area (see Figure 1). A second 5-acre staging area on the southwest side of the proposed reservoir near the proposed pump station would be used during construction of the intake and pump station (see Appendix K of the EIS). A 32-acre temporary workspace near the southwest corner of the embankment would be used during construction of the intake from the Brazos River and the bank stabilization. All temporary areas would be sited to avoid impacts to surface waters and wetlands; however, some construction would occur in the Brazos River during construction of the intake facility and bank stabilization.

1.2.2 Utilities

Three ConocoPhillips pipelines cross the proposed Project site in a single corridor (Figure 6). The pipelines would be relocated in a 100-foot-wide easement along the toe of the perimeter access road at the western and northern sides of the proposed reservoir. ConocoPhillips would demolish and remove the pipelines from the proposed Project site and install new pipelines with conventional open-cut construction methods. The new pipelines would be installed at a depth of approximately 6 feet below grade, matching the design of the existing pipelines.

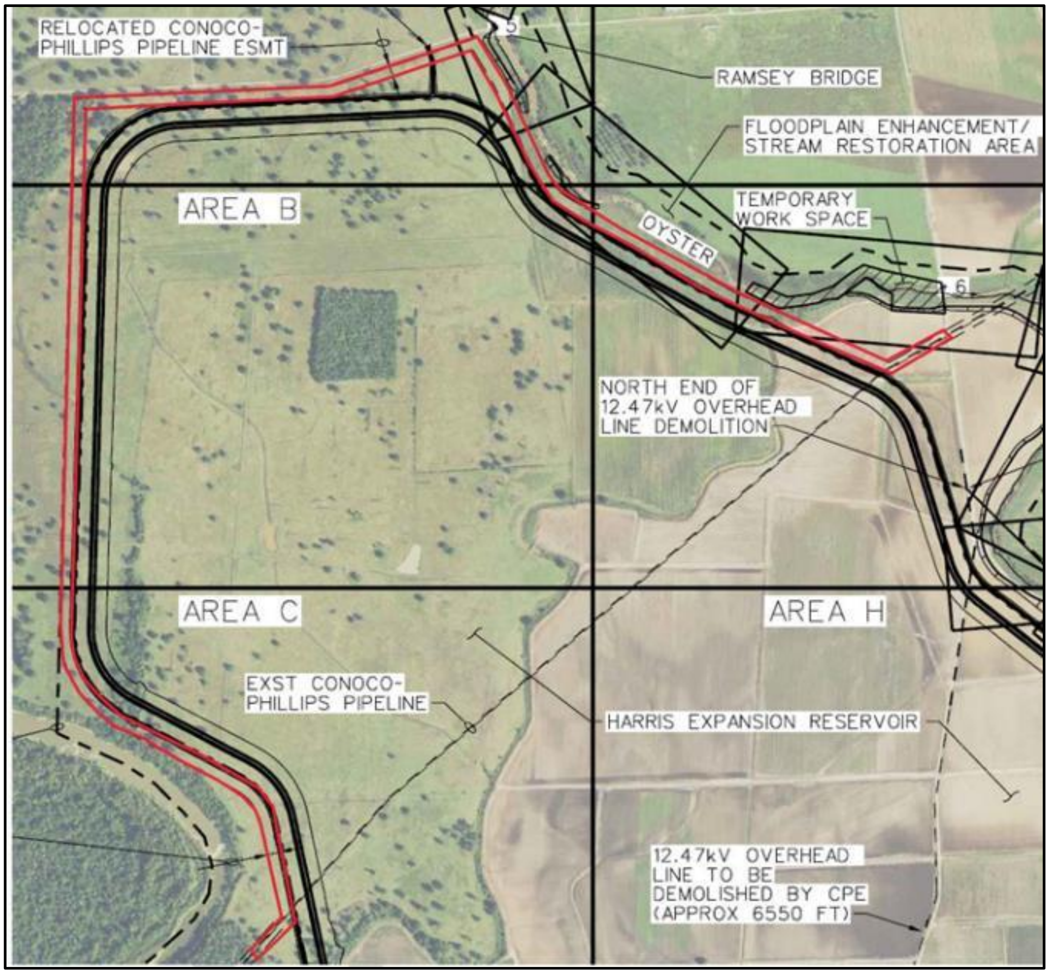

Figure 6. Existing ConocoPhillips pipeline and proposed route (Jacobs 2018).

The existing CenterPoint Energy power line would be relocated to the eastern perimeter of the proposed Project site (Figure 7). CenterPoint Energy would be responsible for relocating the power line. This work would happen in two phases. The first phase would be the demolition and re-route of the 12.47-kilovolt line that currently runs through the proposed Project site. The second phase would be the installation of two new power lines, one on the southwest corner of the proposed Project site, heading north to the new pump station and the second extending from the previously installed rerouted line on the east side of the reservoir over to the new reservoir outlet structure.

A potable water well would be provided to supply water as needed.

Figure 7. Existing CenterPoint Energy power line and proposed route (Jacobs 2018).

1.2.3 Equipment

Major equipment for construction of the proposed Project elements include excavators, scrapers, loaders, dozers, blades, compactors, water trucks, bobcats, tractors, backhoes, electrical trenchers, lifts, and cranes. The quantities of each type of equipment required for each phase of three construction phases is listed in the construction management plan (Jacobs 2018). An on-site concrete batch plant would be used for construction of the inlet, pump station, and outlet.

1.2.4 Construction Access and Road Maintenance

The southern proposed Project site would be accessed from CR 34. Although there is a dirt road on the prison property to Ramsey Bridge, it a private road and would not be used by contractors. All access would be from the southern entrance on CR 34.

In coordination with the contractor and county, access plans would be developed for constructing and maintaining haul roads that can accommodate wet conditions and be operational soon after rain events. In addition, Dow recognizes that CR 34 may need maintenance and repairs during proposed Project construction and would work with the county to manage the need.

1.2.5 Construction Schedule

Dow's proposed construction schedule is shown in Table 3.

Table 3. Dow's Proposed Construction Schedule

Key Construction Milestones	Start Date	Completion Date
Oyster Creek flood mitigation and stream restoration construction	May 2023	April 2024
Reservoir embankment construction	May 2023	March 2026
Pump station and Brazos River intake construction	May 2024	September 2025
Reservoir filling	June 2026	October 2026

1.3 Operations

Dow proposes to operate the proposed new reservoir, existing Harris Reservoir, and Brazoria Reservoir together in a manner similar to current operations. Water would be pumped from the Brazos River into the reservoir for storage and then discharged by the outlet structure into Oyster Creek. Water would flow downstream in Oyster Creek to the Lake Jackson pump station in approximately 30 to 35 hours. The Lake Jackson pump station is located at the intersection of Oyster Creek and Farm-to-Market Road 2004 in Lake Jackson. The proposed reservoir would be used mainly as additional storage to the existing two reservoirs but would become the primary reservoir during drought conditions.

During periods of drought, the proposed Project reservoir would be exhausted first, followed by the existing Harris Reservoir, and then the Brazoria Reservoir. As with current operations, emergency releases would occur from severe weather, such as tropical storms and hurricanes with wind speeds that can overtop the embankments. The decision for emergency releases due to severe weather would remain unchanged.

1.4 Maintenance

Dow's Operation and Maintenance Plan (Dow 2022) defines responsibilities and prescribes guideline procedures for inspection, maintenance, repairs, and operation of the reservoir. The proposed Project would include the following maintenance activities conducted at the frequency listed Dow's Operation and Maintenance Plan (Dow 2022), or as needed based on the inspections, and tracked on the Master Task List:

- Weekly inspections of the basin and upstream and downstream areas of the basin
- Brush-clearing along the basin prior to weekly inspections
- Earthwork maintenance to repair damage from erosion, woody vegetation, or rodent burrow
- Cleaning the trashrack
- Repair of concrete or riprap
- Clearing unwanted vegetation such as brush or trees, mowing the embankment
- Electrical maintenance
- Evaluating changes in storage capacity, sediment dredging

1.5 Off-Site Mitigation

In addition to proposed on-site mitigation on Oyster Creek, off-site compensatory mitigation would occur along Big Slough (located in the Brazos River watershed) for unavoidable impacts to wetlands and waterbodies. The Big Slough mitigation site includes an approximately 1,100-acre area located 7 miles east of Lake Jackson on property owned by Dow near the Brazoria National Wildlife Refuge. The Big Slough mitigation site has been used historically for agriculture and consists of herbaceous/shrub wetland, forested wetland, tidal wetland, and upland rangeland and forest associated with the riparian areas. The existing wetland habitats contain invasive species and lack water retention capabilities. Approximately 6.4 miles of Big Slough and adjacent riparian areas (1,113 acres) would be restored to increase stream function. The key mitigation components include riparian buffer restoration, bank stabilization and re-establishment, and preservation of riparian buffer habitats.

1.6 Prior Agency Coordination

The Applicant coordinated with the USACE while planning for the proposed Project and in the preparation of this BA. The date and a summary of meetings, teleconferences, and written communications between the Applicant and the USACE and/or USFWS are listed below. Where relevant, informal communications are cited herein as personal communications.

- **April 30, 2018** – Charles Adrizzone (USFWS) provides written comments on the Public Notice for the Department of the Army Permit application SWG-2016-01027 dated March 29, 2018.
- **May 10, 2018** – Applicant, USACE, USFWS, and other agencies conducted a site visit to the proposed Project site.
- **May 30, 2018** – Charles Adrizzone (USFWS) provides additional written comments on the Public Notice for the Department of the Army Permit application SWG-2016-01027 dated March 29, 2018.
- **September 4, 2018 –** USACE issues a Memorandum for the Record on the determination of the requirement for an EIS for Department of the Army Permit SWG-2016-01027.
- **April 28, 2020** – USACE invites the USFWS and other cooperating agencies to a virtual public agency scoping meeting for the proposed Project EIS.
- **May 12, 2020** – USACE holds the virtual public agency scoping meeting for the proposed Project EIS. Amber Bearb (USFWS) attends the meeting.
- **June 22, 2020** – USACE sent a request to David Hoth to review initial species list for analysis of the BA and initiated the ESA Section 7 Informal Consultation for the Department of the Army Permit SWG-2016-01027, Dow Chemical Company.
- **July 2, 2020** – Charles Adrizzone (USFWS) provides written comments to USACE on the Notice of Intent to Prepare and EIS for the proposed Project.
- **July 20, 2020 –** USACE sent a letter to Charles Adrizzone (USFWS) requesting coordination and concurrence on the milestones and assumption of the EIS for the Army Permit SWG-2016-01027, Dow Chemical Company SWG-2016-01027.
- **2022**–The Applicant and USACE are working with Sheena Waters (USFWS) to coordinate the implementation of an updated freshwater mussel survey for the proposed Project.
- **February 18, 2022** – Moni Belton (USFWS) provides written comments to USACE on the draft biological assessment.

- **June 6, 2022 –** USACE submitted results from a freshwater mussel survey conducted from April 27 through April 29, 2022, for the proposed Project.
- **June 29, 2022 –** The USFWS recommended that the effect determination for the Texas fawnsfoot (*Truncilla macrodon*) in this BA be changed from *may affect, not likely to adversely affect*, to *no effect*, based on the findings in the April 2022 mussel survey that no federally listed mussel species are present within the Project area.

1.7 Regulatory Background

Federal agencies have the responsibility and obligation to determine whether their activities *may affect* Listed Species or Designated Critical Habitats. Section 7(a)(2) of the ESA addresses federal agency actions and consultations. This section of the ESA states that:

> *… Each Federal agency shall, in consultation with and with the assistance of the Secretary [of the Interior], insure that any action authorized, funded, or carried out by such agency (hereinafter in this section referred to as an "agency action") is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined by the Secretary, after consultation as appropriate with affected States, to be critical…In fulfilling the requirements of this paragraph each agency shall use the best scientific and commercial data available.*

Federal agencies have the responsibility and obligation to determine whether or not their activities *may affect* Listed Species or Designated Critical Habitats. As defined in 50 CFR 402.02, this evaluation of effects addresses "the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline." If a federal agency determines that its activity will have *no effect* on Listed Species or Designated Critical Habitats, then no coordination with or concurrence from the USFWS is necessary under ESA Section 7(a). However, if the federal action *may affect* Listed Species or Designated Critical Habitats, even if the effect is entirely beneficial, then consultation or conference with the USFWS is required.

The USFWS and the National Marine Fisheries Service (NMFS) are responsible for administering the ESA and have published guidance for implementing the ESA Section 7 consultation process in a handbook entitled *Endangered Species Consultation Handbook: Procedures for Conducting Consultation and Conference Activities under Section 7 of the Endangered Species Act* (Consultation Handbook; USFWS and NMFS 1998). The Consultation Handbook identifies the following potential outcomes for evaluating the effects of a proposed federal action (see USFWS and NMFS 1998:x-xix):

- **No effect**—The appropriate conclusion when the federal agency determines its Proposed Action will not affect Listed Species or Designated Critical Habitats.
- **May affect**—The appropriate conclusion when a proposed federal action may pose any effects on Listed Species or Designated Critical Habitats. When the federal agency proposing the action determines that a *may affect* situation exists, then it must either initiate formal consultation/conference or seek written concurrence from the USFWS that the action "is not likely to adversely affect" Listed Species or Designated Critical Habitats.
  - **Is not likely to adversely affect**—The appropriate conclusion when effects on Listed Species or Designated Critical Habitats are expected to be discountable, insignificant, or completely beneficial. Beneficial effects are contemporaneous positive effects without any adverse effects to the species. Insignificant effects relate to the size of the impact and

should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur. Based on the best judgment, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur.

- **Is likely to adversely affect**—The appropriate conclusion if any adverse effect to Listed Species or Designated Critical Habitats may occur as a direct or indirect result of the proposed federal action, and the effect is not discountable, insignificant, or beneficial. In the event the overall effect of the Proposed Action is beneficial to Listed Species or Designated Critical Habitats, but is also likely to cause some adverse effects, then the proposed federal action "is likely to adversely affect" the Listed Species or Designated Critical Habitats. If incidental take is anticipated to occur as a result of the proposed federal action, a determination of "is likely to adversely affect" should be made. An "is likely to adversely affect" determination requires the initiation of formal consultation.

When evaluating whether or not a proposed federal action *may affect* Listed Species or Designated Critical Habitats, the USFWS considers the effects of the proposed federal action in concert with the effects of any interrelated or interdependent actions. Interrelated actions are those that have no independent utility apart from the proposed federal action and interdependent actions are those that are part of a larger action and depend on the larger action for their justification (50 CFR 402.02).

During consultation, the USFWS determines if the proposed federal action *may affect, but is not likely to adversely affect* Listed Species or Designated Critical Habitats or if the activity *may affect, and is likely to adversely affect* Listed Species or Designated Critical Habitats. If adverse effects are not likely, then consultation may be completed informally with written concurrence from the USFWS. If adverse effects are likely, then a formal consultation between the federal agency and the USFWS may be warranted. A BA (or similar document) provides the federal agency's assessment of likely effects to Listed Species and Designated Critical Habitats associated with its proposed federal action.

If formal consultation is appropriate, the USFWS prepares a Biological Opinion wherein the USFWS either determines that the effects of the proposed federal action will not jeopardize the continued existence of a Listed Species or result in the destruction or adverse modification of Designated Critical Habitat, or the USFWS proposes Reasonable and Prudent Alternatives to the proposed federal action that avoid these circumstances. The USFWS also describes the amount and extent of take that is likely to occur, identifies reasonable and prudent measures (RPMs) to minimize take, and includes an Incidental Take Statement (ITS) with terms and conditions needed to implement the RPMs. The federal agency then implements the terms and conditions of the Biological Opinion and ITS.[2]

The ESA defines "take" as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" (16 USC 1532 [19]). "Harm" is defined by USFWS regulations as an "act which actually kills or injures wildlife and may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns including breeding, feeding or sheltering" (50 CFR 17.3). The USFWS issued guidance to its Regional Directors on April 26, 2018, further clarifying that a demonstration of harm via habitat modification must find that habitat modification is likely to be significant, that the significant habitat modification also likely significantly impair an essential behavior pattern of a Listed Species, and that the

[2] The ESA does not prohibit "take" of listed plants. Rather, with respect to listed plants, Section 9(a)(2) of the ESA prohibits, among other things: removing and reducing to possession any such species from areas under federal jurisdiction; maliciously damaging or destroying any such species on any such area; or removing, cutting, digging up, damaging, or destroying any such species from any other area in knowing violation of state law or in the course of any violation of state criminal trespass law (16 USC §1538(a)). Therefore, an ITS for a listed plant is neither required nor appropriate.

significant behavioral impairment is likely to result in the actual killing or injuring of listed wildlife (USFWS 2018).

As required by Section 7(c) of the ESA, this BA includes the information required to initiate formal interagency consultation with the USFWS, should it be necessary, including:

- a description of the action being considered;
- a description of the specific area that may be affected by the action;
- a description of any Listed Species or critical habitat that may be affected by the action;
- relevant reports, including any EISs, environmental assessments, BAs, or other analyses prepared for the action; and
- any other relevant studies or other information available on the action, the affected Listed Species, or critical habitat.

1.8 Analysis Framework

This BA uses the approach described below to identify and characterize the effects of the Proposed Action on Listed Species and Designated Critical Habitats. This approach relies on the following geographies:

- **Project Workspaces**—The Project Workspaces define the limits of the Applicant's proposed Project where all activities related to the proposed Project would occur. The Project Workspaces include lands for permanent easements, temporary workspaces, additional temporary workspaces, ancillary facilities and sites, and access roads, as described in Section 1.1.1 and 1.2.1 of this BA.
- **Action Area**— The Action Area contains the Project Workspaces and areas outside the immediate Project Workspaces where potential effects of the proposed Project may have potential consequences to Listed Species or Designated Critical Habitats.
    - For aquatic areas, the Action Area includes the segments of the Brazos River and Oyster Creek that could have physical, chemical, or biotic effects from the proposed Project. The Applicant conducted an analysis of potential downstream impacts to hydrology and hydraulics of Oyster Creek (Watearth 2021a). The findings from this analysis were used to determine the aquatic extent of the Action Area. According to the hydrology and hydraulic analysis of Oyster Creek, the proposed Project would affect the floodplain via reduced storage of 1,028 ac-ft, and increase peak flows in Oyster Creek, during 50-year or 100-year storm events immediately downstream of the proposed Project (Watearth 2021a). The change in Oyster Creek flows would affect the water quality immediately downstream of the proposed Project (Watearth 2021a). The proposed Project would temporarily affect the water quality of the Brazos River during construction in the vicinity of the proposed intake structure, but the analysis did not indicate potential downstream impacts to the hydrology and hydraulics of the Brazos River (Watearth 2021b). The proposed Project would include compensatory mitigation of the floodplain storage loss. Based on the proposed Project activities, the proposed Project Workspaces, mitigation, and the hydrology and hydraulic analysis (Watearth 2021a, 2021b) the Action Area includes the northern limits of the proposed Project Workspace on Oyster Creek and extends downstream along Oyster Creek to the Lake Jackson pump station that would receive the Oyster Creek discharge from proposed Project (see Section 1.1.6 Conveyance). The Action Area also includes the Brazos River and 5,000 linear foot offset from proposed intake structure to include aquatic areas in the vicinity that may be

potentially affected by turbidity or sediment from construction activities. The offset distance is based off guidance from the NMFS and the Federal Highway Administration (FHWA) on attenuation of turbidity from construction activities in aquatic environments (NMFS and FHWA 2018).

- For terrestrial areas, the Action Area limits are extended beyond the Project Workspace to an offset distance to evaluate any potential effects outside of the immediate Project Workspace caused by the proposed Project. The offset distance described below is based on the ecology of the Listed Species that may be affected by the proposed Project:
  - 1,000-foot Offset: the 1,000-foot offset distance is applied to those portions of the Project Workspaces located within the whooping crane (*Grus americana*) migration corridor (USFWS 2020a) in Brazoria County, to evaluate the Effects of the Action that may have consequences on the whooping crane or its potential stopover habitats. This distance is based on a USFWS (2020b) recommended conservation measure to stop work if an individual whooping crane is observed within 1,000 feet of the proposed Project during construction activities.

2 ENVIRONMENTAL SETTING

2.1 Ecoregions

The Action Area spans two ecoregions - the Northern Humid Gulf Coastal Prairies (Level IV) and the Floodplains and Low Terraces (Level IV) (Figure 8) (Griffith et al. 2007). Both of these are nested within the Western Gulf Coastal Plain (Level III), which is characterized by little topography (Griffith et al. 2007). The Western Gulf Coastal Plain is characterized by mixed forest and savannah vegetation communities toward inland areas and grassland communities toward the coast. The forest vegetation communities are predominantly bottomland forests (Griffith et al. 2007; McMahan et al. 1984) with some gradual changes in tree species composition in terraced areas and along larger streams.

Within the Northern Humid Gulf Coastal Prairies ecoregion are gently sloping coastal floodplains and tallgrass grasslands (Griffith et al. 2007). Forested riparian communities often contain bottomland oaks and hickories (Griffith et al. 2007). Within the Floodplains and Low Terraces ecoregion are floodplains and bottomland hardwood forest vegetation communities along rivers (including the Brazos) and adjacent streams and creeks (including Oyster Creek) that make up the Columbia Bottomlands ecosystem (Rosen et al. 2008; Texas Parks and Wildlife Department [TPWD] 2019). Columbia Bottomlands are ecologically important for migratory neotropical birds, wintering waterfowl, and bald eagles (Haliaeetus leucocephalus), and it is designated as an Aquatic Resource of National Importance (Rosen et al. 2008; TPWD 2019; USACE 2017a). Under Regional Condition 15c, Columbia Bottomlands are designated as a WOUS and are thus protected from unauthorized discharges (USACE 2017a). Uplands located in the Columbia Bottomlands are not subject to federal regulations associated with Section 404 of the CWA. Surveys confirmed the proposed Project site is not located within the Columbia Bottomlands (USACE 2017b; SWCA 2019a); however, they may occur downstream (see Figure 8).

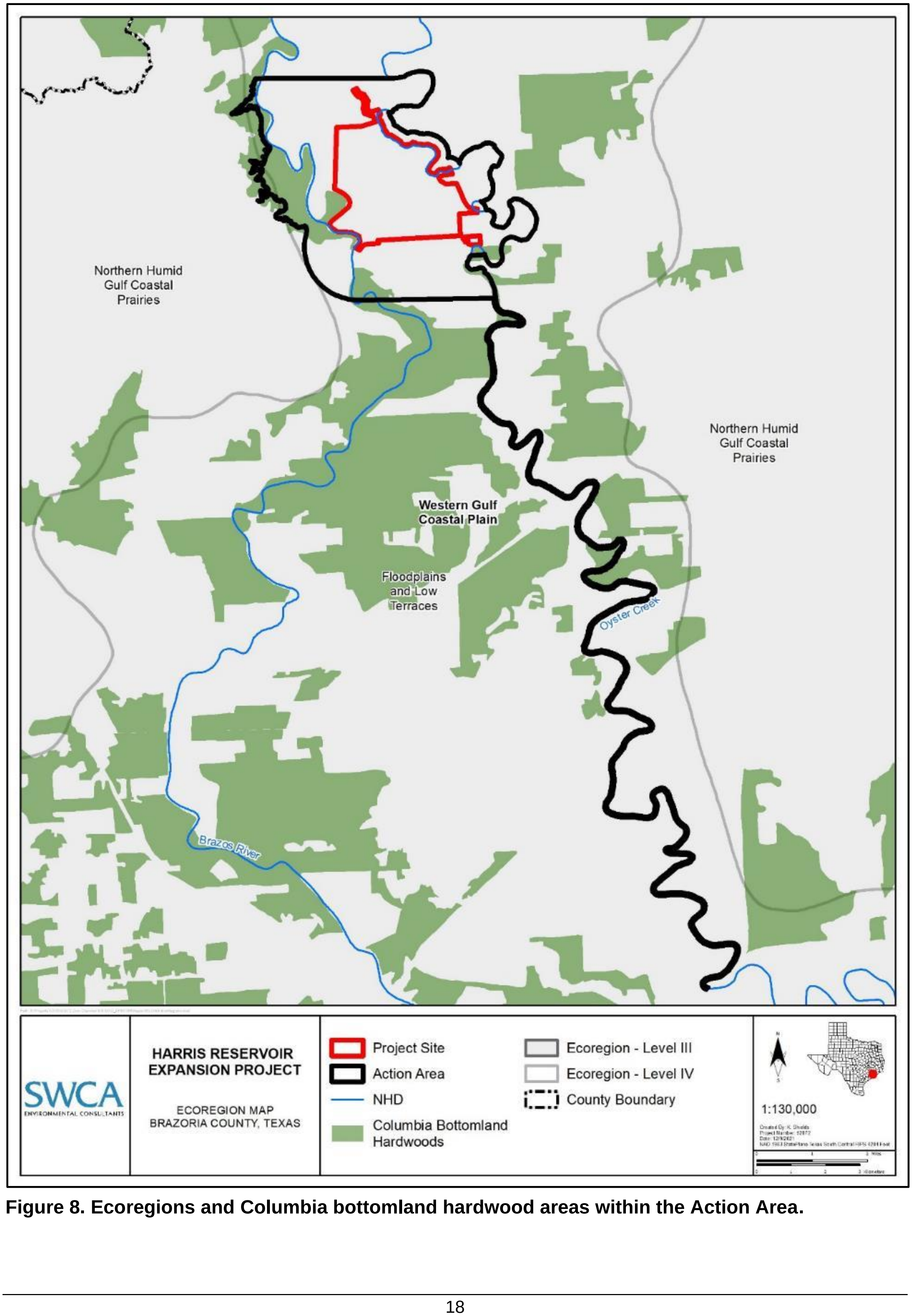

Figure 8. Ecoregions and Columbia bottomland hardwood areas within the Action Area.

The low relief and soil types in both the Northern Humid Gulf Coastal Prairies and the Floodplains and Low Terraces ecoregion make them well suited for agriculture and floodplain forest. Most of the coastal prairies, floodplains and low terraces have been converted to cropland, rangeland, pasture, or urban and industrial land uses (Griffith et al. 2007). Dominant crops are rice (*Oryza sativa*), grain, soybean (*Glycine max*), sorghum (*Sorghum bicolor*), and cotton (*Gossypium hirsutum*) (Griffith et al. 2007).

2.2 Climate

The Action Area is located in Brazoria County. Brazoria County has an average annual rainfall of 57 inches, an average January minimum temperature of 43.7°F, and a July average maximum temperature of 91.8°F (Brazoria County 2020). The average hourly wind speed in Brazoria County varies seasonally and ranges from 7.7 miles per hour in August to up to 11.2 miles per hour in April. Predominant average hourly wind direction also varies throughout the year. From early February through early September and from late October through early December, the predominant wind direction is from the south. From early September through late October, the predominant wind direction is from the east, and from early December through early February, the predominant wind direction is from the north (Weather Spark 2020).

2.3 Geology

The Action Area is located in the Beaumont Formation (Qb), which is overlain by Quaternary alluvium (Qal) deposits (Barnes 1982). The Beaumont Formation consists of barrier island and beach deposits composed of mostly clay, silts, and sands. The Beaumont Formation includes mainly stream channel, point bar, natural levee, and backswamp deposits, and to a lesser extent it contains coastal marsh and mud flat deposits. Concretions of calcium carbonate, iron oxide, and iron-manganese oxides are present in zone of weathering. The Beaumont Formation surface area, which is less than 30 feet in thickness, is almost featureless and characterized by relict river channels shown by meander patterns and pimple mounds on meander-belt ridges and is separated by areas of low, relatively smooth featureless backswamp deposits. Quaternary alluvium, which overlays the Beaumont Formation, is composed of point bars, natural levees, stream channels, backswamps, and narrow beach deposits that are composed of clay, silt, sand, and organic matter (Barnes 1982). There are no faults mapped in or near the proposed Project site.

2.4 Soils

The Action Area contains 12 soil map units as defined by Natural Resources Conservation Service (NRCS) (Table 4, Figures 9–11) (NRCS 2021). NRCS provides soil descriptions for each of the 12 soil map units within the Action Area (NRCS 2021). Soil texture is determined by the proportions of different-sized particles—sand, silt, and clay—found in a soil sample (NRCS 2020). The soils in the Action Area include clays and various loam combinations. The two predominant soil units are the Brazoria Clay (27.3%) and the Pledger Clay (14.6%) (see Table 4). These soils are moderately well drained, have very slow permeability, and feature clayey soils. These soils are rarely flooded, but because the largest component is clay, there is very high shrink-swell potential.

Table 4. Summary of Soil Map Units in the Proposed Project Site and Action Area

Soil Map Unit (map unit code)	Hydric Map Unit (yes or no)	Hydrologic Group*	Prime Farmland (yes/no)	Acreage within Proposed Project Site†	Percentage of Proposed Project Site	Acreage within Action Area†	Percentage of Action Area
Asa silty clay loam, 0% to 1% slopes, rarely flooded (3)	No	B	Yes	15.1	0.6%	336.2	3.5%
Brazoria clay, 0% to 1% slopes, rarely flooded (10)	No	D	Yes	1,028.7	40.5%	2,609.7	27.3%
Brazoria clay, 1% to 3% slopes, rarely flooded (11)	No	D	Yes	70.2	2.8%	199.1	2.1%
Clemville silty clay loam, 0% to 1% slopes, occasionally flooded (12)	No	C	No	138.7	5.5%	451.5	4.7%
Norwood loam, 0% to 1% slopes, rarely flooded (33)	No	B	Yes	183.1	7.2%	1,180.9	12.3%
Norwood silty loam 1% to 5% slopes, rarely flooded (34)	No	B	Yes	115.4	4.6%	205.8	2.1%
Norwood-Asa complex, 1% to 8% slopes, rarely flooded (35)	No	B	No	132.3	5.2%	975.8	10.2%
Pledger clay, 0% to 1% slopes, rarely flooded (36)	No	D	Yes	776.5	30.7%	1,394.2	14.6%
Churnabog clay, 0% to 1% slopes, frequently flooded, occasionally ponded (38)	Yes, hydric criteria 2, 3‡	D	No	12.8	0.5%	163.7	1.7%
Edna loam, 0% to 1% slopes (13)	No	D	Yes	0.0	0.0%	75.3	0.8%
Edna-Aris Complex, 0% to 1% slopes (15)	No	D	Yes	0.0	0.0%	29.6	0.3%
Bernard clay loam, 0% to 1% slopes(7)	No	D	Yes	0.0	0.0%	70.0	0.7%
Total				**2,472.8**	**97.6% (remainder is water)**	**7,691.8 (remainder is water)**	**80.3% (remainder is water**

Source: NRCS (2021).

* Hydrologic Group: B = Soils having a moderate infiltration rate when thoroughly wet. These soils consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission. C = Soils having a slow infiltration rate when thoroughly wet. These soils consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission. D = Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

† Acreages were calculated using Esri ArcMap in July 2019 and were rounded to the nearest 0.1 acre. The alternative laydown area contains 3.9 acres of Brazoria clay, 0% to 1% slopes, rarely flooded (10,) and is Prime Farmland. This is not included in the acreages reported in the table above.

‡ Hydric criteria 2 = somewhat poorly to very poorly drained soils that have a shallow water table (i.e., at a depth of less than 1 foot) during the growing season; 3 = soils that are frequently ponded for a long or very long duration during the growing season.

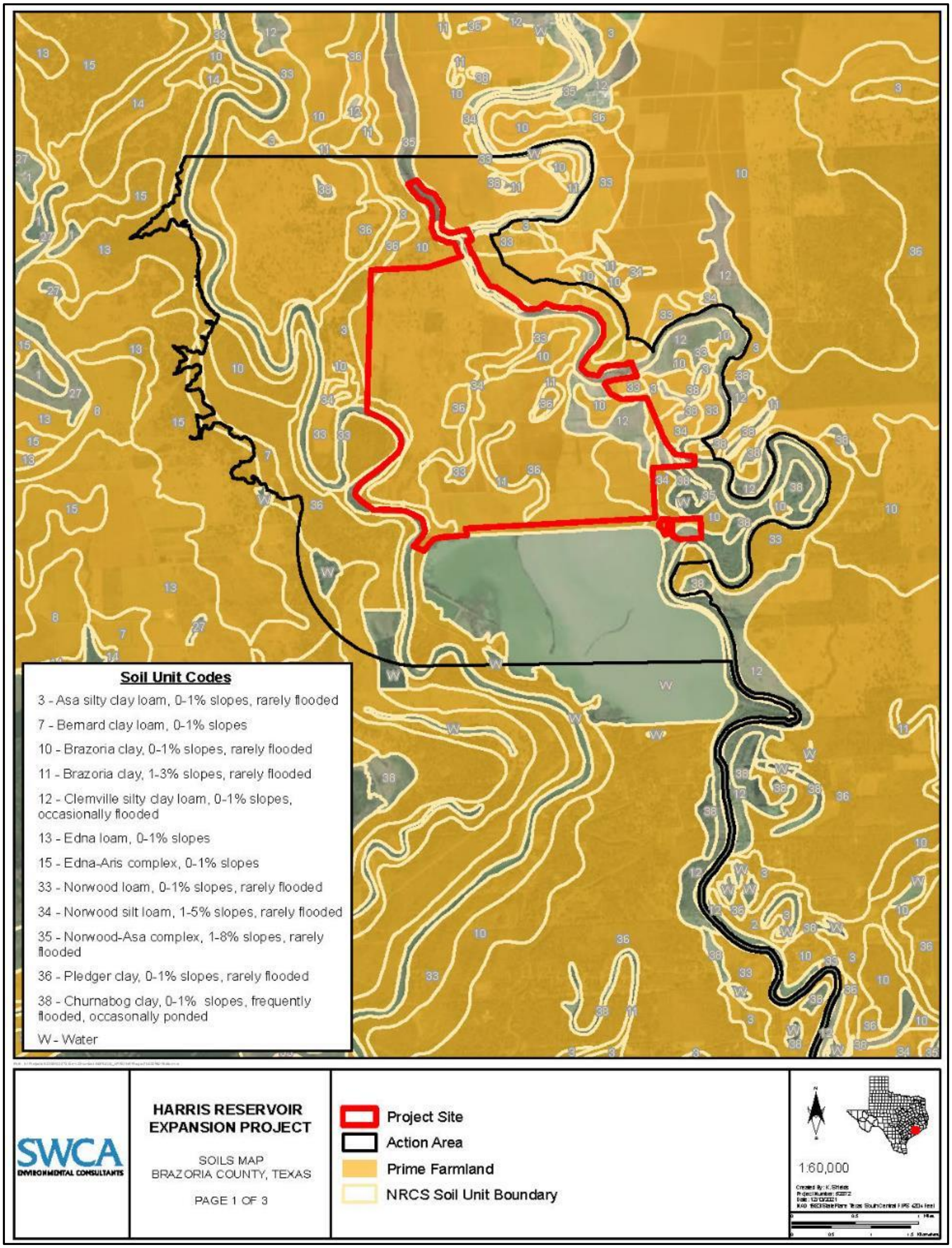

Figure 9. Soil map units in the Action Area (page 1).

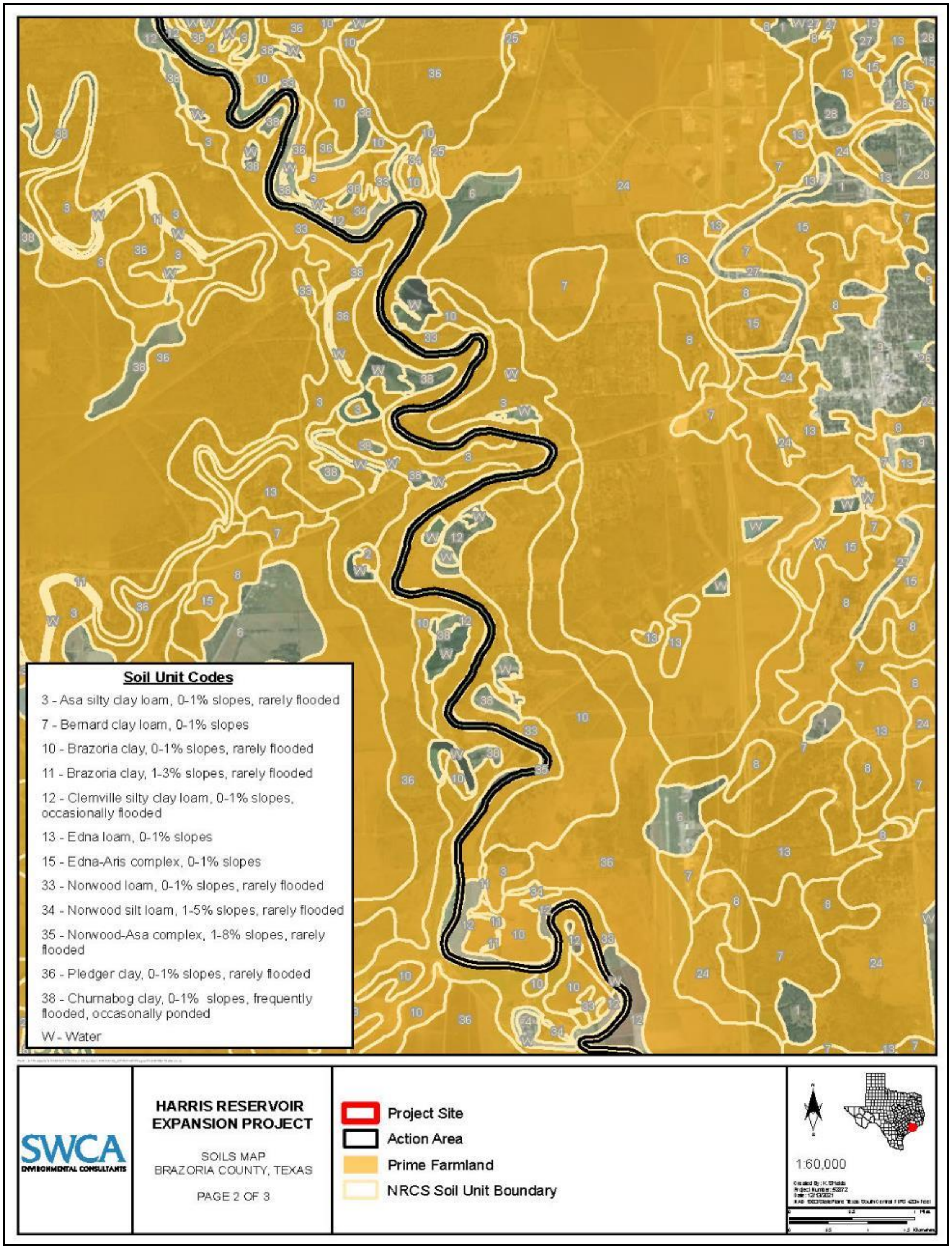

Figure 10. Soil map units in the Action Area (page 2).

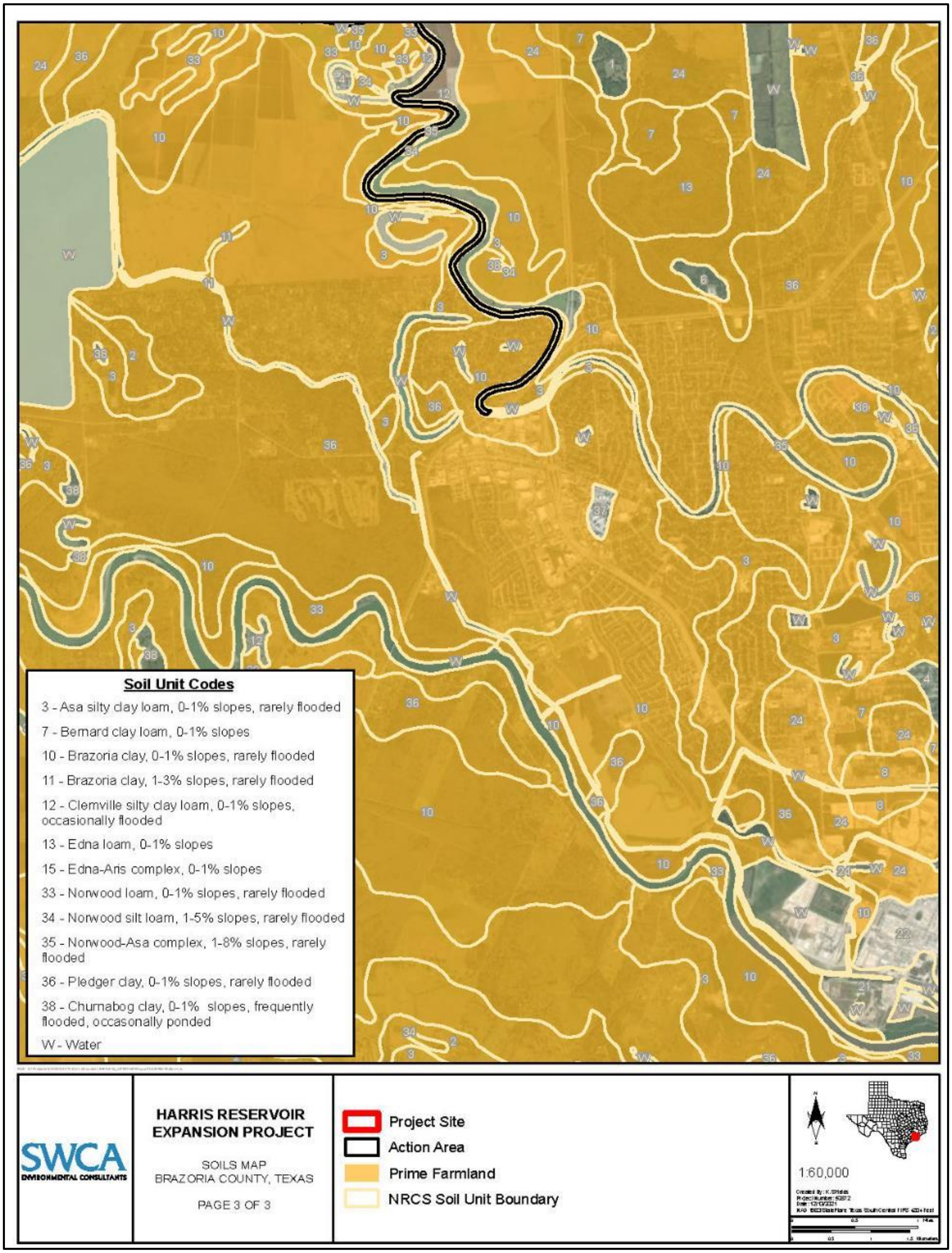

Figure 11. Soil map units in the Action Area (page 3).

2.5 Water Resources

2.5.1 Surface Waters

The Action Area is located in the San Jacinto-Brazos Coastal Basin and abuts the Brazos River Basin along its western perimeter (TPWD 2013; Texas Water Development Board [TWDB] 2021). The San Jacinto-Brazos Coastal Basin is named according to major river basins that bound it (i.e., the San Jacinto River Basin and the Brazos River Basin). The San Jacinto River Basin is a small river basin that supplies surface waters and groundwater to the Houston metropolitan area (TWDB 2021a). The Brazos River, which flows along the western border of the proposed Project site, is associated with the Brazos River Basin, which is the second largest river basin in Texas.

The Action Area is between the Brazos River to the west, Oyster Creek to the east, and the existing Harris Reservoir to the south (see Figure 1). The Brazos River and Oyster Creek both flow from north to south and outfall to the Texas Gulf Coast; the Oyster Creek outfall is east of Freeport, and the Brazos River is west of Freeport, Texas (see Figure 1). Oyster Creek receives water from the Brazos River via a diversion dam at Flat Bank Creek and Harris Reservoir and from overland sheet flow, seepage around dams, and treated wastewater effluent (Linam and Kleinsasser 1987). Surface water demands are increasing in the upper portion of the basin with decreasing availability of groundwater resources (TWDB 2021a).

2.5.2 Waters of the United States, Including Wetlands

A desktop assessment of USFWS National Wetlands Inventory (NWI), U.S. Geological Survey (USGS) National Hydrology Data (NHD), historical USGS topographic quadrangles, and the most recently available Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) (FEMA 2021) data were reviewed to identify potential wetlands and water resources in the Action Area. The NWI depicts the presence of 2,084 acres of palustrine wetlands, including palustrine emergent (PEM) wetlands, palustrine scrub-shrub (PSS) wetlands, palustrine forested (PFO) wetlands, and palustrine unconsolidated bottom (PUB) wetlands (USFWS 2021a), within the Action Area (USFWS 2021a).

A wetland delineation of the proposed Project site was conducted during June and July 2019 (SWCA 2019a) (Figure 12). On June 24 and 26, 2019, the USACE conducted a site visit, and on October 22, 2019, the USACE issued a verification of the 2019 wetland delineation (USACE 2019). As part of Dow's application for the proposed Harris Reservoir, they requested the USACE issue an Approved Jurisdictional Determination (AJD). However, Dow withdrew their AJD request on May 23, 2019. Therefore, at this time, an AJD has not been completed. For the purpose of Dow's permit application, the USACE assumes that all wetlands and waterbodies that have been delineated are WOUS. SWCA's wetland delineation included an evaluation of the presence of forested communities that would be consistent with the descriptions of the historical Columbia Bottomlands. The survey concluded that Columbia bottomlands are not present in the proposed Project site (SWCA 2019a).

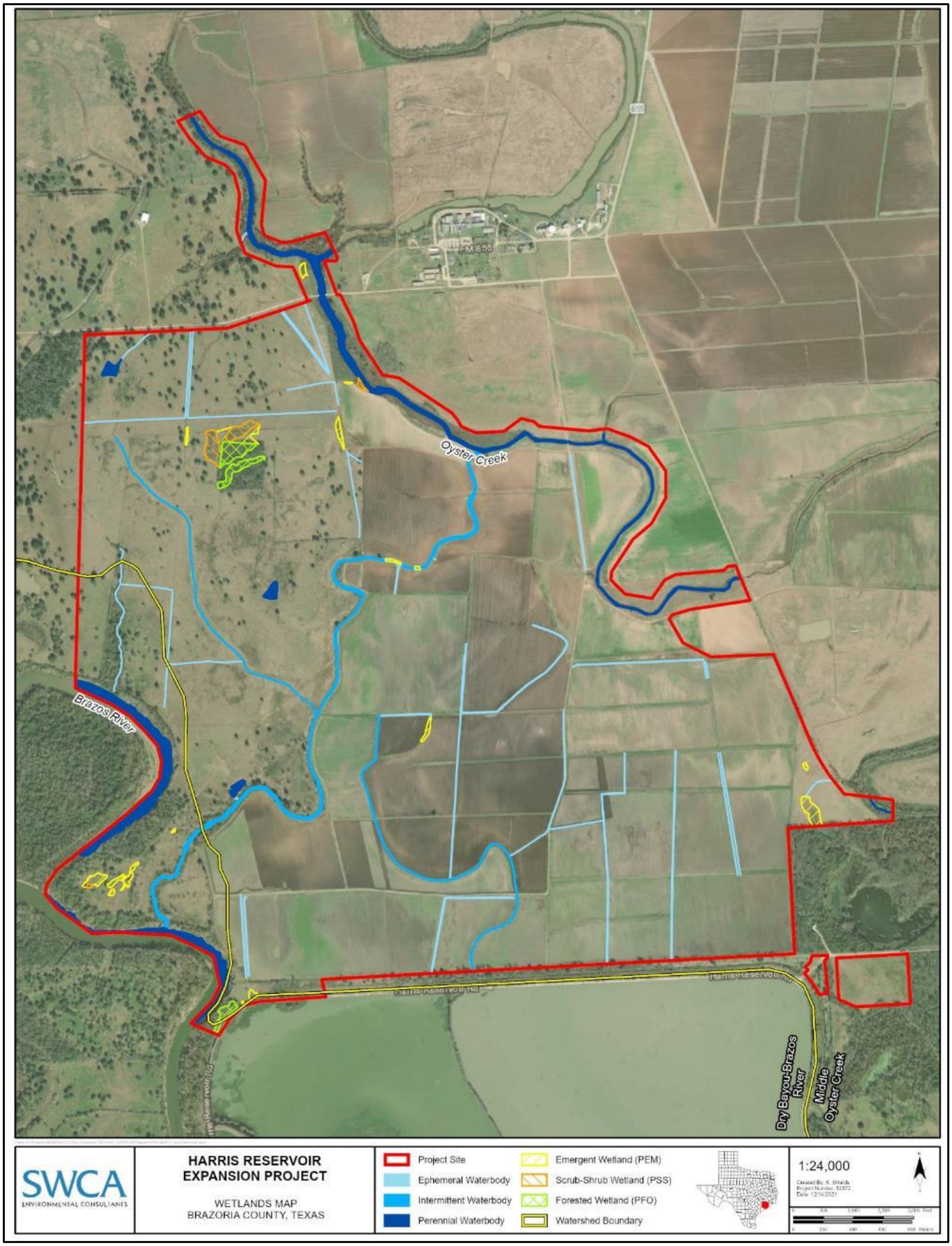

Figure 12. Delineated wetlands and waterbodies in the proposed Project site.

2.5.2.1 WATERBODIES

The 2019 wetland delineation identified 41 waterbodies, consisting of 11 streams or rivers, five ditches, 22 agricultural ditches, and three ponds within the proposed Project site (Table 5; see Figure 12) (SWCA 2019a). These waterbodies, which total 74.10 acres (109,338 linear feet), were verified in the field by the USACE in 2019 (USACE 2019). Named streams include two segments of the Brazos River (perennial) that are approximately 300 feet wide and total 8,838 linear feet. Two segments of Oyster Creek (perennial) in the proposed Project site are 15 to 30 feet wide and total 17,411 linear feet. In addition, Jennings Bayou runs diagonally through the proposed Project site between the Brazos River and Oyster Creek for a length of 13,497 feet.

Table 5. Waterbodies in the Proposed Project Site

Type	USGS Name*	Length in Proposed Project Site (feet)	Proposed Project Site (acres)†
Ephemeral agricultural ditches (22)	N/A	39,337	6.91
Ephemeral ditches (4)	N/A	13,178	2.15
Ephemeral stream	UT of Brazos River	2,589	0.18
Ephemeral stream	N/A	678	0.06
Ephemeral stream	UT of Jennings Bayou	116	0.00
Ephemeral stream	UT of Jennings Bayou	73	0.00
Ephemeral stream	UT of Oyster Creek	201	0.04
Subtotal of ephemeral waterbodies		***56,172***	***9.35***
Intermittent stream	Jennings Bayou	13,497	11.34
Intermittent ditch	UT of Jennings Bayou	6,129	1.41
Intermittent stream	N/A	7,290	2.68
Subtotal of intermittent waterbodies		***26,916***	***15.43***
Perennial stream	Oyster Creek	16,888	21.34
Perennial river	Brazos River	4,309	15.96
Perennial river	Brazos River	4,530	9.01
Perennial stream	Oyster Creek	523	0.18
Perennial ponds (3)	N/A	N/A	2.84
Subtotal of perennial waterbodies		***26,250***	***49.32***
Total		**109,338**	**74.10**

* N/A = not applicable; UT = unnamed tributary.
† Acreages were rounded to the nearest 0.01 acre.

Following the wetland delineation, a qualitative Level I and II Stream Condition Assessment was prepared (SWCA 2019b). The assessment found that most of the ephemeral streams in the proposed Project site are agricultural ditches manipulated into depressional areas within upland areas, and evidence of artificial widening is present. Most of the channels exhibit evidence of past alteration through channelization and impacts by culverts and hoof shear, with some exhibiting stream stability and recovery from these impacts. Riparian buffers, which are important for retaining nutrients along ephemeral streams, were rated as severe (area is dominated by impervious surfaces; mine spoil lands; denuded surfaces; conventional tillage; active feed lots; or other comparable conditions) to low (native woody community species between 30%–60% aerial coverage with no wetlands present and no maintenance or grazing activities present within the buffer) in the proposed Project site. Most of the riparian buffers consist of a mixed land use between herbaceous land maintained by grazing and conventional row crops. However, a few areas dominated by woody vegetation parallel some assessed channels. The presence of native woody community species varies throughout the proposed Project site. Forested riparian areas occur more often along the southwestern portions of the proposed Project site. Overall, the Reach Condition Index (RCI) scores averaged 2.23 for assessed streams, indicating poor or relatively poor quality.

2.5.2.2 WETLANDS

A total of 23 wetlands totaling 21.37 acres were identified within the proposed Project site, consisting of 16 PEM, three PSS, and four PFO wetlands (SWCA 2019a) (see Figure 12), all of which were verified by USACE in 2019 (USACE 2019). The remaining areas were herbaceous, scrub-shrub, and forested uplands that did not meet the wetland criteria (see Figure 12).

The delineated wetlands were assessed to determine their functional capacities indices (FCIs) using the interim hydrogeomorphic functional assessment method (SWCA 2021a). FCIs quantify temporary storage of surface water, maintenance of plant and animal communities, and removal and sequestration of elements and compounds for each wetland to determine physical, biological, and chemical functions, respectively. FCIs are determined based on 10 variables and given a value between 0 and 1.

PEM wetlands: PEM wetland communities consist of a prevalence of hydrophytic non-woody vegetation less than 3 feet in height. Dominant herbaceous species within the 9.62 acres of PEM wetlands (9.624 acres total) in the proposed Project site include jungle-rice (*Echinochloa colona*), sand spike-rush (*Eleocharis montevidensis*), tall scouring-rush (*Equisetum hyemale*), common rush (*Juncus effusus*), golden crown grass (*Paspalum dilatatum*), mild water-pepper (*Persicaria hydropiper*), and swamp smartweed (*P. hydropiperoides*). These communities range from approximately 0.1 to 2.1 acres and may provide some minimal functional capacity for physical, chemical, and biological processes based on their FCIs that average between 0.5 and 0.6.

PSS wetlands: PSS wetland communities consist of a prevalence of hydrophytic woody species less than 20 feet in height and 3 inches or greater in diameter at breast height (dbh). The three PSS wetlands (4.933 acres total) within the proposed Project site are dominated by black willow (*Salix nigra*), poison-bean (*Sesbania drummondii*), and Chinese tallow (*Triadica sebifera*). Golden crown grass is the prevalent herbaceous species within these wetland communities. These wetland communities generally range from 0.1 to 0.3 acre with one exception of a wetland of 4.5 acres in the northwestern portion of the proposed Project site. These PSS wetland communities may also provide some functional capacity for physical, chemical, and biological processes based on their FCIs, which average 0.6 (SWCA 2021a).

PFO wetlands: PFO wetland communities consist of a prevalence of hydrophytic woody species greater than 20 feet in height and 3 inches in dbh. The 6.823 acres of PFO wetlands located on the proposed Project site are dominated by tree and shrub species of pecan (*Carya illinoinensis*), sugarberry (*Celtis laevigata*), green ash (*Fraxinus pennsylvanica*), and American elm (*Ulmus americana*). The tree species found within these communities are typical of forested areas in the coastal plains; however, they do not appear to be consistent with remnants of the historical Columbia Bottomlands. These PFO wetland communities range between 1.6 and 3.1 acres with the exception of one that is less than 0.1 acre. They offer moderate functional capacity for physical, chemical, and biological processes based on the presence of small but dense patches of mast-producing mature trees that result in FCIs that average 0.7.

2.5.3 Aquifers

The Action Area is underlain by the Gulf Coast Aquifer, which is one of nine major aquifers within the state of Texas (TWDB 2021b). The Gulf Coast Aquifer parallels the Texas Gulf Coastline from Louisiana to Mexico and consists of several discontinuous aquifer layers comprising sand, silt, clay, and gravel beds. The uppermost layer comprises the Chicot Aquifer, underlined by the Evangeline Aquifer and the Jasper Aquifer, with depths of freshwater to 1,000 feet deep (TWDB 2021b). The recharge zone and outcrop area for the Gulf Coast Aquifer are approximately 93 miles northwest of the proposed Project site. Overall aquifer depth ranges from 1,300 feet deep in the northern limits to approximately 700 feet deep further south as it gets closer to Mexico (TWDB 2021c, 2021d). The general water quality of the aquifer within the central reach is considered good with TDS levels generally ranging less than 500 mg/L (TWDB 2021b). Primary uses of water from the Gulf Coast Aquifer include municipal, industrial, and irrigation.

The Gulf Coast Aquifer is both a confined and unconfined aquifer. It comprises three minor aquifers: Chicot Aquifer, Evangeline Aquifer, and the Jasper Aquifer. Based on the cross-section data for the Gulf Coast Aquifer (TWDB 2021d), the Chicot Aquifer, which lies under the proposed Project site, is an unconfined aquifer with depths of up to approximately 600 feet. Immediately below the Chicot Aquifer lies the Evangeline Aquifer, which is also an unconfined aquifer with depths between 600 and 2,900 feet. Below the Evangeline Aquifer lies the Burkeville confining unit, which is approximately 700 feet thick below the proposed Project site (with depths between 2,900 and 3,600 feet). Under the Burkeville confining unit lies the Jasper Aquifer (3,600–4,700 feet in depth), which is considered a confined aquifer and is sandwiched between the Burkeville confining unit and the Catahoula confining unit described below. The cross-section data presented for the Gulf Coast Aquifer (TWDB 2021d) show the Catahoula confining unit extending down from 4,700 to 7,600 feet; however, the cross-section map limits the depth of data presented at 7,600 feet, and it is likely that within the proposed Project site, the Catahoula confining unit extends farther down to depths of 9,000 feet or more. Beneath the Catahoula confining unit lies pre-Miocene rocks in which hydrocarbon (oil/gas) pockets can be found in Pre-Miocene source beds.

2.6 Land Use and Land Cover

The 2016 National Land Cover Database (NLCD) shows that the Action Area consists of 48.7% agricultural land covers (i.e., pasture/hay or cultivated crop); 5.8% grassland/herbaceous land cover; 44.7% forest, scrub-shrub, wetlands, and waterbodies; and 0.8% developed lands and open spaces (Figures 13–15; Table 6) (Yang et al. 2018). The NLCD shows that the proposed Project site consists of 79.6% agricultural land covers (i.e., pasture/hay or cultivated crop); 13.4% grassland/herbaceous land cover; and 6.9% forest, scrub-shrub, wetlands, and waterbodies (see Table 6, Figure 13) (Yang et al. 2018).

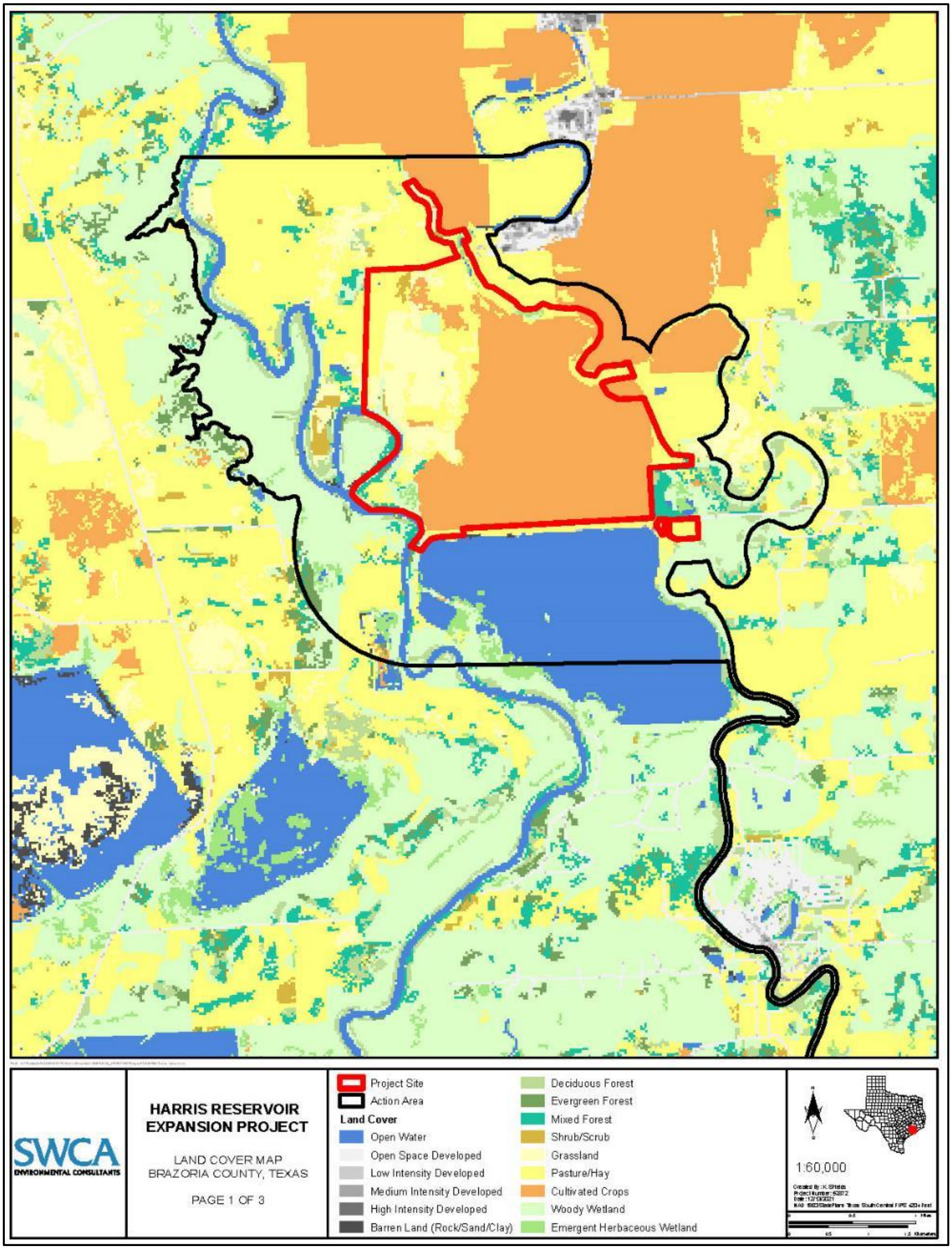

Figure 13. Land use and land cover in the Action Area (map 1 of 3).

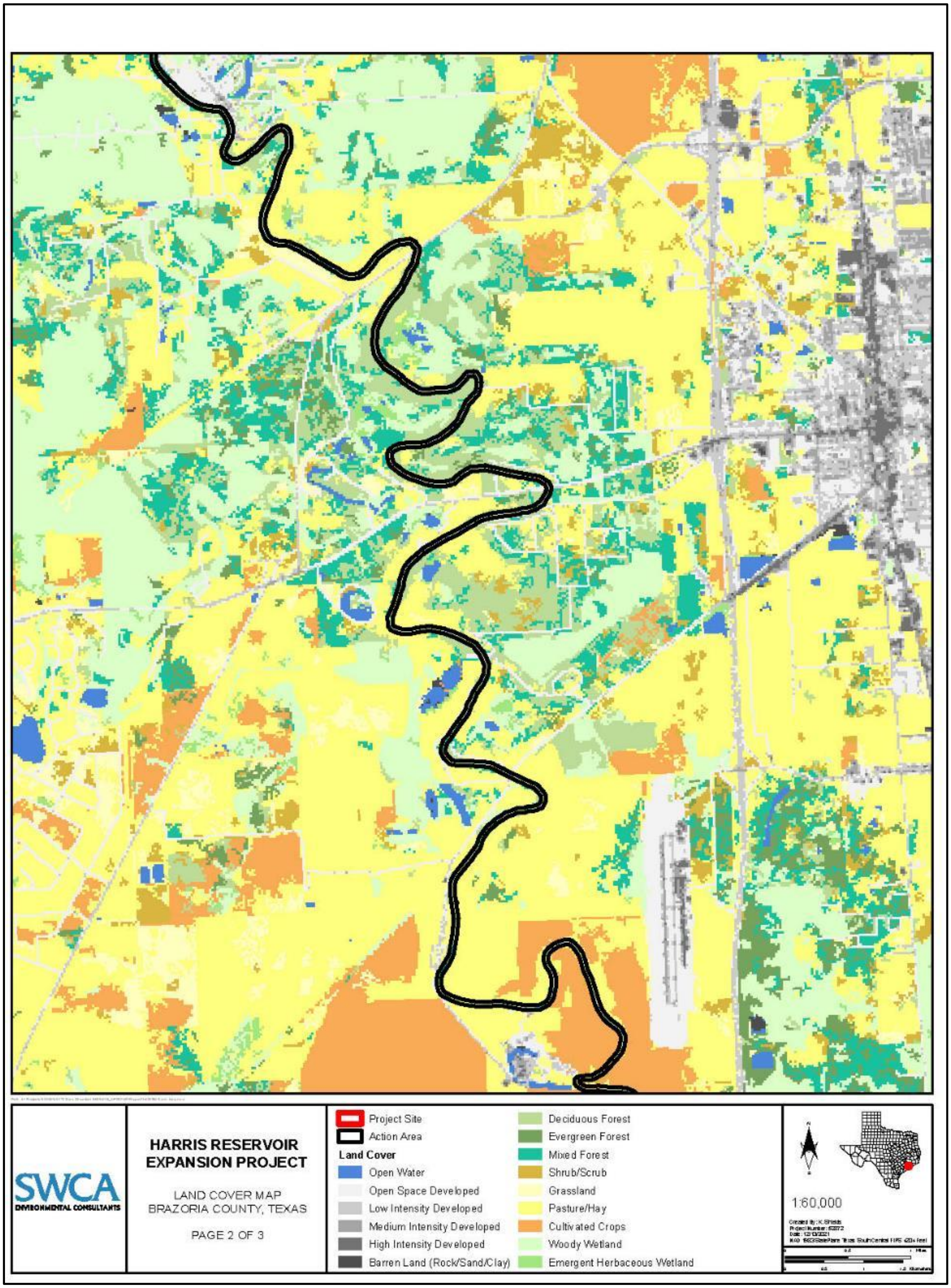

Figure 14. Land use and land cover in the Action Area (map 2 of 3).

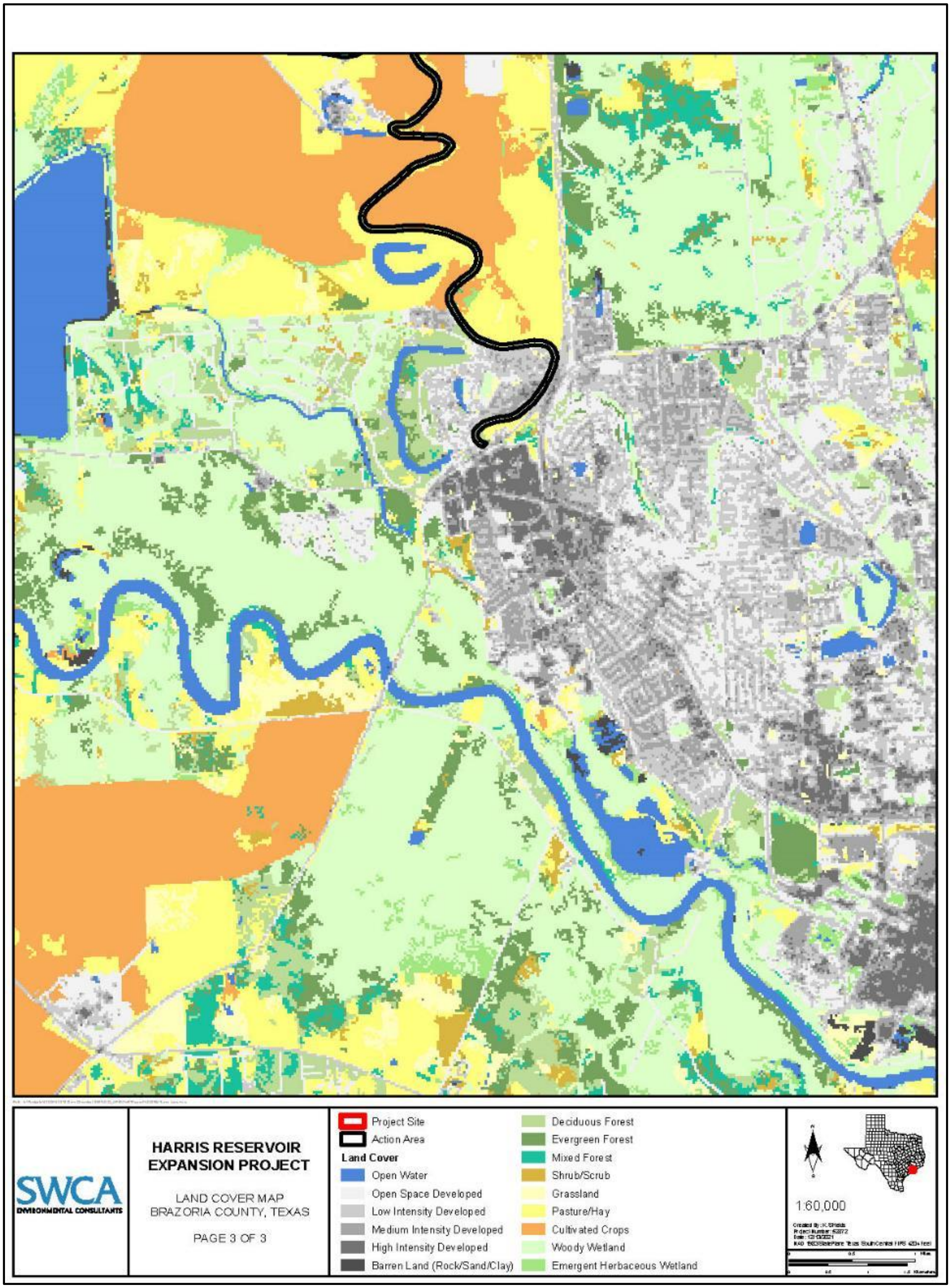

Figure 15. Land use and land cover in the Action Area (map 3 of 3).

Table 6. Land Cover Types within the Proposed Project Site and the Action Area

2016 NLCD Land Cover Type	Proposed Project Site (acres)	Proposed Project Site (%)	Action Area (acres)	Action Area (%)
Deciduous forest	8.2	0.3%	313.7	3.3%
Evergreen forest	3.1	0.1%	50.9	0.5%
Mixed forest	20.4	0.8%	231.1	2.4%
Shrub/scrub	14.0	0.6%	64.9	0.7%
Grassland/herbaceous	339.9	13.4%	554.9	5.8%
Emergent herbaceous wetlands	82.4	3.3%	187.4	2.0%
Woody wetlands	21.8	0.9%	1,905.9	19.9%
Open water	27.2	1.1%	1,524.8	15.9%
Pasture/hay	523.9	20.7%	2,629.2	27.5%
Cultivated crops	1,490.2	58.9%	2,032.7	21.2%
Barren land (rock/sand/clay)	0.2	0.01%	13.8	0.1%
Developed, open space	1.7	0.01%	66.8	0.7%
Total	**2,533.0**	**100%**	**9,576.1**	**100%**
Forest (deciduous, mixed, evergreen)	31.8	1.2%	595.7	6.2%
Wetlands and Waterbodies* (emergent herbaceous wetlands, woody, wetlands, open water)	131.3	5.2%	3,618.1	37.8%
Agricultural (pasture/hay, cultivated crops)	2,014.0	79.6%	4,661.9	48.7%
Developed (low intensity, medium intensity, high intensity, developed open space)	1.7	0.01%	66.8	0.7%

Source: Yang et al. (2018).

* Acreage based on land cover in Yang et al. (2018). Field delineated WOUS acreage differs; see Section 2.5.2.

SWCA documented three upland vegetation communities—herbaceous upland, scrub-shrub upland, and forested uplands during the 2019 wetland delineation (SWCA 2019a). Herbaceous upland communities consist of non-wetland areas dominated by non-woody vegetation. Dominant herbaceous species documented in the proposed Project area include those commonly associated with pasturelands (Ragsdale and Welch 2000). Scrub-shrub upland communities consist of woody vegetation less than 20 feet in height and 3 inches or greater in dbh. Forested uplands consist of a prevalence of non-wetland woody species greater than 3 inches dbh. Forested uplands in the proposed Project site are consistent with the Coastal Plains but do not bear the hallmarks of the Columbia Bottomlands, which contain old-growth wetland forest species such as green ash, cedar elm (*Ulmus crassifolia*), Carolina laurel cherry (*Prunus caroliniana*), water hickory (*Carya aquatica*), water oak (*Quercus nigra*), and an understory dominated by swamp-privet (*Forestiera acuminata*) and buttonbush (*Cephalanthus occidentalis*) (Rosen et al. 2008; SWCA 2019a). Historical Columbia Bottomlands communities have a high diversity of native plant species (Rosen et al. 2008), whereas the forested uplands communities in the proposed Project site contain a low diversity and exotic species such as Bermuda grass (*Cynodon dactylon*) and golden crown grass (Ragsdale and Welch 2000; SWCA 2019a).

The agriculture crops in the proposed Project site provide economic value, and some of the other plant species, such as great ragweed (*Ambrosia trifida*), tumble windmill grass (*Chloris verticillata*), poison-bean, and mast-producing tree species (i.e., produces seeds, nuts, fruits), native to Texas, provide economic and ecological values because they are moderate to well-suited for grazing of livestock and/or wildlife (Ragsdale and Welch 2000). However, several plant species in the proposed Project site are listed as invasive, noxious, and/or exotic (e.g., Bermuda grass, golden crown grass, Johnsongrass [*Sorghum halepense*], and Chinese tallow) and have been introduced to Texas for agriculture, ranching, or commercial purposes (Texas Department of Agriculture 2019; TexasInvasives.org 2019).

No federally listed or state-listed plant species; plant species listed as a Species of Greatest Conservation Need; or rare, unique, and imperiled vegetation communities (TPWD 2011, 2021a, 2021b) were observed during SWCA's 2019 field surveys (SWCA 2019a).

3 LISTED SPECIES AND DESIGNATED CRITICAL HABITATS

For Listed Species, the affected environment area under evaluation is often larger than a project area and may encompass the geographic extent of existing conditions and potential changes to those existing conditions associated with direct and indirect effects from activities that are part of a project's proposed activities. The Action Area described in Section 1.8 encompasses the potential direct and indirect effects to the aquatic and terrestrial environment from the proposed Project's activities. In determining potential occurrence of Listed Species in the Action Area, the Applicant queried the USFWS Information for Planning and Consultation (IPaC) online database on November 9, 2021, and requested an official species list for the Action Area. The USFWS Texas Coastal Ecological Services Field Office responded with official species lists dated November 9, 2021 (USFWS 2021b). The USFWS identified 11 federally Listed Species, one proposed species, and one species that is a candidate for future listing that have the potential to occur within the Action Area. The USFWS (2021b, 2021c) did not identify Designated Critical Habitat in the Action Area (Table 7). The USFWS included the Texas fawnsfoot, a freshwater mussel species proposed for federal listing as threatened, and the monarch butterfly (*Danaus plexippus*), a species that is a candidate for future listing, in its official species list (USFWS 2021b). As the monarch is not a proposed species, conferencing pursuant to Section 7 of the ESA is not required. The proposed Texas fawnsfoot is considered further in Table 7.

Table 7 includes an initial effects determination of *no effect* or *may affect* for each of the proposed and Listed Species included in the USFWS (2021b) official species list. The initial effects determination is based on an assessment of the range, distribution, and habitat of the species, as compared to the location and environmental setting of the Action Area. The Applicant applies the analysis framework presented in Section 1.8 to identify the initial effect determinations.

Species for which the Proposed Action will have *no effect* are not addressed beyond Table 7 in this BA and federal agencies are not obligated to seek concurrence from the USFWS for *no effect* determinations. According to USFWS (2016), "concurrence with a *no effect* determination is not required under the ESA and will not be provided." Species for which the Proposed Action *may affect* are addressed in detail in Section 4.

Table 7. Listed Species and Designated Critical Habitats

Common Name (*scientific name*) or Designated Critical Habitat	Federal Status*	Known Range, Distribution, and Habitat Requirements	Initial Effects Determination	Rationale for Initial Effects Determination
Mammals				
West Indian manatee (*Trichechus manatus*)	T	The West Indian manatee is associated with rivers, estuaries, and coastal areas in the southeastern coast of the United States (Schmidly and Bradley 2016). Distribution in North America is limited with irregular Texas occurrences representing migrants from Mexico or Florida (Schmidly and Bradley 2016).	No effect	The southern terminus of the Action Area does not reach the Texas Gulf Coast and is approximately 13 miles inland from the coast. Due to the lack of marine and coastal waters, this species has no potential to occur within the Action Area. Activities associated with the construction of the proposed Project would not affect marine or estuarine habitats or the West Indian manatee. The West Indian manatee has been documented in August 2019 in Galveston Bay, which is approximately 45 miles southeast of the Action Area (Texas Marine Mammal Stranding Network 2019).
Designated Critical Habitat for West Indian manatee		Designated Critical Habitat for the West Indian manatee occurs in Florida (USFWS 1977).	No effect	Designated Critical Habitat for the West Indian manatee is outside of the Action Area and located in Florida. The proposed Project would not destroy or adversely modify Designated Critical Habitat for the West Indian manatee.
Birds				
Black rail, Eastern Population (*Laterallus jamaicensis ssp. jamaicensis*)	T	Species occurs in wetland habitats, including, salt, brackish, and freshwater marshes, pond borders, wet meadows, and flooded grassy areas (TPWD 2021a). In Brazoria County, the eastern black rail may occur year-round as a resident breeder or as a migrant or winter resident (Eddleman et al. 2020; Lockwood and Freeman 2014). In Texas, eastern black rails primarily breed in saltmarsh habitat and typically occur in wetlands dominated by *Spartina* and *Scirpus* species (Oberholser 1974; Butler et al. 2015). The USFWS (2021d) Texas Coast Ecological Services Field Office provides guidance on evaluating presences of suitable habitat for eastern black rails in their action areas. According to this guidance, palustrine emergent and estuarine intertidal wetlands that are regularly or irregularly flooded with nearby shallow water features (i.e., E2EM1P and PEM1J; E2EM1N), dense vegetative cover, and upland ecotones for refuge during flood events are features of suitable habitat for eastern black rails (USFWS 2021e). The USFWS (2019a) notes that flooding is a frequent cause of nest failure. Therefore, areas subject to flooding between March and August may be less suitable nesting habitat for eastern black rails.	No effect	The eastern black rail has low potential to occur in the Action Area but no potential to occur in the proposed Project site due to lack of suitable habitat. Activities associated with the construction of the proposed Project would not affect eastern black rail habitats or eastern black rail individuals. The Action Area contains PEM wetlands that are seasonally flooded primarily along flood zones of the Brazos River and Oyster Creek. These wetlands vary in their amounts of cover and are expected to hold shallow water seasonally. Perennial water sources are mostly lotic, associated with the Brazos River and Oyster Creek. The proposed Project site contains PEM wetlands with relative short herbaceous cover species that vary from dense to patchy open cover (SWCA 2019a). Aquatic areas in the proposed Project site include agricultural ponds and ditches that are unlikely suitable shallow waters for the eastern black rail. The proposed Project site seasonally floods, making it less suitable for nesting. The proposed Project site lacks tall dense vegetative cover in the emergent wetlands, shallow aquatic habitats for foraging, and suitable nesting habitat. Additionally, the available suitable habitat at Brazoria National Wildlife Refuge and San Bernard National Wildlife Refuge (with documented occurrences of eastern black rail [iNaturalist 2021]) are likely more attractive to eastern black rails.

Common Name (*scientific name*) or Designated Critical Habitat	**Federal Status***	**Known Range, Distribution, and Habitat Requirements**	**Initial Effects Determination**	**Rationale for Initial Effects Determination**
Piping plover (*Charadrius melodus*)	T	Piping plovers do not nest in Texas, but occur as a scarce winter migrant, mostly in the eastern half of the state, and as a non-breeding resident along the Texas Gulf Coast (Lockwood and Freeman 2014). The piping plover prefers bare or sparsely vegetated tidal areas that are periodically covered with water, which provides habitat for polychaete worms, a primary food for the species (Campbell 2003). Coastal habitats include tidal flats, beaches, mudflats washovers, and dredge spoil islands (Federal Register 74:23476-23600; TPWD 2021a). The Action Area is within the migration pathway of the piping plover, but outside the wintering range for the species in Texas (Lockwood and Freeman 2014; Nicholls and Baldassarre 1990a, 1990b). The piping plovers that migrate and winter in Texas are member of the Northern Great Plains and Great Lakes interior breeding populations. In general, beaches and alkali flats are preferred during migration. Within the interior United States, the species most commonly uses reservoir shoreline, but also utilize natural lakes, river, marsh wetlands, and constructed ponds as stopover habitat, especially if water levels are low and mud flats are exposed. However, inland breeding populations of piping plover appear to migrate nonstop to coastal wintering habitats and the species is rarely detected at seemingly appropriate inland stopovers areas (Elliott-Smith and Haig 2020).	No effect	The Action Area does not reach the Texas Gulf Coast and its terminus is approximately 12.5 miles away from coastal areas. No piping plovers are expected to occur in the vicinity of the Action Area. Activities associated with the construction of the proposed Project would not affect wintering habitats or the piping plover.
Designated Critical Habitat for the piping plover		Designated Critical Habitat for wintering populations of the piping plover in Texas occurs in 18 units along the Texas coast in Galveston, Brazoria, Matagorda, Calhoun, Refugio, Aransas, Nueces, Kleberg, Kennedy, Willacy, and Cameron Counties (Federal Register 74:23476-23600).	No effect	Designated Critical Habitat falls outside the Action Area and is approximately 12.5 miles to the south along the Texas Gulf Coast. The proposed Project would not destroy or adversely modify Designated Critical Habitat for the piping plover.
Red knot (*Calidris canutus rufa*)	T	Lockwood and Freeman (2014) identify the red knot as an uncommon migrant along the Texas Gulf Coast, and a very rare migrant through the eastern half of the state. Red knots overwinter along the Texas Gulf Coast (Federal Register 86:3741-37668). Habitats include large areas of exposed intertidal sediments, which are generally associated with coastal marine and estuarine areas (Harrington 2001). During migration, red knots use marine habitat and prefer sandy coastal areas and tidal inlets (Baker et al. 2020).	No effect	Action Area does not reach the Texas Gulf Coast and its terminus is approximately 12.5 miles away from coastal areas. No red knots are expected to occur in the vicinity of the Action Area. Activities associated with the construction of the proposed Project would not affect migratory habitats or the red knot. Migrating individuals flying over the Action Area would not be expected to utilize the Action Area due to absence of preferred coastal marine and estuarine habitats (SWCA 2019a; Federal Register 86:37410-37668). There have been no recent records of the species within, or adjacent to the Action Area (eBird 2021; iNaturalist 2021; National Audubon Society 2021; USGS 2021). No red knots are expected to occur within the vicinity of the Action Area.

Common Name (*scientific name*) or Designated Critical Habitat	Federal Status*	Known Range, Distribution, and Habitat Requirements	Initial Effects Determination	Rationale for Initial Effects Determination
Proposed Designated Critical Habitat for the red knot		Proposed Designated Critical Habitat for wintering populations of the red knots in Texas occurs in 11 units along the Texas coast in Galveston, Matagorda, Nueces, Kleberg, Kennedy, Willacy, and Cameron Counties (Federal Register 86:37410-37668).	No effect	Proposed Critical Habitat falls outside the Action Area and is located approximately 17 miles to the southwest along the coast. The proposed Project would not destroy or adversely modify Proposed Critical Habitat for the red knot.
Whooping crane (*Grus americana*)	E	The whooping crane is known to winter along the Texas Gulf Coast and 30 to 35 miles inward, starting from San Jose Island and the Lamar Peninsula on the south to Welder Point and Matagorda Island on the north (Canadian Wildlife Service [CWS] and USFWS 2005). This wintering habitat consists of estuarine marshes, shallow bays, and tidal flats, and occasional use of nearby flooded pasture or flooded cropland (CWS and USFWS 2005). Wintering whooping cranes in Texas generally occur near Aransas National Wildlife Refuge (ANWR) in Aransas, Calhoun, and Refugio Counties (CWS and USFWS 2005). The whooping cranes migrate during spring and fall through an approximately 200-mile-wide corridor through Alberta, Saskatchewan, extreme eastern Montana, North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas (CWS and USFWS 2005). Stopover roosting habitats are predominantly palustrine or riverine wetland systems adjacent to cropland or grassland (Austin and Richert 2001).	May affect	Due to the presence of potentially suitable habitat and nearby occurrence records (USFWS 2020a), the whooping crane has potential to occur in the Action Area and the proposed Project site. Activities associated with the construction of the proposed Project may remove or modify potentially suitable stopover habitat and *may affect* the whooping crane. The Action Area is located approximately 100 miles northeast of ANWR and approximately 7.5 miles east of the outermost edge (i.e., 95% core) the central flyway whooping crane migration corridor (USFWS 2020a) (Figure 16). Areas of the proposed Project contain crop fields, which may be used by foraging or migrating cranes if flooded by rainfall events, as well as the Harris Reservoir, which may provide suitable habitat for the species. According to USFWS (2020a), there have been two whooping crane detections within or immediately adjacent to the Action Area. There is one record of four adult cranes observed flying less than 1.5 miles south of the proposed Project in December 2010. Another record, from approximately 3 miles north of the proposed Project, concerns a single adult in January 1999 on the ground near Brazos Bend State Park. There have been several nearby records of whooping crane detections that have been submitted to eBird (2021) from the proposed Project vicinity; the nearest records are approximate 8 miles northeast of the proposed Project near Brazos Bend State Park, which appear to indicate a single bird observed over several days in January and February 1999.
Designated Critical Habitat for the whooping crane		Designated Critical Habitat occurs within and adjacent to the ANWR (USFWS 1978).	No effect	Designated Critical Habitat falls outside the Action Area and is located approximately 82 miles to the southwest in the ANWR. The proposed Project would not destroy or adversely modify Proposed Critical Habitat for the whooping crane.
Reptiles				
Green sea turtle (*Chelonia mydas*)	T	Green sea turtles globally occupy tropical and sub-tropical waters, and in the United States nest on shore in small numbers concentrated mostly in Florida (USFWS 1991). Green sea turtles occupy high-energy oceanic beaches, convergence zones in the pelagic habitat, and benthic feeding grounds in relatively shallow, bay waters (USFWS 1991). In Texas, green sea turtles most commonly nest along the Padre Island National Seashore, which is over 200 miles south of the proposed Project site (National Park Service 2021).	No effect	Due to the lack of marine and coastal waters, and coastal beaches for nesting, this species has no potential to occur within the Action Area. Activities associated with the construction of the proposed Project would not affect the nesting habitats or green sea turtles. Marine habitats used for foraging and breeding, and coastal beaches used for nesting, would not be impacted by the activities associated with the construction of the proposed Project.

Common Name (*scientific name*) or Designated Critical Habitat	**Federal Status***	**Known Range, Distribution, and Habitat Requirements**	**Initial Effects Determination**	**Rationale for Initial Effects Determination**
Hawksbill sea turtle (*Eretmochelys imbricata*)	E	Hawksbill sea turtles nest on insular and mainland sandy beaches throughout the tropics and subtropics (NMFS and USFWS 2013a). Hawksbills feed mostly in offshore and nearshore reef habitats (NMFS and USFWS 2013a). In Texas, hawksbill sea turtles most commonly nest along the Padre Island National Seashore, which is over 200 miles south of the proposed Project site (National Park Service 2021). Females show high interannual nesting site fidelity (Witzell 1983).	No effect	Due to the lack of marine and coastal waters, and coastal beaches for nesting, this species has no potential to occur within the Action Area. Activities associated with the construction of the proposed Project would not affect the nesting habitats or hawksbill sea turtles. Marine habitats used for foraging and breeding, and coastal beaches used for nesting would not be impacted by the activities associated with the construction of the proposed Project.
Kemp's ridley sea turtle (*Lepidochelys kempii*)	E	The Kemp's ridley sea turtle has a restricted distribution, inhabiting the Gulf of Mexico and northwest Atlantic north into Canada to Nova Scotia with infrequent occurrences in the northeast Atlantic and Mediterranean (NMFS and USFWS 2015). Nesting is limited to the western Gulf of Mexico primarily in Tamaulipas, Mexico, but in the United States, nesting occurs mostly in Texas and occasionally in Florida, Alabama, Georgia, South Carolina, and North Carolina (NMFS and USFWS 2015). Post-nesting females from the upper Texas coast forage primarily in marine waters between Louisiana and southwest Florida (NMFS and USFWS 2015). In Texas, Kemp's ridley sea turtles most commonly nest along the Padre Island National Seashore, which is over 200 miles south of the proposed Project site (National Park Service 2021).	No effect	Due to the lack of marine and coastal waters, and coastal beaches for nesting, this species has no potential to occur within the Action Area. Activities associated with the construction of the proposed Project would not affect the nesting habitats or Kemp's ridley sea turtles. Marine habitats used for foraging and breeding, and coastal beaches used for nesting, would not be impacted by the activities associated with the construction of the proposed Project.
Leatherback sea turtle (*Dermochelys coriacea*)	E	Leatherback sea turtles are distributed globally, nesting in tropical and sub-tropical waters and foraging into higher-latitude sub-polar waters (NMFS and USFWS 2013b). Their diet consists mainly of gelatinous organisms, but also include crustaceans, vertebrates, and plants (Jones and Seminoff 2013). Leatherbacks migrate up to 6,835 miles per year from their breeding areas and navigate back to these areas for nesting each season (NMFS and USFWS 2013b).	No effect	Due to the lack of marine and coastal waters, this species has no potential to occur within the Action Area. Species occurs in marine aquatic habitats that are not expected to be impacted by the activities associated with the proposed Project. This species goes on shore only to nest, although infrequently in Texas (NMFS and USFWS 2013b). The Action Area does not contain potentially suitable nesting habitat and no leatherback sea turtles are expected to occur in the Action Area.
Loggerhead sea turtle (*Caretta caretta*)	T	Loggerheads occupy temperate to tropical regions of the Atlantic. Pacific, and Indian Oceans (NMFS and USFWS 2008). The Turtle Expert Working Group (2000) estimated between 53,000 and 92,000 nests per year in the southeastern United States from North Carolina to Florida, with the great majority of those nests along coastlines in Florida. Annual nest totals for the Northern Gulf of Mexico Unit (from Franklin County, Florida to Texas) average 906 nests from 1995–2007 (NMFS and USFWS 2008). However, essentially all shelf waters along the Atlantic and Gulf of Mexico are inhabited by Loggerheads (NMFS and USFWS 2007). The most common prey item of loggerhead sea turtles in Texas are sea pens (coral) and benthic crabs (Plotkin et al. 1993).	No effect	Due to the lack of marine and coastal waters, this species has no potential to occur within the Action Area. Species occurs in marine aquatic habitats that are not expected to be impacted by the activities associated with the proposed Project. The Action Area does not contain potentially suitable nesting habitat and no loggerhead sea turtles are expected to occur in the Action Area.

Common Name (*scientific name*) or Designated Critical Habitat	Federal Status*	Known Range, Distribution, and Habitat Requirements	Initial Effects Determination	Rationale for Initial Effects Determination
Designated Critical Habitat for the loggerhead sea turtle (USFWS)		Designated Critical Habitat under USFWS are the terrestrial environment of the U.S. Atlantic and Gulf of Mexico coasts of North Carolina, South Carolina, Georgia, Florida, Alabama, and Mississippi, for the Northwest Atlantic Ocean Distinct Population Segment (Federal Register 79:39756-39854).	No effect	Designated critical habitat for the loggerhead sea turtle in loggerhead sea turtle nesting beaches in the states of North Carolina, South Carolina, Georgia, Florida, Alabama, and Mississippi. The proposed Project would not destroy or adversely modify Designated Critical Habitat for the loggerhead sea turtle.
Mollusks				
Texas fawnsfoot (*Truncilla macrodon*)	PT	Historically endemic to the Brazos and Colorado river basins (USFWS 2019b). Current range includes the Brazos, Colorado, and Trinity river basins (Federal Register 86:47916-48011; Randklev et al. 2017; USFWS 2019b). Relies on host-mediated dispersal but specific fish species have not been determined (USFWS 2019b). Habitats are characterized by medium- to large-sized perennial streams and rivers with stable substrates of mud, sand, or gravel substrates (Howells 2014). Loose mud, unstable gravel deposits, and bedrock without large cracks are not likely to provide habitat for this species (Randklev et al. 2017). Adults can be found in bank, backwater, riffle and point bar areas of streams and rivers where flow velocities are reduced (Randklev et al. 2017).	No effect	No Texas fawnsfoot individuals were detected during the 2019 stream condition assessment of waterbodies in the proposed Project site (SWCA 2019b). No Texas fawnsfoot individuals, nor evidence of live mussel, shell, shell fragments, nor habitat to support Texas fawnsfoot were observed during freshwater mussel surveys conducted in the proposed Project site in 2012 (HDR Engineering [HDR] 2012) and 2022 (Stantec 2022). The 2012 survey was located in the Brazos River 560 feet downstream of the existing Harris Reservoir water intake structure (HDR 2012). The 2022 freshwater mussel surveys were located near Mitigation Project 2 and Mitigation Project 3 along 840 linear feet of Oyster Creek (Stantec 2022); and near the Pump Station along 755 linear feet of Brazos Creek (Stantec 2022) (see Figure 2). The nearest known occurrence for the Texas fawnsfoot in the vicinity of the Action Area is located approximately 9.8 miles north, along the Brazos River (Texas Natural Diversity Database 2021) (see Figure 16). There is low potential for the Texas fawnsfoot to occur in the Action Area based on low documented abundances of Texas fawnsfoot in the Lower Brazos River and no documented occurrences of this species in Brazoria County (USFWS 2019b). Although activities associated with construction of the proposed Project *may affect* the water quality of aquatic habitats in the Action Area, the best available data indicates low potential for the Texas fawnsfoot to occur in the Action Area. Consequently, the Texas fawnsfoot is not expected to be exposed to the effects of the action. The Applicant will implement minimization measures to protect water quality and aquatic habitats to further reduce the potential for exposure of effects of the action.
Proposed Designated Critical Habitat for the Texas fawnsfoot		Proposed Designated Critical Habitat occurs among eight units: three in the Brazos River, one in the Little River, one in the Lower San Saba/Upper Colorado River, one in the Lower Colorado River, and two in the Trinity River (Federal Register 86:47916-48011).	No effect	Proposed Designated Critical Habitat Unit TXFF-3 Lower Brazos River is outside of the Action Area, located approximately 79 miles north of the Action Area (Federal Register 86:47916-48011). The proposed Project activities would not destroy or adversely modify Proposed Critical Habitat for the Texas fawnsfoot.

Common Name (*scientific name*) or Designated Critical Habitat	**Federal Status***	**Known Range, Distribution, and Habitat Requirements**	**Initial Effects Determination**	**Rationale for Initial Effects Determination**
Flowering Plants				
Texas prairie dawn-flower (*Hymenoxys texana*)	E	Texas prairie dawn-flower is endemic to Texas (USFWS 1989). Texas prairies dawn-flower is found in poorly drained, sparsely vegetated areas of fine, sandy, compact soils at the base of mima mounds in open grasslands or almost barren areas on slightly saline soils that are sticky when wet and powdery when dry (USFWS 2015). The mima mounds range in height from 4 inches to over 6.5 feet and range from 3 to 98 feet in diameter (USFWS 2015). The mima mounds are typically composed of unstratified sandy loam soils and are surrounded by less coarse soils like clay (USFWS 2015). This species has been known to occur in areas where soils have been severely disturbed in the past, including vacant lots, abandoned rice fields, and pastures where mima mounds have been leveled (USFWS 1989). The Texas prairie-dawn flower has known populations in Fort Bend, Gregg, Harris, Trinity, and Waller Counties (USFWS 2015).	No effect	Due to the lack of suitable habitat, no documented occurrences in the proposed Project site (SWCA 2019a), and no documented occurrences in Brazoria County (USFWS 2015), this species has no potential to occur within the Action Area. As of 2015, the Texas prairie dawn flower is not known to occur in Brazoria County where the proposed Project is located (USFWS 2015). No Texas prairie dawn-flowers were detected during SWCA's 2019 wetland delineation of the proposed Project site (SWCA 2019a). The proposed Project site lacks suitable habitat including poorly drained sandy loam soils, mima mounds, and open grasslands.

Note: Species in shaded rows have a determination of *may affect* and are discussed in the sections following the table.

* USFWS Status Definitions: C = Candidate; E = Endangered; PT = Proposed Threatened; T = Threatened.

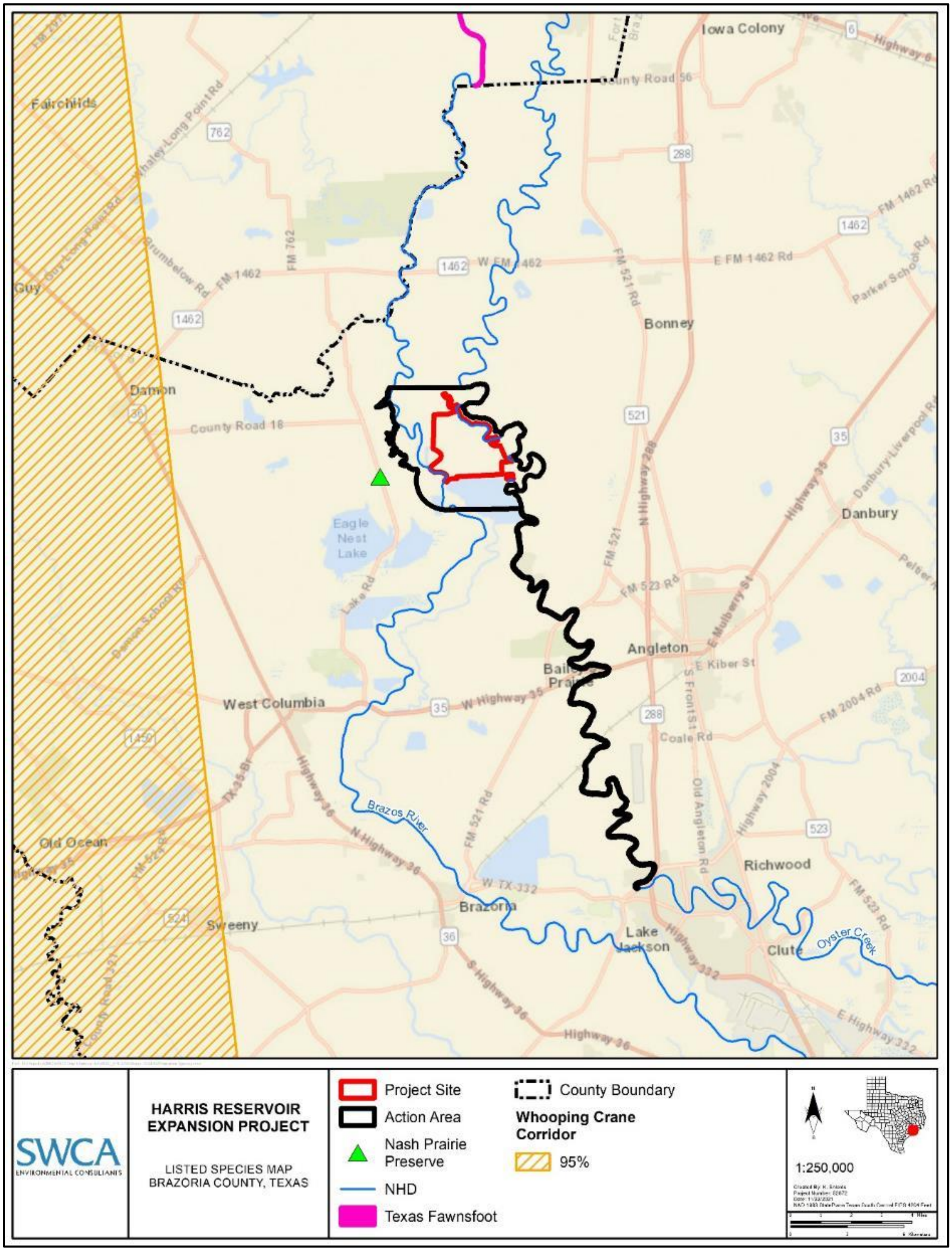

Figure 16. Documented occurrence of Texas fawnsfoot and the whooping crane migration corridor in the vicinity of the Action Area and proposed Project site. There is no Designated Critical Habitat in the vicinity of the Action Area.

4 EFFECTS OF THE ACTION

The initial analysis in Table 7 identified that one federally Listed Species, whooping crane, has the potential to occur in the Action Area and may be affected by the activities of the proposed Project. In this section, the BA includes background information on the biology, baseline status, and an evaluation of the potential effects and potential consequences on whooping crane arising from the proposed Project.

This BA uses the following definitions adapted from the guidance in the Consultation Handbook (USFWS and NMFS 1998), and consistent with the October 2019 ESA regulation revisions (Federal Register 84:44976-45018), to describe the types of consequences to Listed Species that may arise from activities performed within USACE Action Areas and Applicant Action Areas:

- **Effects of the Action:** Includes all consequences to Listed Species and Designated Critical Habitat caused by the actions of the proposed Project. Effects of the Action include consequences that may occur later in time and may include consequences occurring outside of the immediate area of the proposed Project.
- **Consequences:** Effects of the actions of the proposed Project that would not occur but for the proposed Project and are reasonably certain to occur.
- **Cumulative Effects:** Effects of other future state or private activities that are reasonably certain to occur within the Action Area.

The Action Area is composed of lands that are largely agricultural and rural (i.e., where the county population is no more than 150,000) and is entirely in Brazoria County (Texas Legislative Council 2016). The Texas Demographic Center (2021) projects a 13.7% increase in human population between the years 2020 and 2025 for Brazoria County. This indicates there may be some land use change and/or increased surface water demands in the years to come that could contribute to cumulative effects to Listed Species. Land use changes and changes in surface water demands are expected to occur near populated areas such as Houston, Angleton and Lake Jackson and may involve conversion of rural areas to developed lands in and around these cities. Given the cities are over 10 miles east of the whooping crane migration corridor, there are likely to be few significant changes that would contribute to cumulative effects to the whooping crane. Brazoria County and the Action Area have already been converted to agricultural land, thus large-scale conversion of grasslands is not expected to occur (Griffith et al. 2007; USFWS 2020b). It is unlikely that lands in the Action Area and in vicinity in Brazoria County, would experience much change in surface waters that would not also be subject to some form of federal involvement (i.e., most linear projects, such as new utility lines or roads, are likely to trigger the need for some federal authorization—such as under Section 404 of the CWA or under the ESA). Neither the Applicant nor the USACE are aware of any other future non-federal activities that are reasonably certain to occur within the Action Area; therefore, Cumulative Effects to the *may affect* Listed Species are not discussed further in this BA.

4.1 Whooping Crane (*Grus americana*)

4.1.1 Biology, Life History, and Habitat

The whooping crane is the tallest North American bird, with males approaching 5 feet tall and weighing (in captivity) approximately 16 pounds (Canadian Wildlife Service [CWS] and USFWS 2005; USFWS 2012). Adult whooping cranes have pure white body plumage, black primaries in the wing, and black and red facial markings. Immature whooping cranes have a combination of grayish-white and reddish-cinnamon coloration and no facial markings (CWS and USFWS 2005; USFWS 2012). Whooping cranes may live 28 years or more in the wild, and up to 38 years in captivity (CWS and USFWS 2005; USFWS 2012). Whooping cranes are monogamous and form life-long pair bonds, but individuals would re-mate following the death of its partner (Blankinship 1976). Pairs construct nests of bulrush and females lay one to three eggs in late April to early May. Both parents contribute to raising chicks and typically one chick survives to fledging (CWS and USFWS 2005; USFWS 2012). Whooping cranes reach maturity at 3 to 4 years of age, and most females are able to produce eggs by 4 years of age (Campbell 2003). Whooping cranes are omnivorous, opportunistically consuming a variety of agricultural grains, berries, invertebrates, and vertebrates present at their breeding grounds, stopover areas, and wintering grounds (Hunt 1987; Chavez-Ramirez et al. 1995; CWS and USFWS 2005; USFWS 2012). Whooping cranes may alter their diet to consume more readily available or energy-rich food items (e.g., fruits of the Carolina wolfberry [*Lycium carolinianum*], blue crabs [*Callinectes sapidus*]) prior to or after migration (Blankinship 1976; USFWS 2012).

Whooping cranes are migratory birds; the largest migratory and only natural self-sustaining population of whooping cranes is referred to as the Aransas-Wood Buffalo Population (AWBP) (CMS and USFWS 2005; USFWS 2012). This population migrates along a narrow, 200-mile wide corridor through the Great Plains between their breeding grounds in and adjacent to the Wood Buffalo National Park (WBNP), Canada and their wintering grounds in ANWR, Texas (CWS and USFWS 2005; USFWS 2012). Fall migration for the AWBP occurs when individuals leave their breeding grounds in mid-September to early October and then arrive at their Texas wintering grounds between late October and mid-November (Austin and Richert 2001; CWS and USFWS 2005; Urbanek and Lewis 2015). Spring migration from Texas occurs between mid-March and early May with north-bound birds typically completing spring migration in 2 to 4 weeks (CWS and USFWS 2005). Injured or sick whooping cranes and their mates may forego migration and remain in their wintering grounds (CWS and USFWS 2005). There is some evidence that climate change has affected these migration windows, with a 2017 study by Jorgensen and Brown stating that “birds are migrating earlier (22 days) in spring and later (22 days) in fall throughout the central United States.” Whooping cranes may migrate as single individuals, pairs, family groups, or in small flocks, sometimes accompanying sandhill cranes (*Antigone canadensis*) (Campbell 2003). During migration, whooping cranes may reach elevations of 6,200 feet and travel between 200 and 400 miles a day. Whooping cranes roost and forage during their migration in various land covers further described below (Austin and Richert 2001; Campbell 2003).

Potentially suitable stopover habitat for whooping cranes may encompass various types of land covers to support the roosting, sheltering, and foraging needs of the whooping cranes during their migration (Pearse et al. 2015). PEM and lacustrine wetlands and rivers are the most common land covers associated with nocturnal roosting at stopover sites during migration (Austin and Richert 2001; Pearse et al. 2015). Dry and flooded agricultural fields, grasslands, and palustrine wetlands are common land covers associated with diurnal foraging sites at stopover sites during migration (Austin and Richert 2001; Pearse et al. 2015).

Land covers used by whooping cranes at their wintering grounds in Texas include salt, brackish and freshwater marshes, brackish bays, salt flats that lie between the mainland and out-lying barrier islands, and adjacent uplands (CWS and USFWS 2005). The wintering grounds are largely centered on approximately 22,500 acres of marshy salt flats in ANWR in Aransas, Calhoun, and Refugio Counties (CWS and USFWS 2005). The whooping crane wintering grounds are dominated by plants such as salt grass (*Distichlis spicata*), saltwort (*Batis maritima*), smooth cordgrass (*Spartina alterniflora*), glasswort (*Salicornia* sp.), and sea ox-eye daisy (*Borrichia frutescens*) (CWS and USFWS 2005). The average size of a wintering territory is approximately 289 acres at peak crane densities (CWS and USFWS 2005).

Estimates of the historical abundance of whooping cranes differed by orders of magnitude from hundreds to thousands in the mid to late 1800s but were consistently below 100 in the early 1900s (CWS and USFWS 2005). In 1944, the estimated whooping crane population was 21 birds consisting of 15 breeding adults, three non-breeding adults, and three sub-adults that wintered at ANWR; this group of birds was the founders of the current AWBP population (CWS and USFWS 2005). All other natural populations of whooping cranes have been extirpated (CWS and USFWS 2005). There are two experimental populations in Florida, one non-migratory and one population that migrates to summering areas in Wisconsin (CMS and USFWS 2005). The current estimated abundance of the AWBP population is 506 individuals (USFWS 2020c). This estimate was derived from a combination of data from aircraft surveys at ANWR and surrounding areas during the 2019–2020 winter season, and eBird (Sullivan et al. 2009) observations located outside of the aircraft survey area. According to USFWS (2020c), the "long-term growth rate of the whooping crane population has averaged 4.4%."

Threats to whooping crane wintering, foraging, and roosting habitat near the Texas Gulf Coast arise primarily from land conversion and development (e.g., homes, roads, building, utilities) (Austin and Richert 2001; CWS and USFWS 2005; USFWS 2012). Increasing development on the Texas Gulf Coast has encroached on the salt marsh habitats used by wintering whooping cranes and is expected to limit the availability of wintering habitat and limit the potential for expansion of the AWBP (USFWS 2012).

4.1.2 Status in the Action Area

The whooping crane migration corridor crosses over Brazoria County (see Figure 16). The Action Area is approximately 7.5 miles from the eastern edge of the whooping crane migration corridor that encompasses 95% of all whooping crane observations as held by the USFWS (2020a). According to USFWS (2020a), there have been two whooping crane detections within or immediately adjacent to the Action Area. One record listed four adult birds observed flying less than 1.5 miles south of the proposed Project in December 2010. Another record, from approximately 3 miles north of the proposed Project, concerned a single adult in January 1999 on the ground near Brazos Bend State Park. Several records of whooping crane detections have been submitted to eBird (2021) from the proposed Project vicinity, the nearest records are approximate 8 miles northeast of the proposed Project near Brazos Bend State Park, which appear to indicate a single bird observed over several days in January and February 1999.

Whooping cranes in Texas roost primarily in palustrine wetlands near agricultural or grassland landscapes (CWS and USFWS 2005; Pearse et al. 2015). The Action Area contains crop fields, which may be used by foraging or migrating cranes if flooded by rainfall events, as well as the Harris Reservoir, which may provide suitable habitat for the species. The proposed Project site contains 9.63 acres of PEM wetlands within agricultural areas (SWCA 2019a). Thus, the Action Area and the proposed Project site contain potentially suitable roosting and foraging stopover habitats.

4.1.3 Effects of the Action

The available data on whooping crane occurrences in the vicinity of the Action Area indicate that individual whooping cranes may occasionally stopover in the Action Area. Individual whooping cranes and potentially suitable stopover roosting and foraging habitat in the proposed Project site may be affected from construction of the proposed Project. It is unlikely that proposed Project activities would directly kill or wound individuals. Effects of the proposed Project actions may include human disturbance to any whooping cranes that may be present during the construction phase, and destruction or modification of potential stopover habitat.

Disturbance of whooping crane individuals due to human presence has potential to occur within the Action Area. The risk to encounter a whooping crane exists only when whooping cranes are migrating to and from their wintering grounds at ANWR. If individuals of this species are spotted near the proposed Project during construction, they could easily avoid the disturbance by moving to adjacent habitat. Nevertheless, the disturbance would affect these potential individuals by causing them to leave the area they were occupying. As a voluntary conservation measure, the Applicant proposes to immediately halt work (thus limiting disturbance) when a whooping crane is observed within 1,000 feet of the construction activities (see Section 5). Halting construction activities is expected to reduce the effects of human disturbance and development on a whooping crane that is foraging or roosting within vicinity of the Action Area.

The proposed Project would result in the loss of 15.97 acres (75%) of the 21.38 acres of palustrine wetlands within the proposed Project site that could be used for roosting and foraging by whooping cranes during migration (SWCA 2019a). The loss of these wetlands may result in a small reduction in the total available stopover habitats for whooping cranes. This loss is not expected to substantially affect the whooping crane, given whooping cranes have not been documented in the proposed Project site and suitable wetlands known to be used by the whooping crane are available in protected lands (i.e., Brazos Bend State Park, Brazoria National Wildlife Refuge and San Bernard National Wildlife Refuge (eBird 2021; iNaturalist 2021).

The CWS and USFWS (2005) and USFWS (2009) list collisions with humanmade objects as a current threat to whooping cranes. Whooping crane collisions with electric transmission lines and distribution lines have been responsible for the death or serious injury of at least 45 whooping cranes since 1956 (Stehn and Wassenich 2008). Whether or not, and to what extent, construction equipment may pose a risk for whooping crane collision is unknown. Regardless, the Applicant would voluntarily lower all construction equipment taller than 15 feet at night when constructing within the whooping crane migration corridor to reduce any known or perceived threats of collision to whooping cranes that may be wintering, foraging, or roosting within the Action Area.

The whooping crane are expected to be opportunistic in their use of available stopover habitat during their migrations and use available habitat should they require a break during migration. The amount of potential stopover habitat that would be lost or modified by the proposed Project is less than 0.01% of the USFWS (2021a) NWI mapped palustrine wetlands in the Action Area, and are not within the migration corridors used by the majority of migrating whooping cranes (CWS and USFWS 2005; Pearse et al. 2015). The Applicant's proposed conservation measures would minimize or avoid effects to whooping cranes in the unlikely event that an individual enters the proposed Project site. Therefore, the proposed Project's actions would not jeopardize the continued existence of the whooping crane.

The USACE determines that the effects of the proposed Project's actions *may affect, but is not likely to adversely affect* the whooping crane due to loss of potential stopover habitat and potential human disturbance during construction activities. As previously mentioned, the Applicant has voluntarily proposed to implement conservation measures to address these adverse effects.

5 APPLICANT-PROPOSED CONSERVATION MEASURES

As part of the proposed Project, the Applicant proposes to implement certain voluntary conservation measures to minimize the likelihood or magnitude of adverse effects, or both, of the proposed Project on certain Listed Species (Table 8). The beneficial effects of these voluntary conservation measures are considered in the analyses of the effects of the USACE Proposed Action.

Table 8. Applicant-Proposed Conservation Measures for Listed Species

Proposed Conservation Measure	Anticipated Benefit
Texas fawnsfoot (*Truncilla macrodon*)	
Monitoring and Mitigation of Oyster Creek: Impacts to water quality including the temperature, dissolved oxygen, and total suspended solids would monitored and mitigated during drawdown and addressed through adaptive management in Dow's mitigation and monitoring plan and operation and maintenance plan.	Although individual Texas fawnsfoot, and habitat suitable for Texas fawnsfoot have not been documented in the proposed Project site, they have low potential to inhabit the Action Area. The USFWS listed impacts to water quality as a primary threat to the Texas fawnsfoot. Monitoring erosion and sedimentation in Oyster Creek and adaptively managing Dow's operations to reduce or avoid impacts to the water quality of Oyster Creek is expected to minimize impacts to the quality of habitat in Oyster Creek that could support the Texas fawnsfoot.
Best Management Practices for Construction and Operation Activities: During construction Dow proposes to implement measures to avoid or minimize impacts to surface waters and aquatic faunal communities. Some examples include 1) 150-foot setbacks of staging areas from aquatic habitats including streams, 2) streambank stabilization measures, 4) sediment and erosion control measures, 5) monitoring and management of aquatic nonnative invasive species, and 6) stream restoration in accordance with the compensatory mitigation and monitoring plan (SWCA 2022).	Dow's measures would reduce the impacts to the physio-chemical and biological aspects of water quality of Oyster Creek. This is also expected to minimize impacts downstream in Oyster Creek that could support the Texas fawnsfoot.
Whooping Crane (*Grus americana*)	
Stop Work Order: During the construction phase, if a whooping crane is observed within 1,000 feet of construction activities, the Applicant would immediately halt work until the whooping crane leaves the area.	Stopping work if a whooping crane is spotted within 1,000 feet of construction activities is expected to reduce the effects of human disturbance and development on a crane that is either foraging or stopping over within a flooded agricultural field.
Lowering of Construction Equipment: During the construction phase, the Applicant would lower all construction equipment taller than 15 feet at night when constructing within the whooping crane migration corridor when the species is present during the winter months and the short period of migration to and from breeding grounds in which they are within the project vicinity.	Lowering tall construction equipment at night would reduce the potential for collision with whooping cranes that may be using the proposed Project site for foraging or roosting during migration.

Other general conservation measures for all species consist of the following:

- Streams, riparian zones, and wetlands would not be used as staging or refueling areas. Equipment will be stored, serviced, and fueled a minimum of 150 feet from aquatic habitats and other sensitive areas.
- Wetlands and other WOUS that are not within the Project footprint will be protected by a 150-foot buffer. The avoidance area will be clearly marked with flagging or fencing.
- Streambank stabilization measures, including sheet piling, native backfill, and riprap, would be installed along the Brazos River approximately 200 feet upstream and 100 feet downstream of the

proposed intake structure to reinforce the toe and a portion of the slope of the riverbank, preventing lateral migration of the Brazos River.

- Wetland and stream restoration areas would be monitored in accordance with the compensatory mitigation and monitoring plan (SWCA 2022).
- An environmental awareness training program will be presented to all construction personnel to brief them on the status of the special-status species and the required avoidance measures. Training would help ensure that the Applicant-proposed conservation measures are properly implemented for the duration of the proposed Project.

6 CONCLUSIONS

The USFWS identified 11 federally Listed Species, one proposed species, and one species that is a candidate for future listing that have the potential to occur within the Action Area. Based on the analysis in this BA, the proposed Project *may affect, but is not likely to adversely affect* the endangered whooping crane. The proposed Project would have *no effect* on the other proposed and Listed Species.

The proposed Project would have *no effect* on any Designated Critical Habitat under the ESA or areas proposed for such designations.

The proposed Project is not expected to jeopardize the continued existence of any Listed Species, nor cause the destruction or adverse modification of any Designated Critical Habitats.

The USACE and the Applicant request concurrence from the USFWS that the proposed Project is not likely to adversely affect the whooping crane.

7 LITERATURE CITED

Austin, J.E., and A.L. Richert. 2001. *A Comprehensive Review of Observational and Site Evaluation Data of Migrant Whooping Cranes in the United States, 1943-99*. Available at: https://pubs.usgs.gov/unnumbered/93805/report.pdf. Accessed October 10, 2019.

Baker, A., P. Gonzalez, R. I. G. Morrison, and B. A. Harrington. 2020. Red Knot (*Calidris canutus*), version 1.0. In *Birds of the World,* edited by S.M. Billerman. Ithaca, New York: Cornell Lab of Ornithology. Available at: https://doi.org/10.2173/bow.redkno.01. Accessed September 2021.

Barnes, V.L. 1982. Geologic Atlas of Texas. Houston Sheet. Bureau of Economic Geology. The University of Texas at Austin, Texas.

Blankinship, D.R. 1976. *Studies of Whooping Cranes on the Wintering Grounds.* In *Proc. International Crane Workshop*, edited by J.C. Lewis, pp.197–206. Stillwater: Oklahoma State University Press.

Brazoria County. 2020. Statistics and Data. Available at: https://www.brazoriacountytx.gov/about-us/statistics-and-data. Accessed December 2020.

Butler, C.J., J.B. Tibbits, and J. Wilson. 2015. *Assessing Black Rail occupancy and vocalizations along the Texas Gulf Coast*. Final Report. February 16, 2015. Available at: https://tpwd.texas.gov/huntwild/wild/wildlife_diversity/nongame/grants-research/media/2015-black-rail.pdf. Accessed September 2021.

Campbell, L. 2003. *Endangered and Threatened Animals of Texas—Their Life History and Management*. Austin, Texas: Texas Parks and Wildlife Department, Wildlife Division.

Canadian Wildlife Service and U.S. Fish and Wildlife Service (CWS and USFWS). 2005. *Draft International Recovery Plan for the Whooping Crane*. Ottawa, Ontario: Recovery of Nationally Endangered Wildlife (RENEW) and Albuquerque, New Mexico: U.S. Fish and Wildlife Service.

Cardno. 2019. Interim Wetland and Other "Waters of the U.S." Delineation Report, 1,383.8-Acre Agricultural Parcel—Harris Expansion Project Rosharon, Texas. February 14, 2019.

Chavez-Ramirez, F., H.E. Hunt, R.D. Slack, and T.V. Stehn. 1995. Ecological correlated of whooping crane use of fire-treated upland habitats. *Conservation Biology* 10(1):217–233.

Dow Chemical Company (Dow). 2022. *Draft Operation and Maintenance Plan. Harris Expansion Reservoir. Texas Operations.* Updated January 2022.

eBird. 2021. An online database of bird distribution and abundance [web application]. eBird. Ithaca, New York: Cornell Lab of Ornithology. Available at: http://www.ebird.org. Accessed November 2021.

Eddleman, W.R., R.E. Flores, and M. Legare. 2020. Black Rail (*Laterallus jamaicensis*), version 1.0. In *Birds of the World*, edited by A.F. Poole and F.B. Gill. Ithaca, New York: Cornell Lab of Ornithology. Available at: https://doi.org/10.2173/bow.blkrai.01. Accessed September 2021.

Elliott-Smith, E. and S.M. Haig. 2020. Piping Plover (*Charadrius melodus*), version 1.0. In *Birds of the World*, edited by A.F. Poole. Ithaca, New York: Cornell Lab of Ornithology. Available at: https://doi.org/10.2173/bow.pipplo.01. Accessed September 2021.

Federal Emergency Management Agency (FEMA). 2021. National Flood Hazard Layer Viewer. Available at: https://www.arcgis.com/apps/webappviewer/index.html?id=8b0adb51996444d4879338b5529aa9cd. Accessed September 2021.

Griffith, G., S. Bryce, J. Omernik, and A. Rogers. 2007. *Ecoregions of Texas*. Prepared for Texas Commission on Environmental Quality. Available at: ftp://newftp.epa.gov/EPADataCommons/ORD/Ecoregions/tx/TXeco_Jan08_v8_Cmprsd.pdf. Accessed October 4, 2019.

Harrington, B.A. 2001. Red knot (*Calidris canutus*). In *The Birds of North America,* edited by A.F. Poole and F.B. Gill. Ithaca, New York: Cornell Lab of Ornithology. Available at: https://www.allaboutbirds.org/guide/red_knot. Accessed October 10, 2019.

HDR Engineering, Inc (HDR). 2012. *Limited Shallow River Survey for Freshwater Mussels*, October 18, 2012. Austin, Texas: HDR Engineering.

Howells, R.G. 2014. Field Guide to Texas Freshwater Mussels. Second Edition. *BioStudies*, Kerrville, Texas.

Hunt, H.E. 1987. The Effects of Burning and Grazing on Habitat Use by Whooping Cranes and Sandhill Cranes on the Aransas National Wildlife Rescue, Texas. Ph.D. Dissertation. College Station, Texas A&M University.

iNaturalist. 2021. *Observations*. Online map viewer. Available at: https://www.inaturalist.org/. Accessed September 2021.

Jacobs. 2018. *Stage 2 Construction Management Plan.* Memorandum. December 13, 2018. On file, SWCA Environmental Consultants.

Jones, T.T., and J.A. Seminoff. 2013. Feeding biology: advances from field observations, physiological studies, and molecular techniques. *The Biology of Sea Turtles* 3:211–247.

Jorgensen, J.G., and M.B. Brown. 2017. Temporal Migration Shifts in the Aransas-Wood Buffalo Population of Whooping Cranes (*Grus americana*) Across North America. *Waterbirds* 40(3): 195–206.

Journey North. 2019. Journey North: Tracking Migrations and Seasons. Available at: https://journeynorth.org/. Accessed November 2021.

Linam, G.W., and L.J. Kleinsasser. 1987. *Fisheries Use Attainability Study for Oyster Creek (Segment 1110).* River Studies Report No. 3. Resource Protection Division, Texas Parks and Wildlife Department. Austin, Texas. Available at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.493.5130&rep=rep1&type=pdf. Accessed November 2019.

Lockwood, M.W., and B. Freeman. 2014. *The TOS Handbook of Texas Birds, 2nd Edition*. College Station: Texas A&M University Press.

McMahan, C., R. Frye, and K. Brown. 1984. *The Vegetation Types of Texas.* Austin, Texas: Texas Parks and Wildlife Department.

National Audubon Society 2021. The Christmas Bird Count Historical Results. Available at: http://www.christmasbirdcount.org. Accessed September 2021.

National Marine Fisheries Service and Federal Highway Administration (NMFS and FHWA). 2018. *Best Management Practices Manual For Transportation Activities in the Greater Atlantic Region*. Gloucester, Massachusetts, and Washington, D.C.

National Marine Fisheries Service and U.S. Fish and Wildlife Service (NMFS and USFWS). 2007. *Loggerhead Sea Turtle (*Caretta caretta*) 5-Year Review: Summary and Evaluation.*

———. 2008. *Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle (*Caretta caretta*).*

———. 2013a. *Hawksbill Sea Turtle (*Eretmochelys imbricata*) 5-Year Review: Summary and Evaluation.*

———. 2013b. *Leatherback Sea Turtle (*Dermochelys coriacea*) 5-Year Review: Summary and Evaluation.*

———. 2015. *Kemp's Ridley Sea Turtle (*Lepidochelys kempii*) 5-Year Review: Summary and Evaluation*.

National Park Service. 2021. Reptiles - Padre Island National Seashore (U.S. National Park Service) (nps.gov) Available at: https://www.nps.gov/pais/learn/nature/reptiles.htm. Accessed November 2021.

Natural Resources Conservation Service (NRCS). 2020. United States Department of Agriculture, Guide to Texture by Feel, modified from S.J. Thien, 1979. Available at: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/edu/?cid=nrcs142p2_054311. Accessed November 2021.

———. 2021. Web Soil Survey. Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Natural Resources Conservation Service. Available at: https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx. Accessed December 10, 2020.

Nicholls, J.L., and G.A. Baldassarre. 1990a. Habitat associations of piping plovers wintering in the United States. *Wilson Bulletin* 102(4):581–590.

———. 1990b. Winter Distribution of Piping Plovers Along the Atlantic and Gulf Coasts of the United States. *Wilson Bull* 102(4):581–590.

Oberholser, H.C. 1974. *The Bird Life of Texas.* Austin: University of Texas Press.

Pearse, A.T., F.A Brandt, W.C. Harrell, K.L. Metzger, D.M. Baasch, and T.J. Hefley. 2015. *Whooping Crane Stopover Site Use Intensity Within the Great Plains*. USGS Open-File Report 2015-1166. Reston. Virginia.

Plotkin, P.T., M.K. Wicksten, and A.F. Amos. 1993. Feeding ecology of the loggerhead sea turtle, *Caretta*, in the northwestern Gulf of Mexico. *Marine Biology* 115(1):1–15.

Ragsdale, B.J., and Welch, T.G., 2000. Descriptions of Range and Pasture Plants. Available at: https://oaktrust.library.tamu.edu/handle/1969.1/86922. Accessed February 2021.

Randklev, C.R. N.A. Johnson, T. Miller, J.M. Morton, J. Dudding, K. Skow, B. Boseman, M. Hart, E.T. Tsakiris, and R.R. Lopez. 2017. *Freshwater Mussels (Unionidae): Central and West Texas Final Report.* College Station: Texas A&M Institute of Renewable Natural Resources.

Rosen, D.J., D. De Steven, and M.L. Lange. 2008. Conservation strategies and vegetation characterization in the Columbia Bottomlands, an under-recognized southern floodplain forest formation. *Natural Areas Journal*, *28*(1):74–83.

Schmidly, D.J., and R.D. Bradley. 2016. *The Mammals of Texas*. Austin: University of Texas Press.

Stehn, T., and T. Wassenich. 2008. Whooping Crane Collisions with Power Lines: an issue paper. *Proceedings of the North American Crane Workshop* 10:25–36.

Sullivan, B.L., C.L. Wood, M.J. Iliff, R.E. Bonney, D. Fink, and S. Kelling. 2009. eBird: a citizen-based bird observation network in the biological sciences. *Biological Conservation* 142:2282–2292.

Stantec. 2022. *Freshwater Mussel Survey and Relocation Harris Reservoir Project*. Report submitted to Dow Chemical Company. May 2022. Austin, Texas: Cardo.

SWCA Environmental Consultants (SWCA). 2019a. *Wetland Delineation Report for the Dow Harris Reservoir Expansion Project in Brazoria County, Texas*. Report submitted to Dow Chemical Company. September 2019. Austin, Texas: SWCA Environmental Consultants.

———. 2019b. *Stream Condition Assessment Report for the Dow Harris Reservoir Expansion Project in Brazoria County, Texas*. Prepared for Dow Chemical Company. November 2019. Austin, Texas: SWCA Environmental Consultants.

———. 2021a. *Interim Hydrogeomorphic Functional Assessment Report for the Dow Harris Reservoir Expansion Project in Brazoria County, Texas*. Prepared for Dow Chemical Company. Austin, Texas: SWCA Environmental Consultants.

———. 2021b. *Oyster Creek Aquatic Assessment*. Report submitted to Dow Chemical Company. October 2021. Austin, Texas: SWCA Environmental Consultants.

———. 2022. *Compensatory Mitigation and Monitoring Plan*. Report submitted to Dow Chemical Company. March. Austin, Texas: SWCA Environmental Consultants.

Texas Demographic Center. 2021. *Texas Population Projections Program—Population Projections for the State of Texas and Counties by Migration Scenario for 2010-2050*. Available at: http://txsdc.utsa.edu/Data/TPEPP/Projections. Accessed November 2021.

Texas Department of Agriculture (TDA). 2019. TDA's List of Noxious and Invasive Plants. Rule §19.300(a) Subchapter T.

TexasInvasives. 2019. Invasive Plants Database. Available at: https://texasinvasives.org/plant_database/detail.php?symbol=TRSE6. Accessed December 2019.

Texas Legislative Council. 2016. *Definitions of "rural" in Texas Statutes and the Texas Administrative Code as of July 2016*. Research Report. Texas Legislative Council, Research Division. Austin, Texas. Available at: http://www.tlc.state.tx.us/docs/policy/Def_Rural_Statutes.pdf. Accessed November 2021.

Texas Marine Mammal Stranding Network. 2019. Facebook Updates. Available at: https://www.facebook.com/tmmsn.dolphin.rescue/photos/a.123761124329705/2522207677818359/. Accessed November 2021.

Texas Natural Diversity Database (TXNDD). 2021. Element Occurrence data export. Wildlife Diversity Program of Texas Parks and Wildlife Department. https://tpwd.texas.gov/huntwild/wild/wildlife_diversity/txndd/. Accessed November 2021.

Texas Parks and Wildlife Department (TPWD). 2011. *Texas Conservation Action Plan 2011: Status and Rank Key for use with SGCN and Rare Communities List*. Available at: https://tpwd.texas.gov/huntwild/wild/wildlife_diversity/nongame/tcap/documents/species_key_tcap_2011.pdf. Accessed November 15, 2019.

———. 2013. Texas Major River Basins, Coastal Basins and Major Bays. Available at: https://texasaquaticscience.org/watershed-aquatic-science-texas/. Accessed December 2019.

———. 2019. Columbia Bottomlands Forest and Woodlands. Available at: https://tpwd.texas.gov/landwater/land/programs/landscape-ecology/ems/emst/woody-wetlands-and-riparian/columbia-bottomlands-forest-and-woodland. Accessed November 2019.

———. 2021a. Rare, Threatened, and Endangered Species of Texas by County Database. Available at: https://tpwd.texas.gov/gis/rtest/. Accessed November 2021.

———. 2021b. *Species of Greatest Conservation Need*. Available at: https://tpwd.texas.gov/huntwild/wild/wildlife_diversity/nongame/tcap/sgcn.phtml. Accessed November 2021.

Texas Water Development Board (TWDB). 2021a. Texas Water Development Board. Water Data Interactive GIS Viewer. Online mapping tool. Available at: https://www3.twdb.texas.gov/apps/WaterDataInteractive/GroundWaterDataViewer. Accessed November 2021.

———. 2021b. Texas Aquifers - Major Aquifers Map. Available at: http://www.twdb.texas.gov/groundwater/aquifer/. Accessed November 2021.

———. 2021c. Brazos River Alluvium Aquifer. Interactive Map. Available at: http://www.twdb.texas.gov/groundwater/aquifer/. Accessed November 2021.

———. 2021d. Gulf Coast Aquifer. Interactive Map. Available at: http://www.twdb.texas.gov/groundwater/aquifer/. Accessed November 2021.

Turtle Expert Working Group. 2000. *Assessment Update for the Kemp's Ridley and Loggerhead Sea Turtle Populations in the Western North Atlantic*. National Oceanic and Atmospheric Administration Technical Memorandum NMFS-SEFSC 444(2000):115.

U.S. Army Corps of Engineers (USACE). 1963. U.S. Army Corps of Engineers. 1963. *Impact Type Energy Dissipators for Storm-Drainage Outfalls Stilling Well Design*. Technical Report No. 2-620 March, WES. Vicksburg, Mississippi.

———. 1987. *U.S. Army Corps of Engineers Wetlands Delineation Manual*. Technical Report Y-87-1. Vicksburg, Mississippi: U.S. Army Engineers Waterways Experiment Station Environmental Laboratory.

———. 2010. *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coastal Plain Region* (Version 2.0). ERDC/EL TR-10-20. Vicksburg, Mississippi: U.S. Army Engineer Research and Development Center.

———. 2017a. 2017 Nationwide Permit (NWP) Regional Conditions for the State of Texas. Available at: https://www.swg.usace.army.mil/Portals/26/docs/regulatory/2017NWP/2017%20NWP%20TX%20RC.pdf?ver=2017-03-28-104803-940. Accessed November 2019.

———. 2017b. Columbia Bottomland Hardwoods map. Available at: https://www.swg.usace.army.mil/Portals/26/docs/regulatory/2017NWP/CBH%20Map%20Book.pdf?ver=2017-03-28-133346-113. Accessed November 2019.

———. 2019. *Delineation Verification. Memorandum for Record. SWG-2016-01027; Dow Chemical Harris Reservoir Expansion Project*. Signed October 22, 2019.

U.S. Geological Survey. 2021. North American Breeding Bird Survey Dataset 1966-2019. U.S. Geological Survey, Patuxent Wildlife Research Center. Available at: www.pwrc.usgs.gov/BBS/RawData/. Accessed September 2021.

U.S. Fish and Wildlife Service (USFWS). 1977. *Final Correction and Augmentation of Critical Habitat Reorganization*. Washington, D.C.

———. 1978. *Determination of Critical Habitat for the Whooping Crane*. Washington, D.C.

———. 1989. *Hymenoxys texana* Recovery Plan. Albuquerque, New Mexico: U.S. Fish and Wildlife Service.

———. 1991. *Recovery Plan for U.S. Population of Atlantic Green Turtle (*Chelonia mydas*)*. Southeast Region. Atlanta, Georgia.

———. 2009. *Whooping Cranes and Wind Development – An Issue Paper*. U.S. Fish and Wildlife Service, Regions 2 and 6. Available at: https://www.fws.gov/southwest/es/oklahoma/documents/te_species/wind%20power/whooping%20crane%20and%20wind%20development%20fws%20issue%20paper%20-%20final%20%20april%202009.pdf. Accessed February 2020.

———. 2012. *Whooping Crane 5-Year Review: Summary and Evaluation.* Aransas National Wildlife Refuge, Austwell, Texas and Corpus Christi Ecological Services Field Office, Corpus Christi, Texas.

———. 2015. Texas prairie dawn-flower (*Hymenoxys texana*) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Houston, Texas.

———. 2016. *Section 7 Consultations—Will the Austin Office concur with "no effect" determinations?* Available at: https://www.fws.gov/southwest/es/AustinTexas/ESA_Consultations.html#No_effect. Accessed October 3, 2019.

———. 2019a. *Species Status Assessment Report for the Eastern Black Rail (Laterallus jamaicensis jamaicensis)*. Version 1.3. August 2019. Atlanta, Georgia.

———. 2019b. *Species status assessment report for the Central Texas Mussels*, Version 1.5. December 2019. Albuquerque, New Mexico.

———. 2020a. Whooping crane migration corridor and confirmed United States sightings through spring 2020. GIS shapefile dataset provided via e-mail to SWCA Environmental Consultants by the U.S. Fish and Wildlife Service, Grand Island, Nebraska.

———. 2020b. *Biological Opinion for the Dallas to Houston High-Speed Rail; Dallas, Ellis, Navarro, Freestone, Limestone, Leon, Madison, Grimes, Waller, and Harris Counties, Texas.* Consultation 02ETTX00-2019-F-2135. Clear Lake, Texas.

———.2020c. Whooping Crane Survey Results: Winter 2019-2020. Aransas National Wildlife Refuge, Austwell, Texas. Available at: https://www.fws.gov/nwrs/threecolumn.aspx?id=6442464082. Accessed December 2021.

———. 2021a. National Wetlands Inventory. U.S. Department of the Interior, U.S. Fish and Wildlife Service. Available at: https://www.fws.gov/wetlands/data/Mapper.html. Accessed November 2021.

———. 2021b. Information for Planning and Conservation Endangered and Threatened Wildlife and plants (IPaC). Available at: https://ecos.fws.gov/ipac/. Accessed November 2021.

———. 2021c. Critical Habitat for Threatened & Endangered Species [USFWS] – Updated August 2021. Online Mapper Available at: https://fws.maps.arcgis.com/home/webmap/viewer.html?webmap=9d8de5e265ad4fe09893cf75b8dbfb77. Accessed September 2021.

———. 2021d. *National Domestic Listing Workplan: Fiscal Years 21-25 5-Year Workplan (January 2021 Version)*. Available at: https://www.fws.gov/endangered/esa-library/pdf/National-Listing-Workplan-FY21-FY25.pdf. Accessed November 2021.

———. 2021e. *Steps that project proponents should take to determine if a project proponent's action area includes suitable eastern black rail habitat*. Houston, Texas: Texas Coastal Ecological Services Field Office.

U.S. Fish and Wildlife Service and National Marine Fisheries Service (USFWS and NMFS). 1998. *Endangered Species Consultation Handbook: Procedures for Conducting Consultation and Conference Activities under Section 7 of the Endangered Species Act—March 1999 FINAL*.

Urbanek, R.P., and J.C. Lewis. 2015. Whooping Crane (*Grus americana*). In *The Birds of North America*, edited by A.F. Poole and F.B. Gill. Ithaca: Cornell Lab of Ornithology. Available at: https://birdsna.org/Species-Account/bna/species/whocra/introduction. Accessed March 4, 2020.

Watearth 2021a. *Oyster Creek Downstream Hydrologic and Hydraulic Impacts Final Report. DCC Harris Reservoir Expansion EIS*. September 2021.

———. 2021b. *Hydrology and Hydraulics Report DCC Harris Reservoir Expansion EIS*. September 2021.

Weather Spark. 2020. Average Weather in Brazoria Texas, United States. Available at: https://weatherspark.com/y/9220/Average-Weather-in-Brazoria-Texas-United-States-Year-Round#Sections-Precipitation. Accessed December 2020.

Witzell, W.N. 1983. Synopsis of biological data on the hawksbill turtle *Eretmochelys imbricate* (Linnaeus, 1766). *FAO Fisheries Synopsis* No. 137.

Yang, L., S. Jin, P. Danielson, C. Homer, L. Gass, S.M. Bender, A. Case, C. Costello, J. Dewitz, J. Fry, M. Funk, B. Granneman, G.C. Liknes, M. Rigge, and G. Xian. 2018. A new generation of the United States National Land Cover Database: Requirements, research priorities, design, and implementation strategies. *ISPRS Journal of Photogrammetry and Remote Sensing* 146:108–123.

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