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

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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:

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

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

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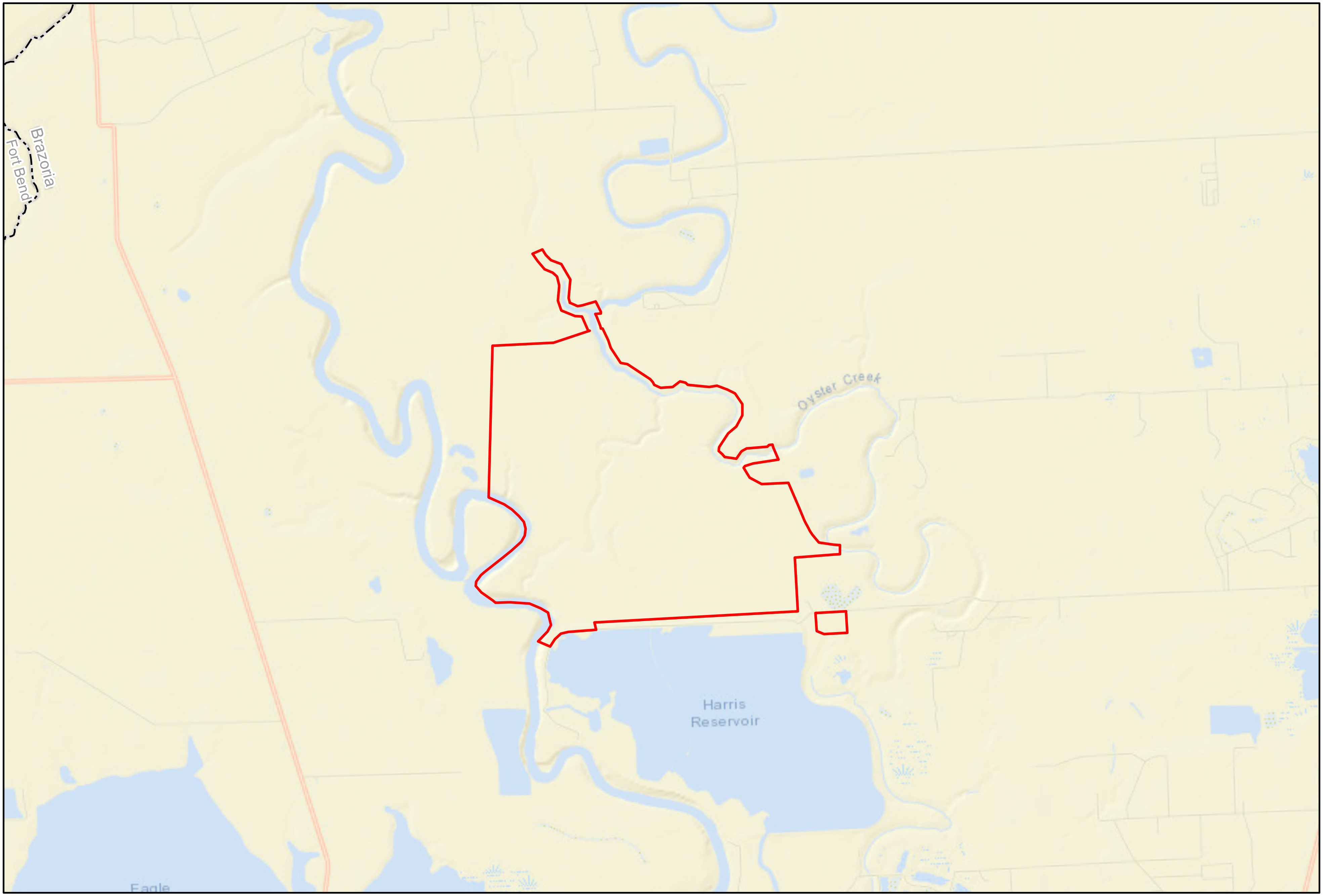
APPENDIX A

Maps



SWCA® ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

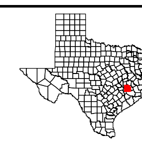
VICINITY MAP

BRAZORIA COUNTY, TEXAS

FIGURE 1

Project Boundary

County Boundary



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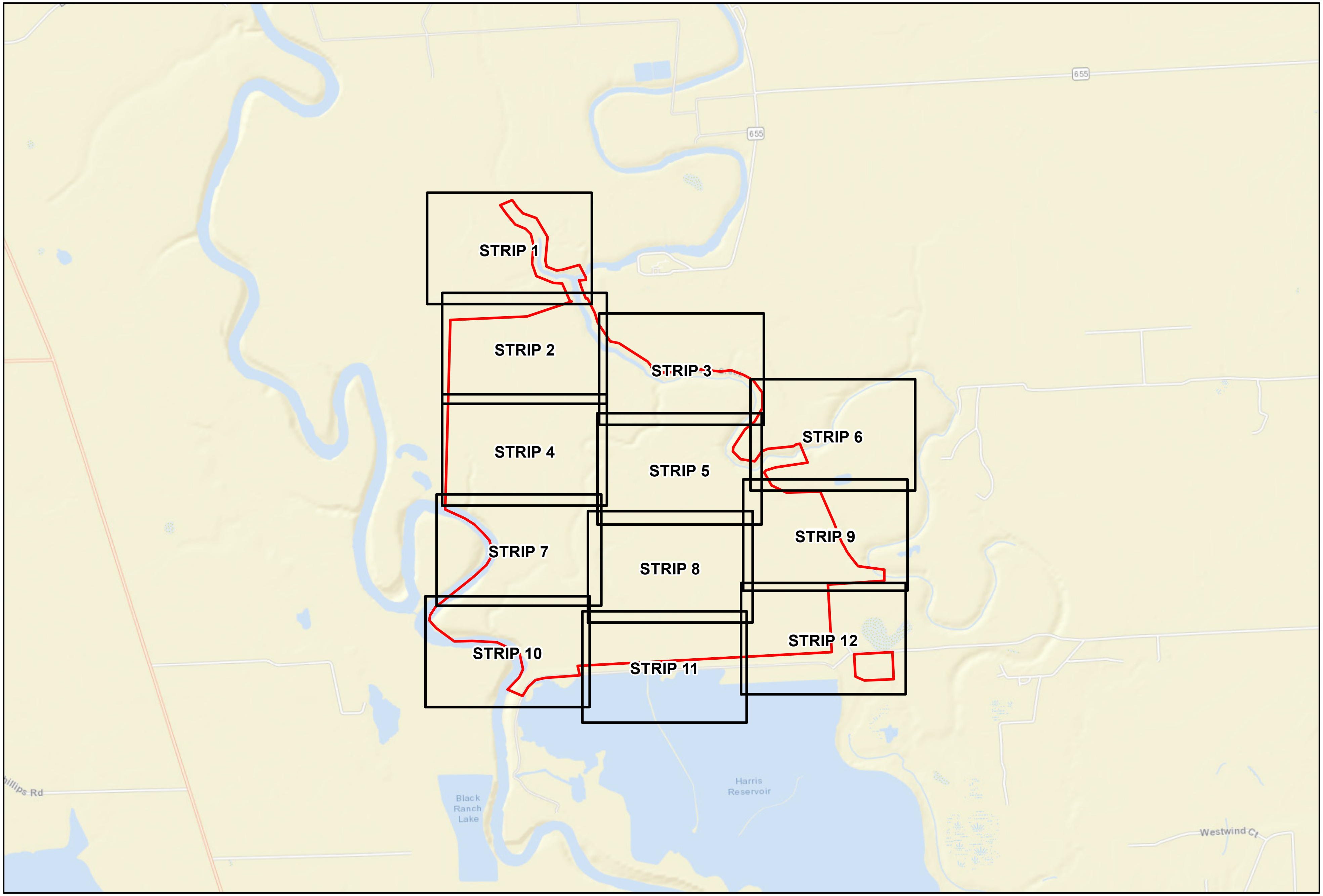

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DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

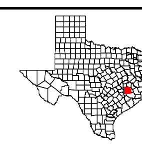
INDEX MAP

BRAZORIA COUNTY, TEXAS

FIGURE 2

Project Boundary

Mapbook Index



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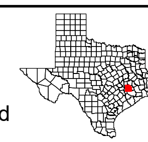
DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

LEVEL I STREAM ASSESSMENT MAP

BRAZORIA COUNTY, TEXAS

SHEET 1 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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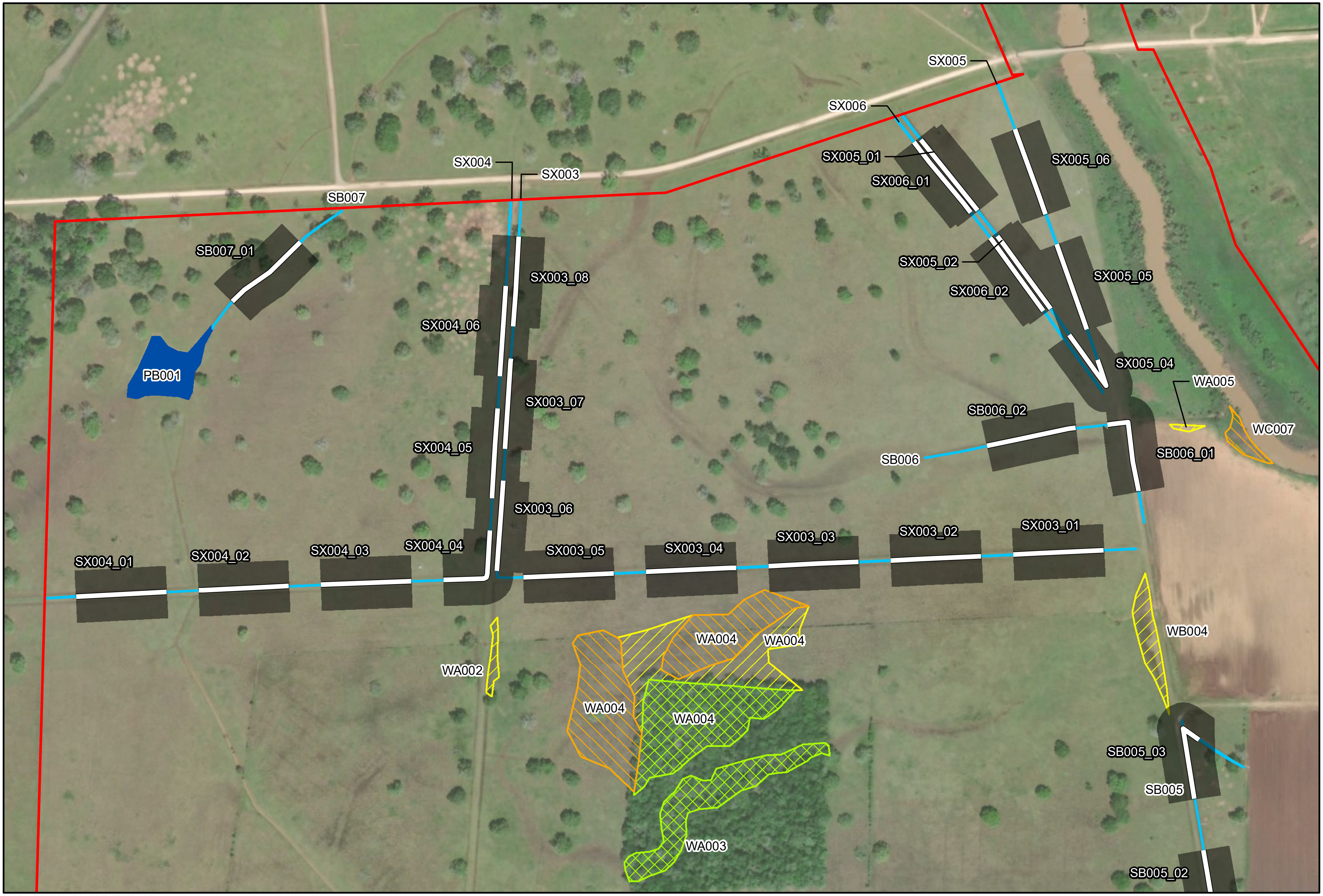

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DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

LEVEL I STREAM ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 2 OF 12 FIGURE 3

Project Boundary
Stream Transect
Stream Assessment Survey
Ephemeral Waterbody
Intermittent Waterbody
Perennial Waterbody
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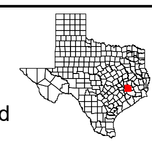
DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

LEVEL I STREAM ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 3 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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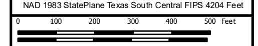

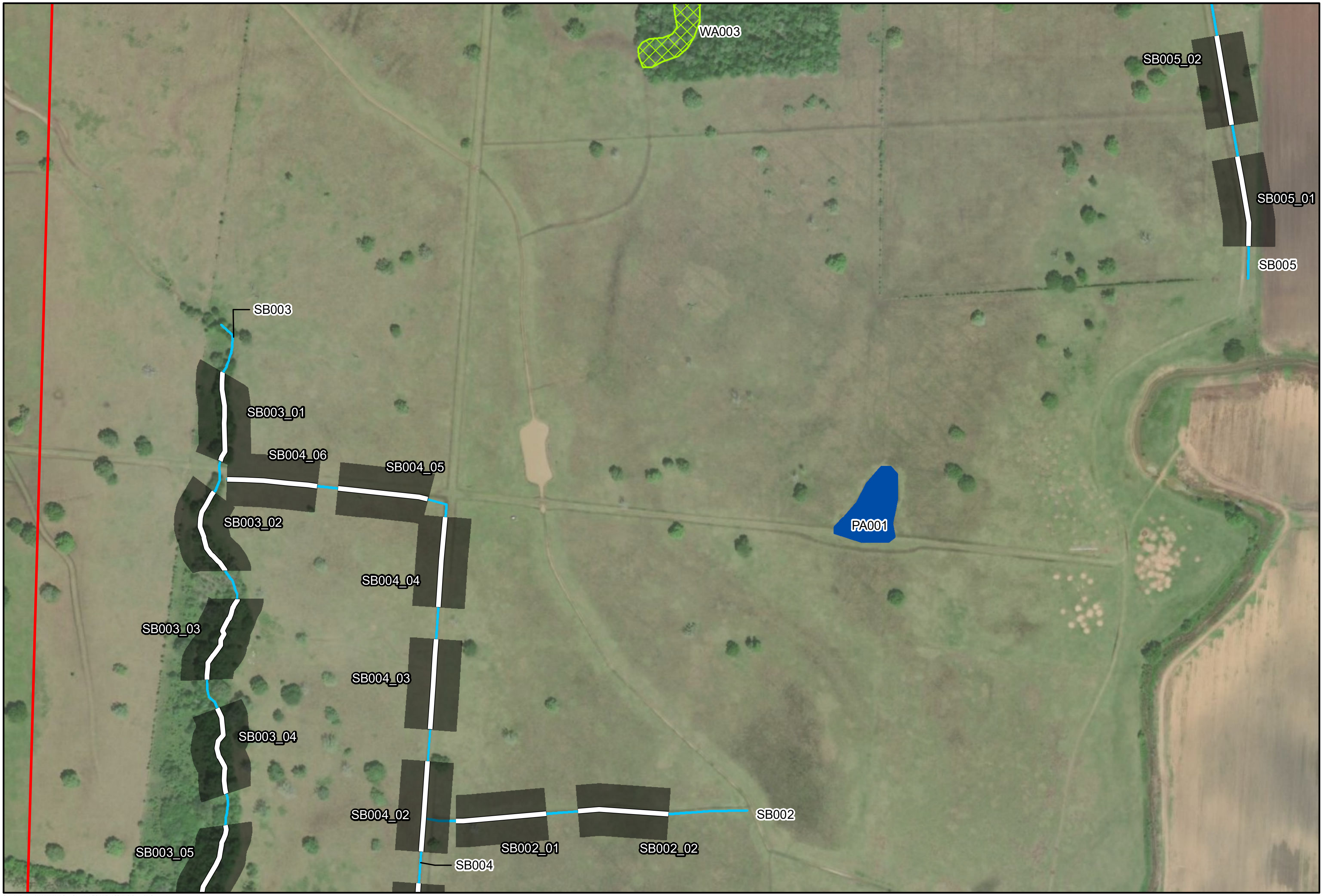

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DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

LEVEL I STREAM ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 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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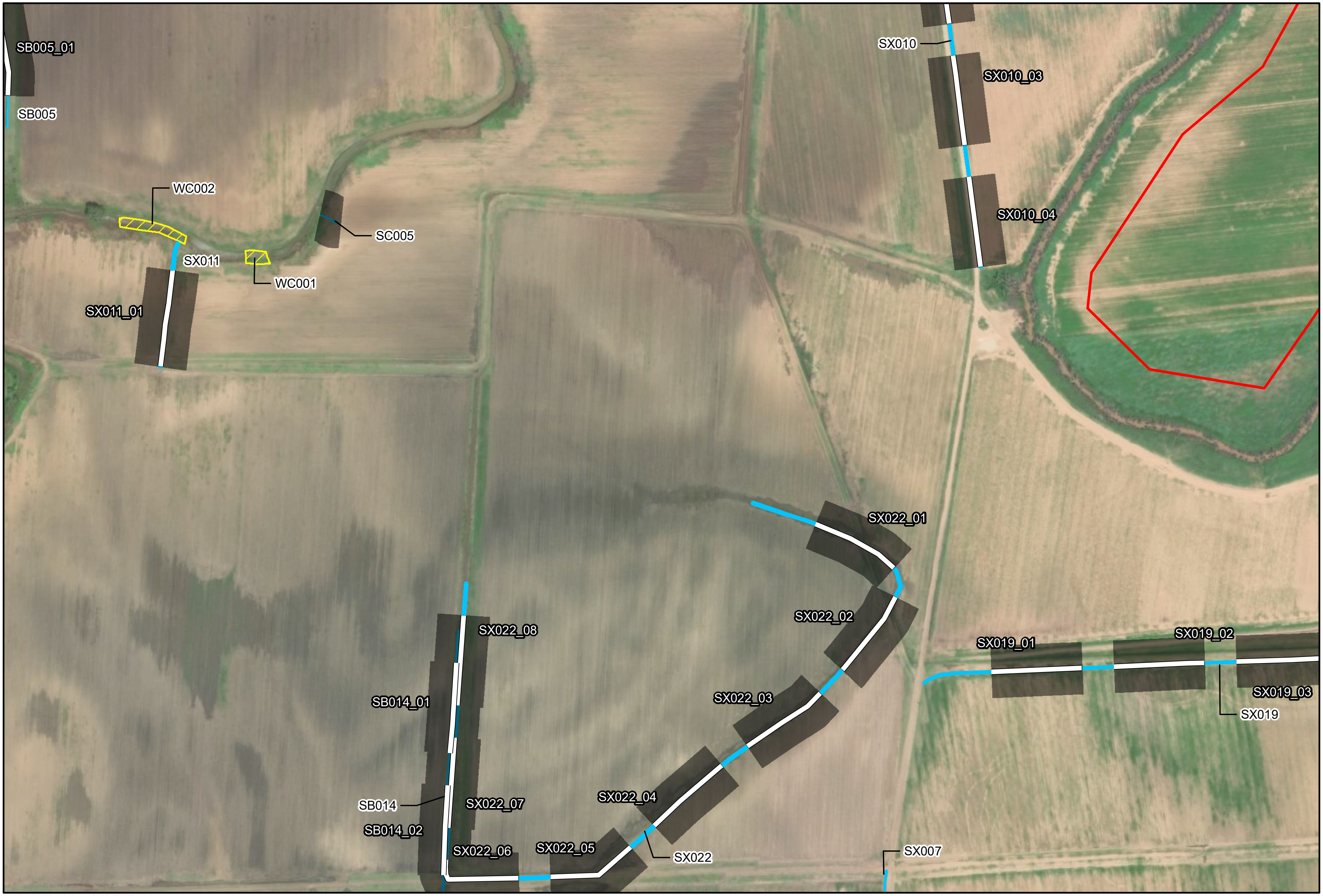

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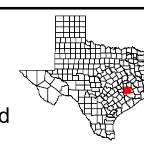
DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

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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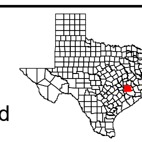
DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

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



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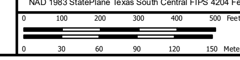

DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

LEVEL I STREAM ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 7 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
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DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

LEVEL I STREAM ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 8 OF 12

FIGURE 3

- Project Boundary
- Stream Transect
- Stream Assessment Survey
- Ephemeral Waterbody
- Intermittent Waterbody
- Perennial Waterbody
- Emergent Wetland
- Forested Wetland
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Project Number: 52872.10
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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

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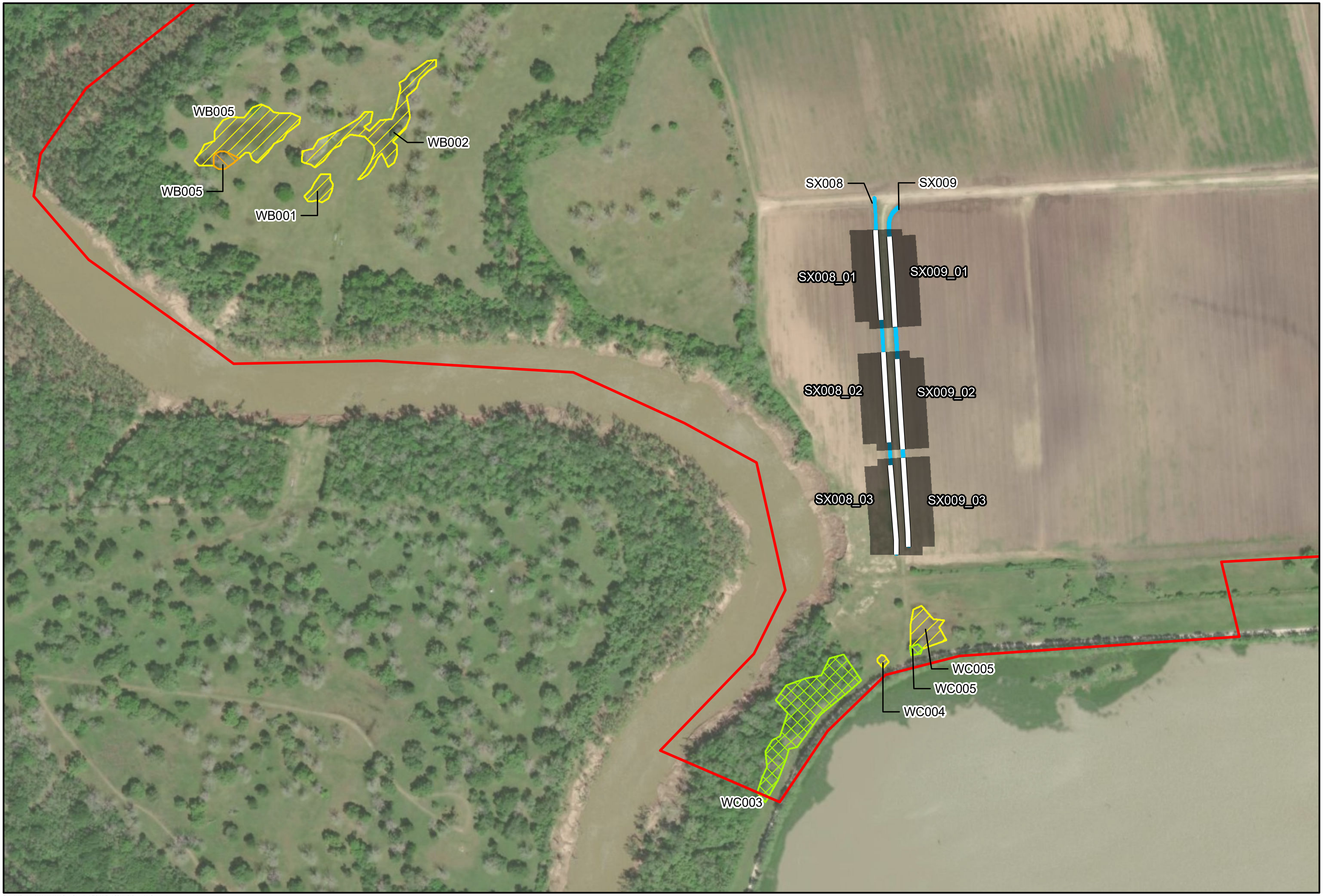

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DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

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
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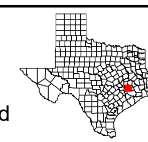

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DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

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
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DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

LEVEL I STREAM ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 12 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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SWCA ENVIRONMENTAL CONSULTANTS

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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DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

LEVEL II STREAM ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 2 OF 12 FIGURE 4

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

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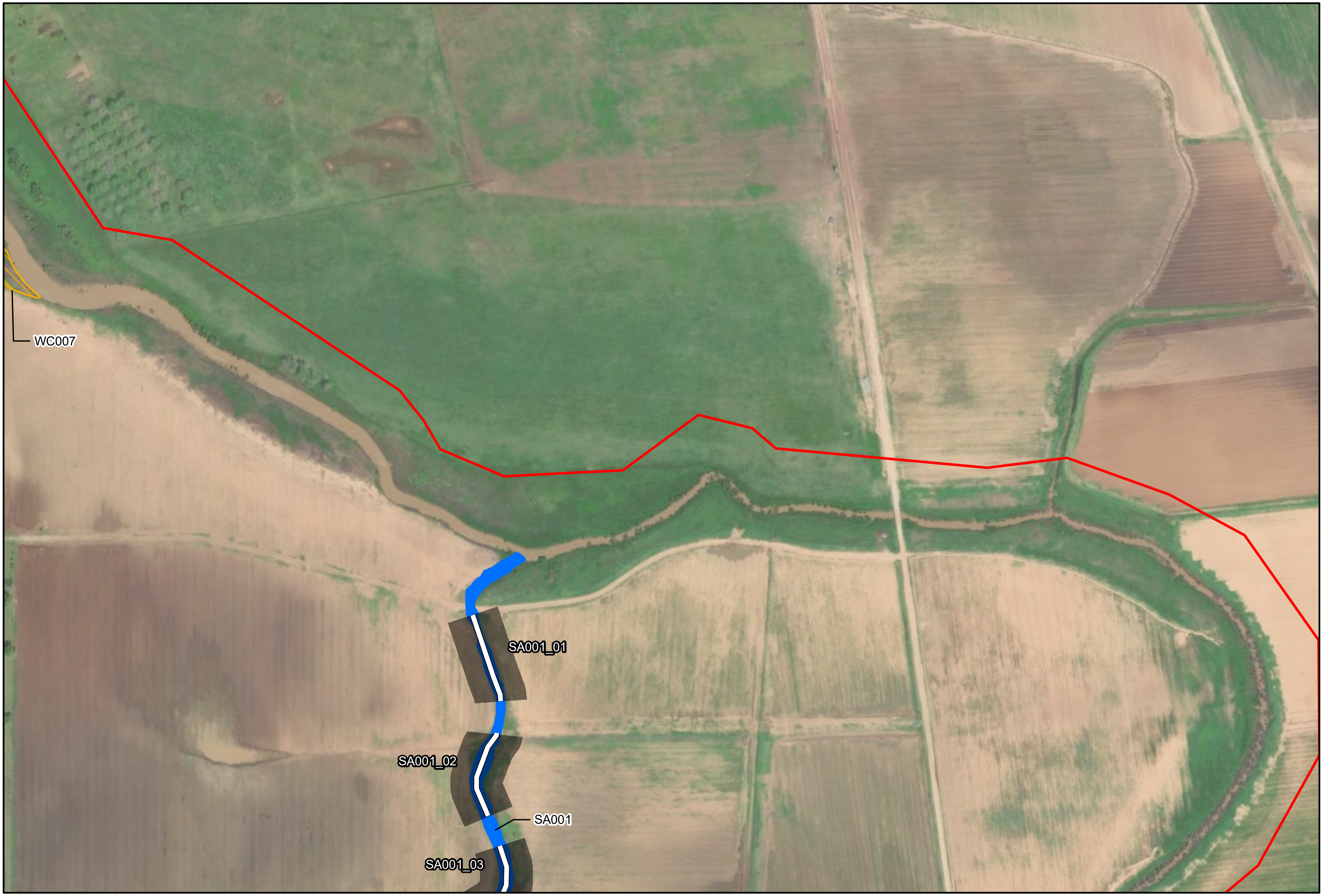

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DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

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
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Project Number: 52872.10
Date: 11/12/2019
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DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

LEVEL II STREAM ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

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FIGURE 4

- Project Boundary
- Stream Transect
- Stream Assessment Survey
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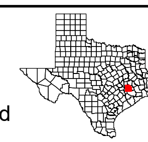

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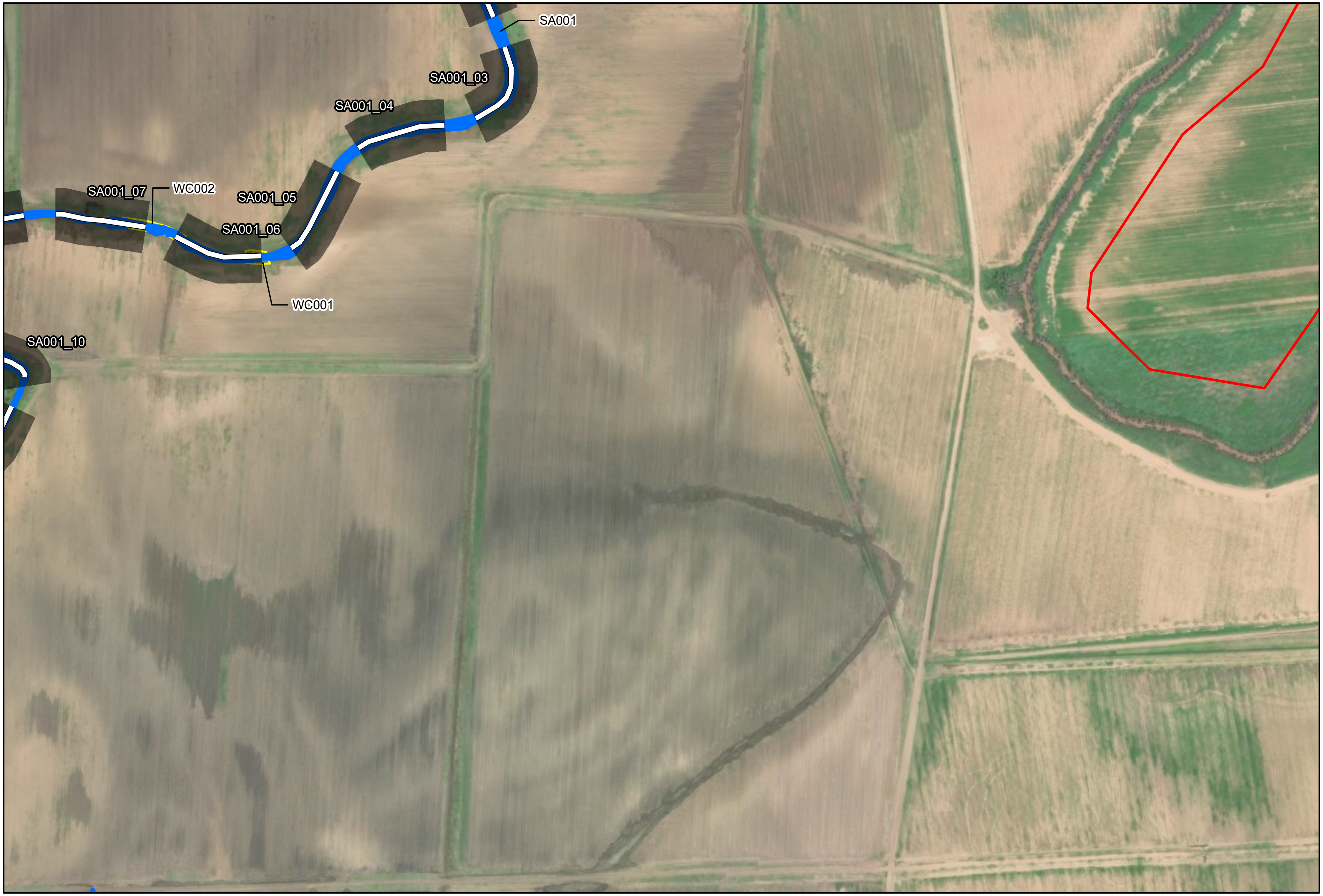

DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

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
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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
Stream Transect
Stream Assessment Survey
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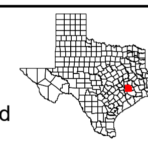

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DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

LEVEL II STREAM ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 7 OF 12 FIGURE 4

- Project Boundary
- Stream Transect
- Stream Assessment Survey
- Ephemeral Waterbody
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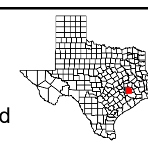

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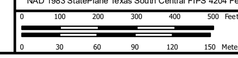

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DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

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
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ENVIRONMENTAL CONSULTANTS

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
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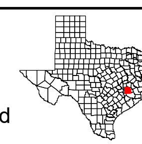

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SWCA
ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

LEVEL II STREAM ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 10 OF 12

FIGURE 4

Project Boundary
Stream Transect
Stream Assessment Survey
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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
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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
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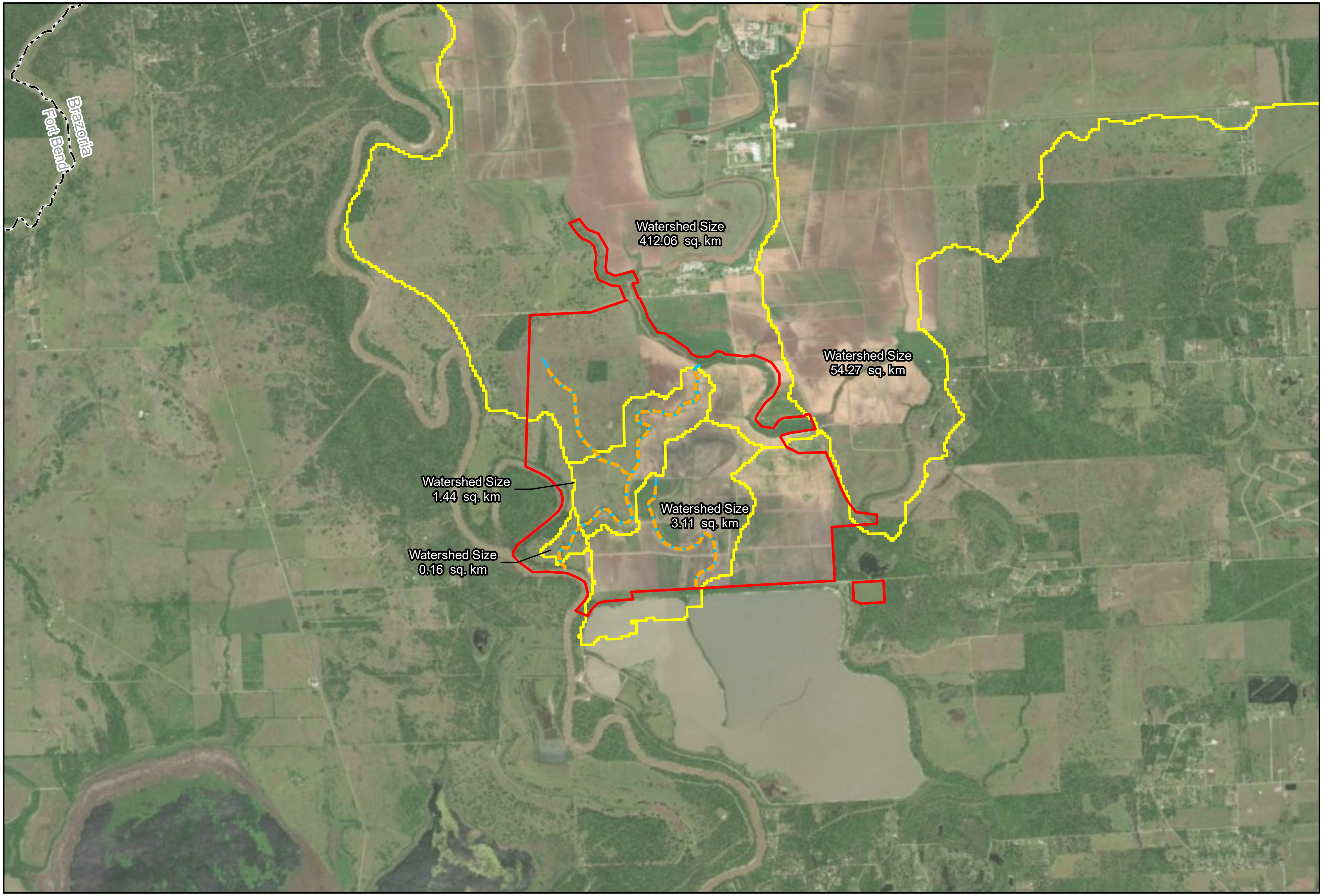
0 30 60 90 120 150 Meters

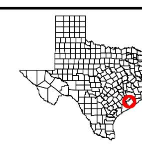


SWCA ENVIRONMENTAL CONSULTANTS

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



1:60,000

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

0 1,000 2,000 3,000 4,000 Feet
0 300 600 900 1,200 Meters

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

Transec t	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 5	Scoring Criteria 3	Scoring Criteria 1	1 Value	1 Score	2 Value	2 Score	3 Value	3 Score	4 Value	4 Score	5 Value	5 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 5	Scoring Criteria 3	Scoring Criteria 1	6 Value	6 Score	7 Value	7 Score	8 Value	8 Score	9 Value	9 Score	10 Value	10 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

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USACE File No. SWG-2016-01027

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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

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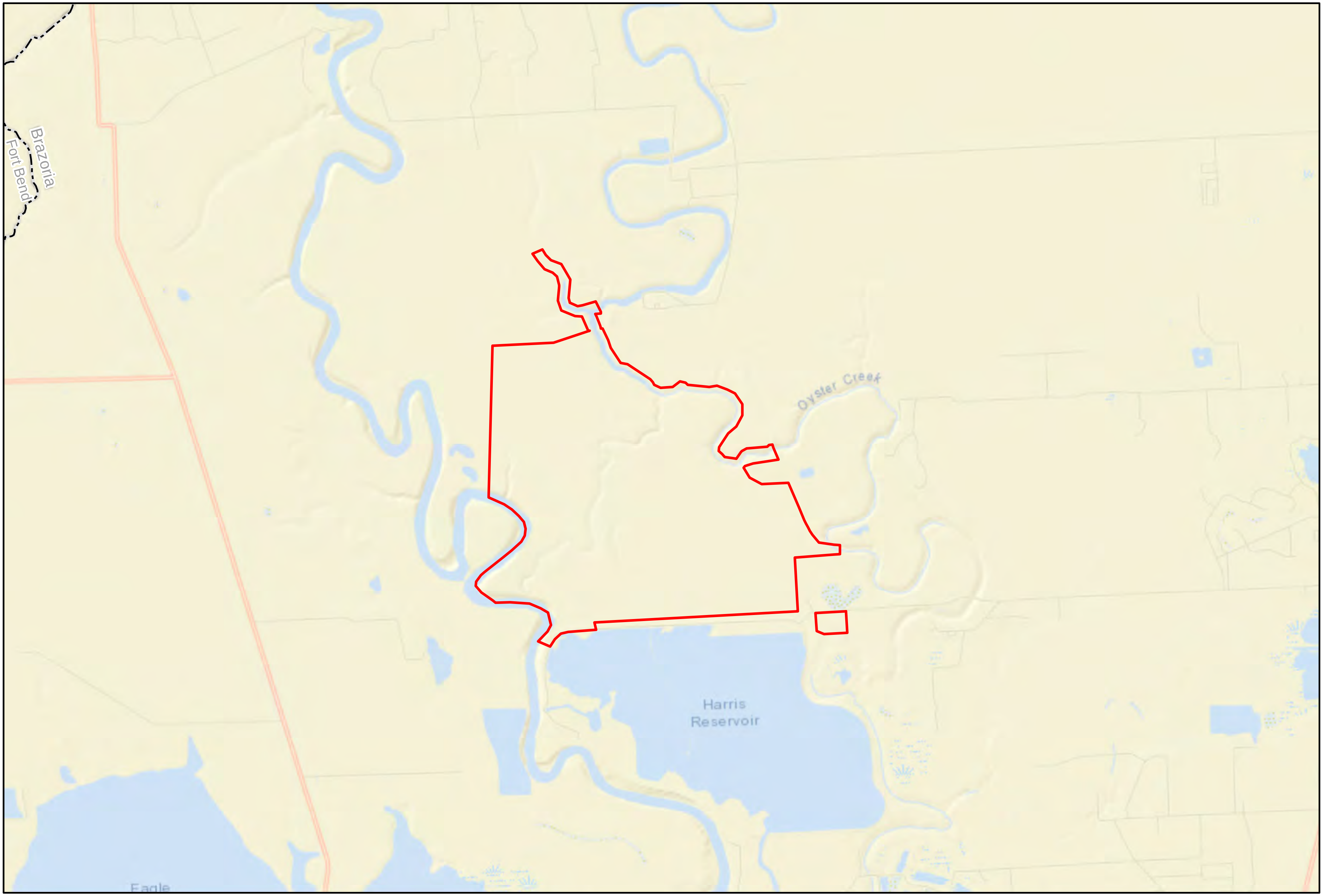
APPENDIX A

Vicinity and Wetland Assessment Maps



SWCA® ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

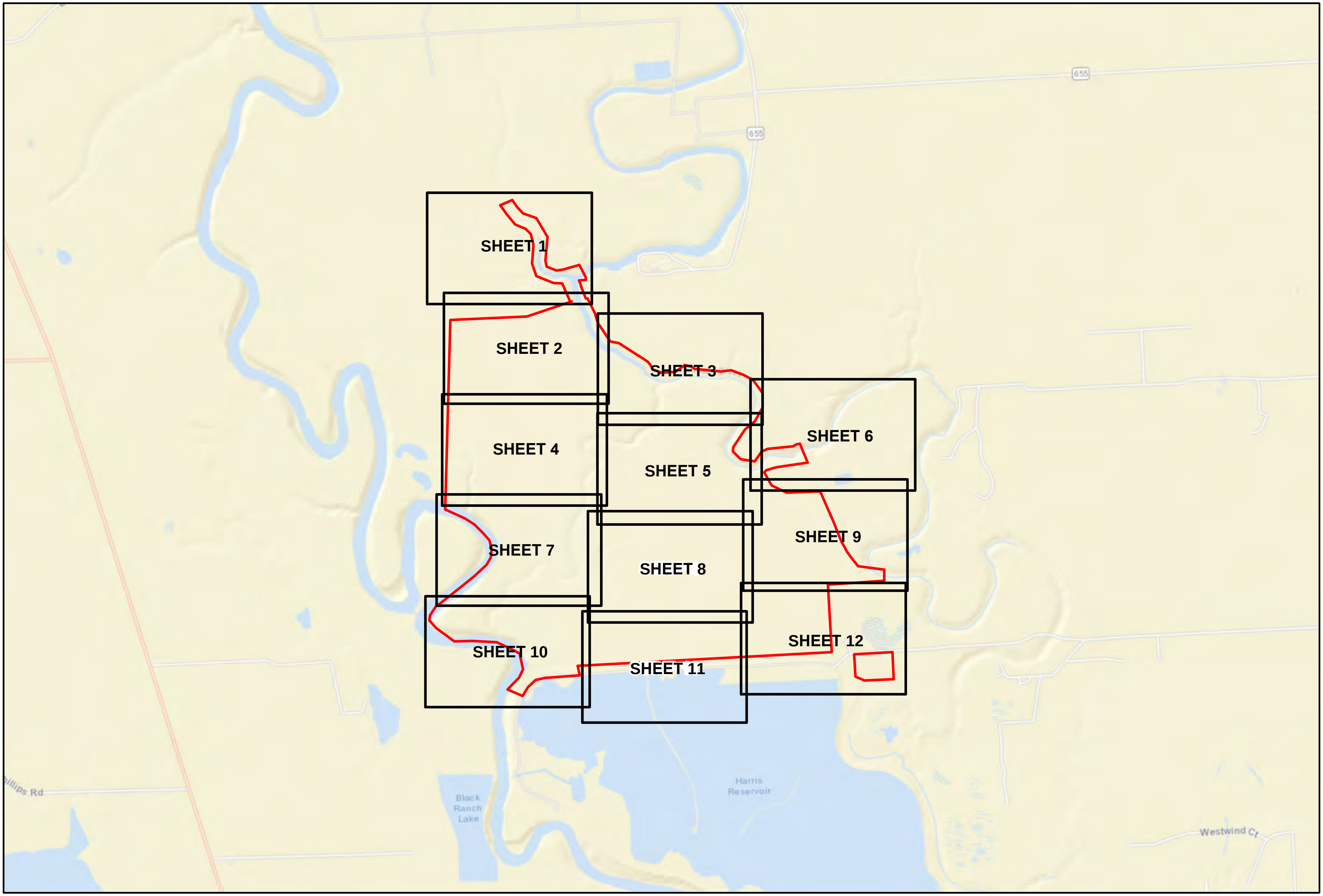
VICINITY MAP
BRAZORIA COUNTY, TEXAS
FIGURE 1

Project Boundary
County Boundary

1:60,000

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

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

Project Boundary
Mapbook Index

1:48,000

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

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

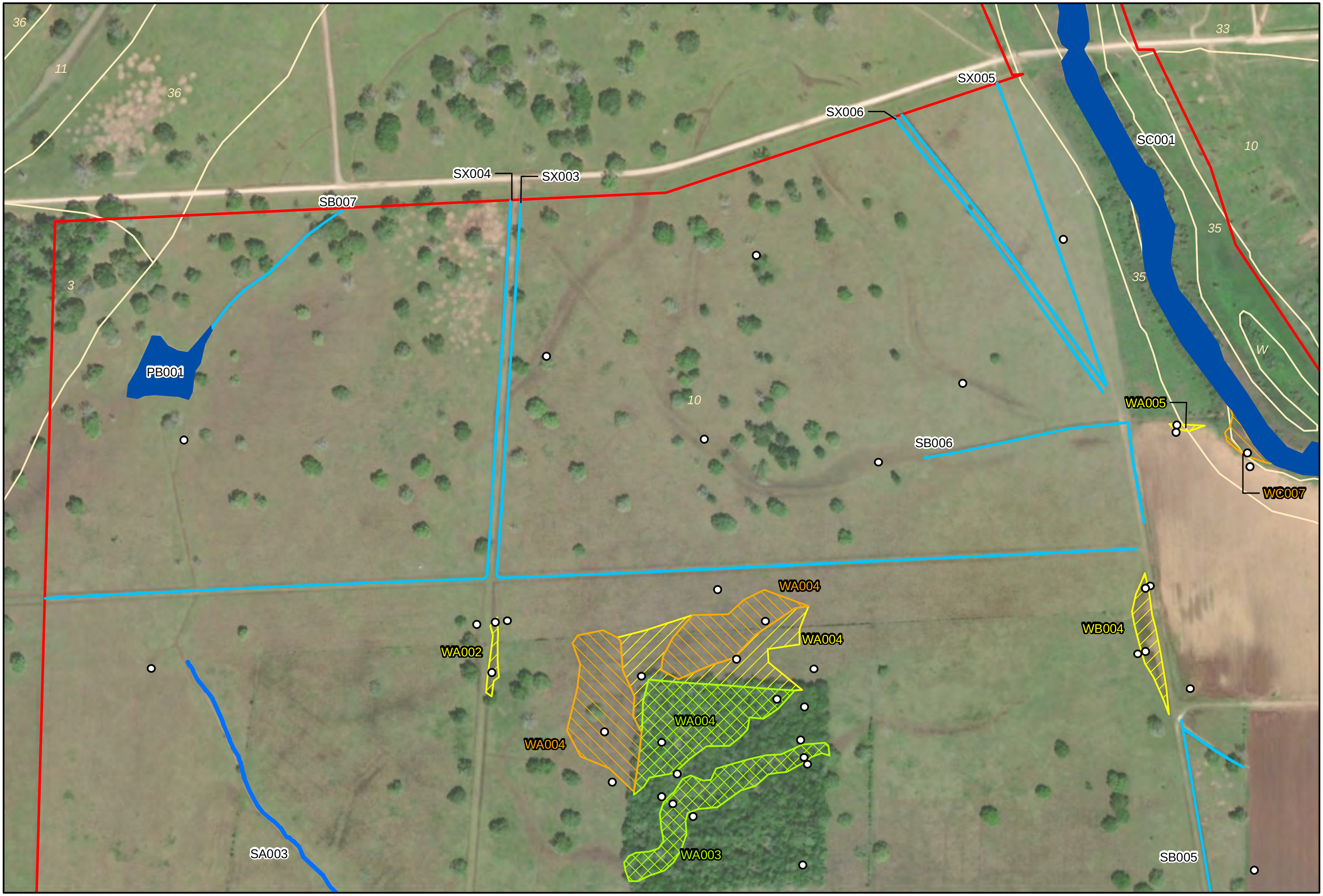
SWCA ENVIRONMENTAL CONSULTANTS

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 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

1:6,000

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

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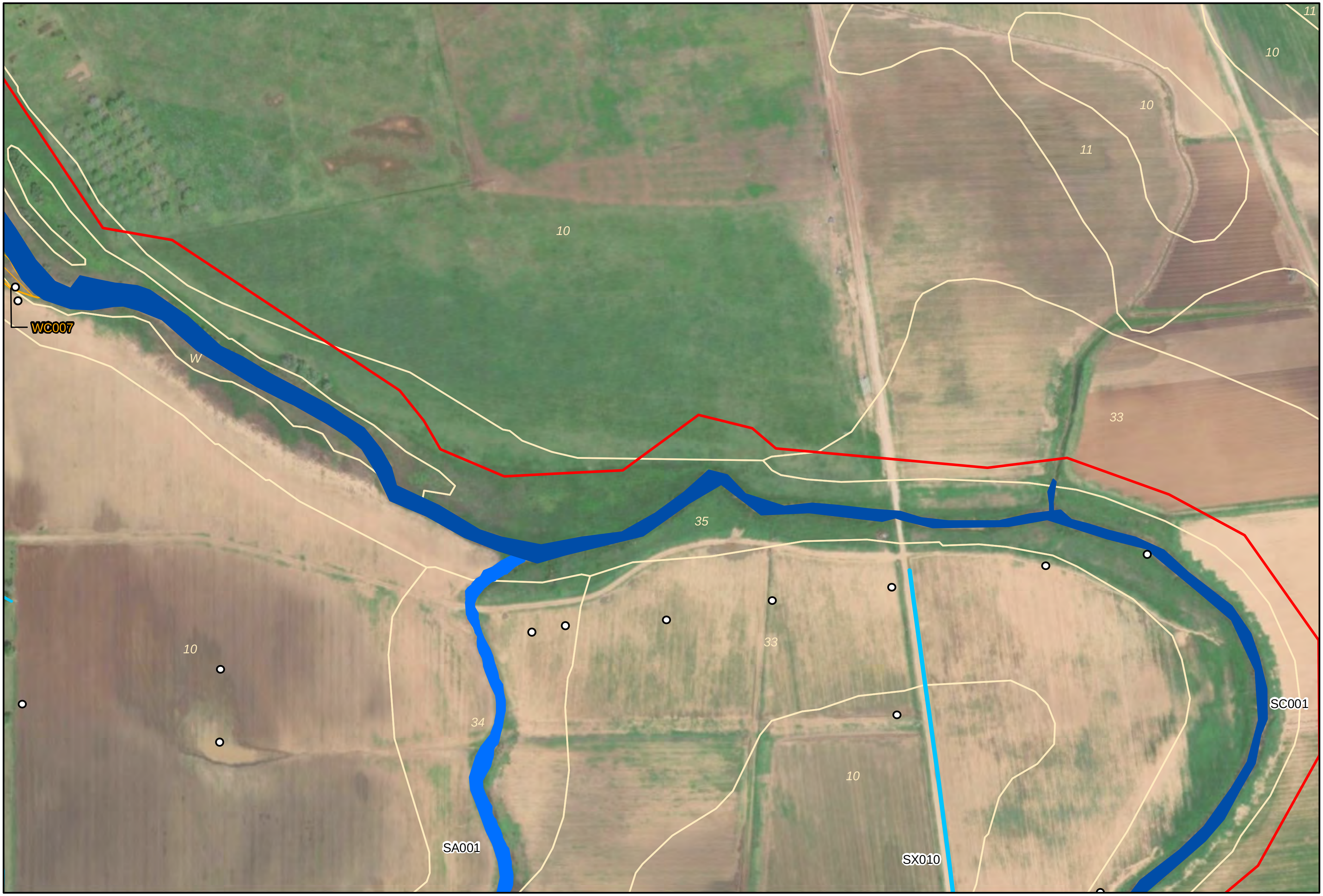
0 30 60 90 120 150 Meters



SWCA® ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

WETLAND ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 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

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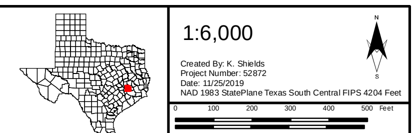
0 100 200 300 400 500 Feet
0 30 60 90 120 150 Meters



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

DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

WETLAND ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 5 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 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

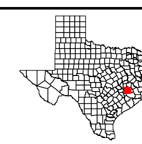
0 30 60 90 120 150 Meters

DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

WETLAND ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 7 OF 12 FIGURE 3

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
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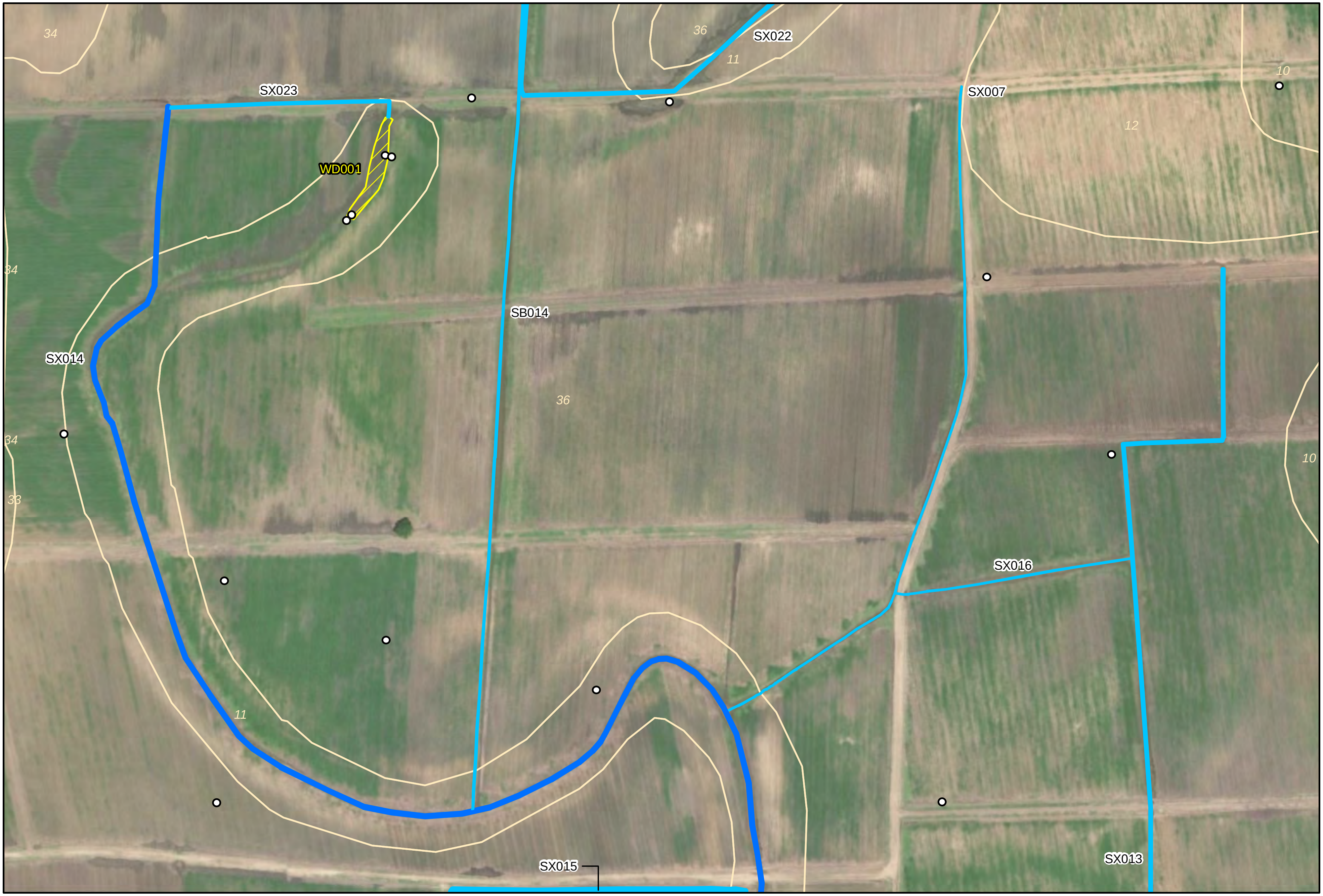
0 30 60 90 120 150 Meters



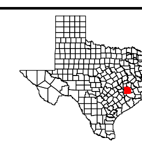
SWCA ENVIRONMENTAL CONSULTANTS

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



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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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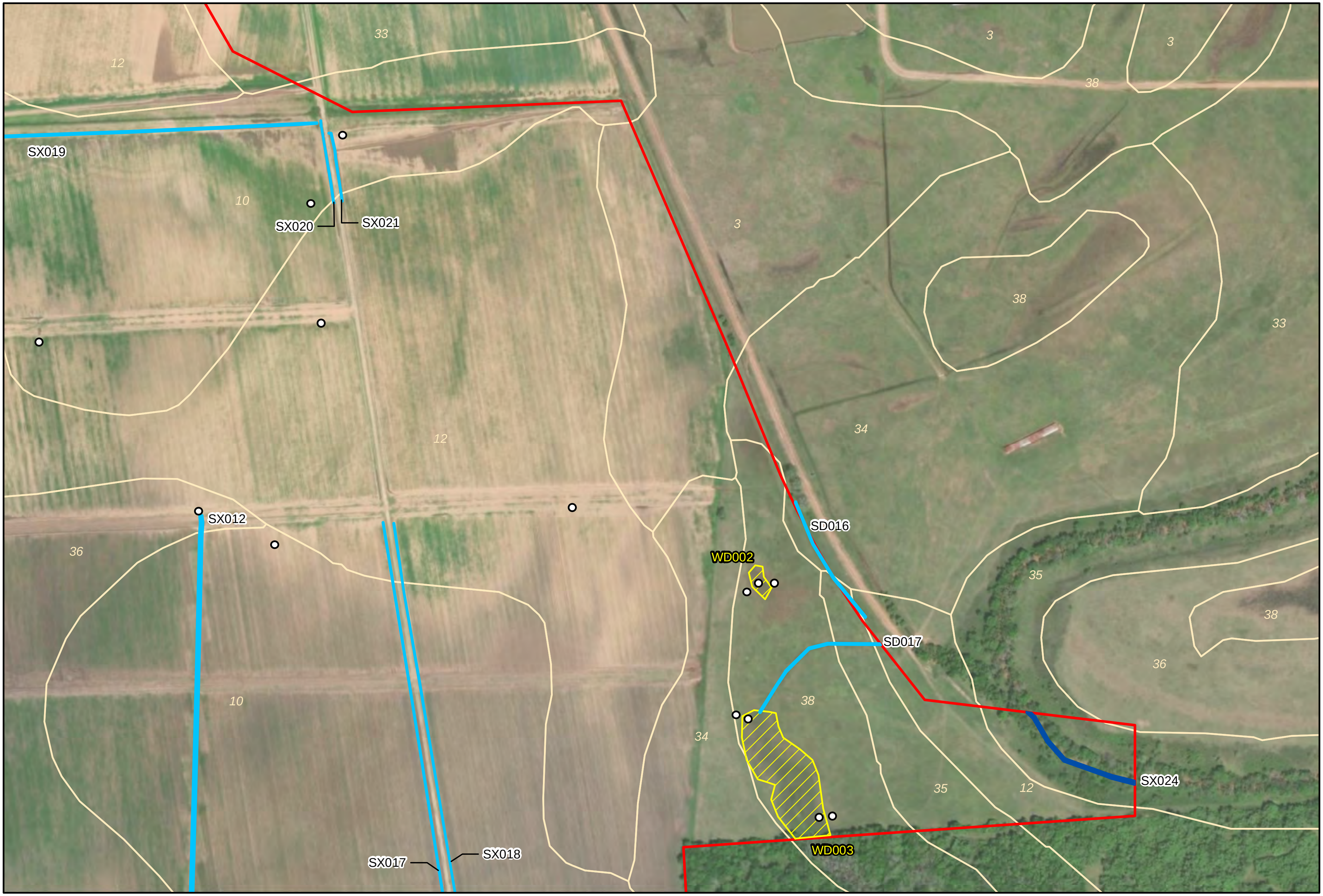
0 30 60 90 120 150 Meters



SWCA ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

WETLAND ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 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

SWCA ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

WETLAND ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 10 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

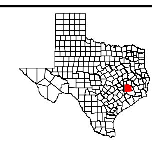
WETLAND ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

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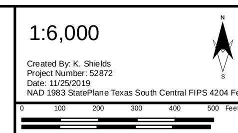
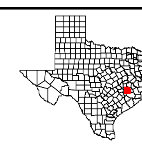
Created By: K. Shields
Project Number: 52872
Date: 11/25/2019
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet





DOW CHEMICAL HARRIS RESERVOIR EXPANSION PROJECT

WETLAND ASSESSMENT MAP
BRAZORIA COUNTY, TEXAS

SHEET 12 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

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)

	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

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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., postprocess) 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.

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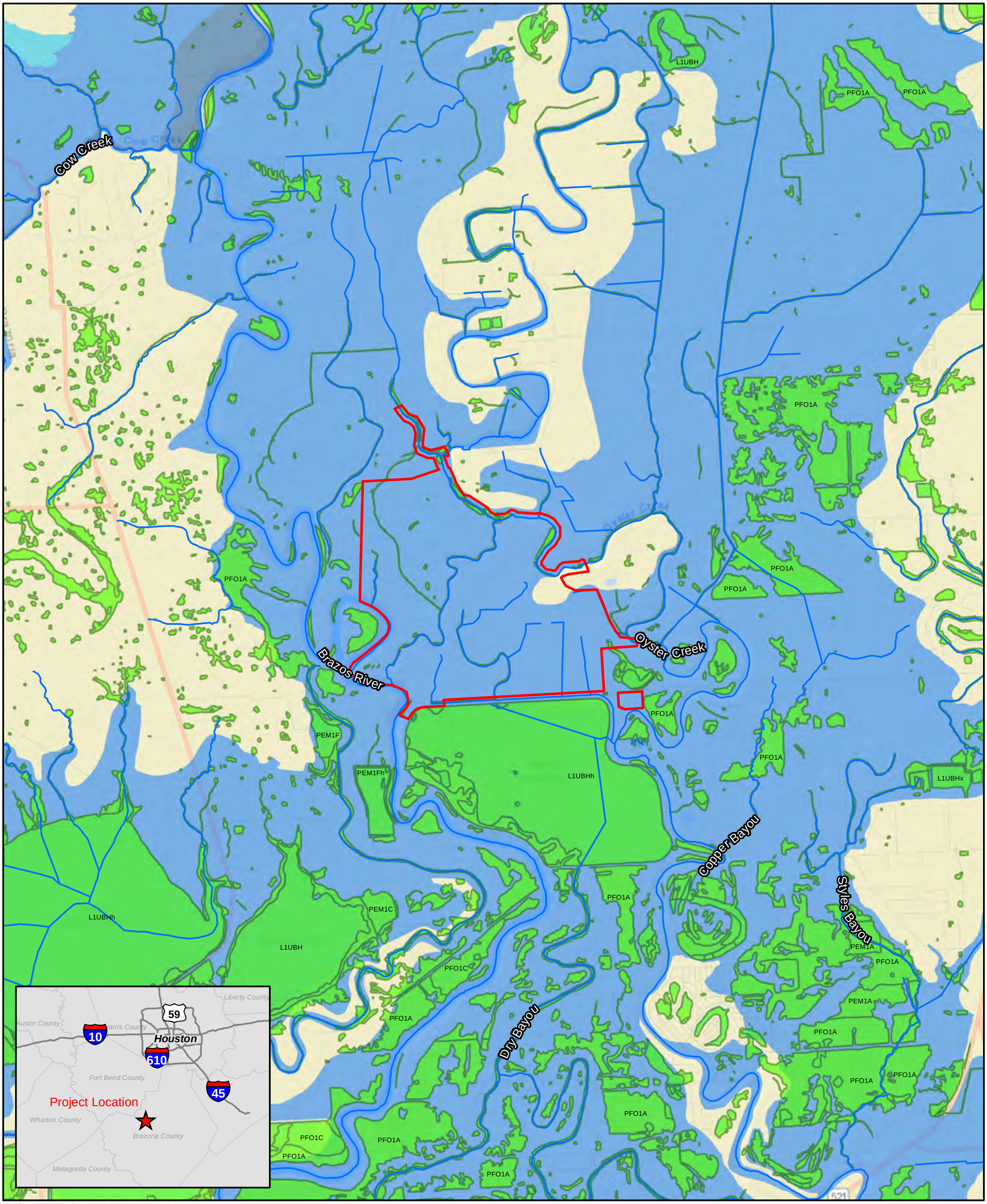
APPENDIX A

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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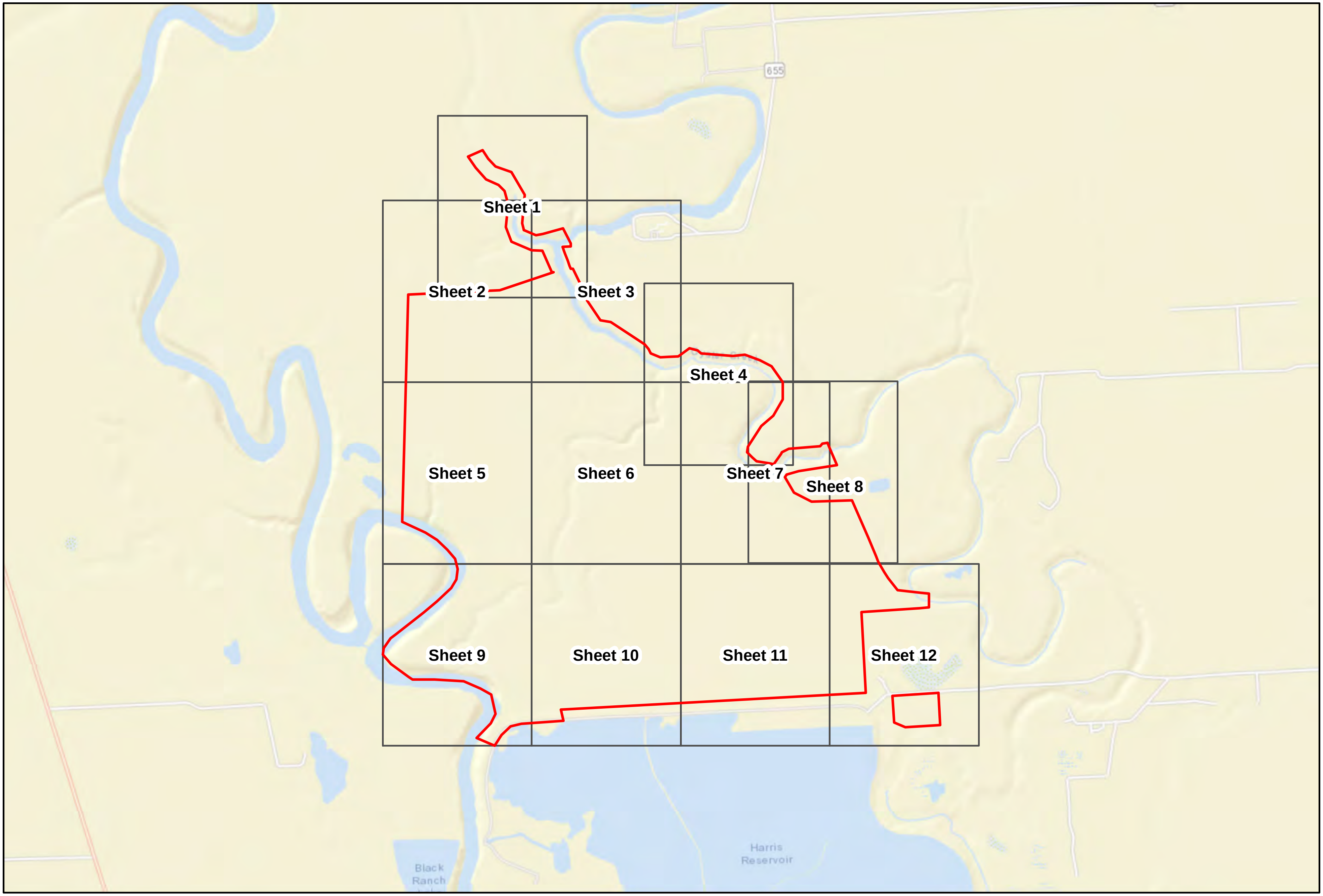


SWCA ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESEVOIR EXPANSION PROJECT

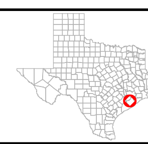
INDEX MAP

USACE GALVESTON DISTRICT

Figure 2

Project Boundary

Mapbook Index



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Created By: C. McConnell

Project Number: 52872

Date: 7/30/2019

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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

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Created By: CM
Project Number: 52872
Date: 7/30/2019
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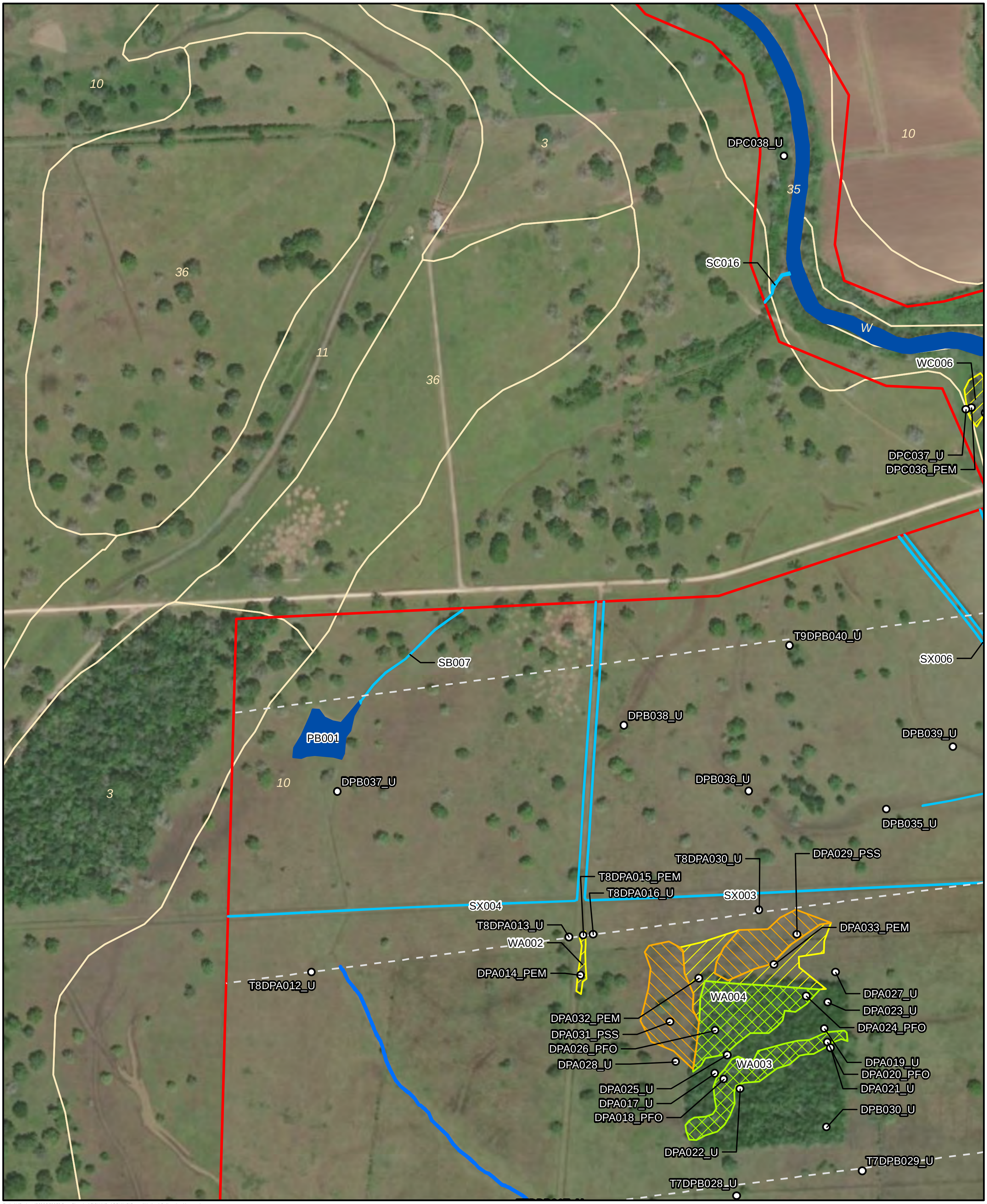
0 30 60 90 120 150 Meters



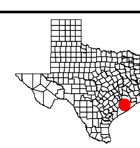
SWCA
ENVIRONMENTAL CONSULTANTS

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



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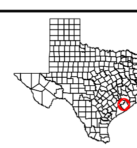
SWCA ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESEVOIR EXPANSION PROJECT

WETLAND DELINEATION MAP
BRAZORIA COUNTY, TEXAS

FIGURE 3 - SHEET 3 of 12

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



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Date: 7/30/2019
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0 150 300 450 600 Feet
0 30 60 90 120 150 Meters

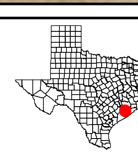
SWCA ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESEVOIR EXPANSION PROJECT

WETLAND DELINEATION MAP
BRAZORIA COUNTY, TEXAS

FIGURE 3 - SHEET 4 of 12

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



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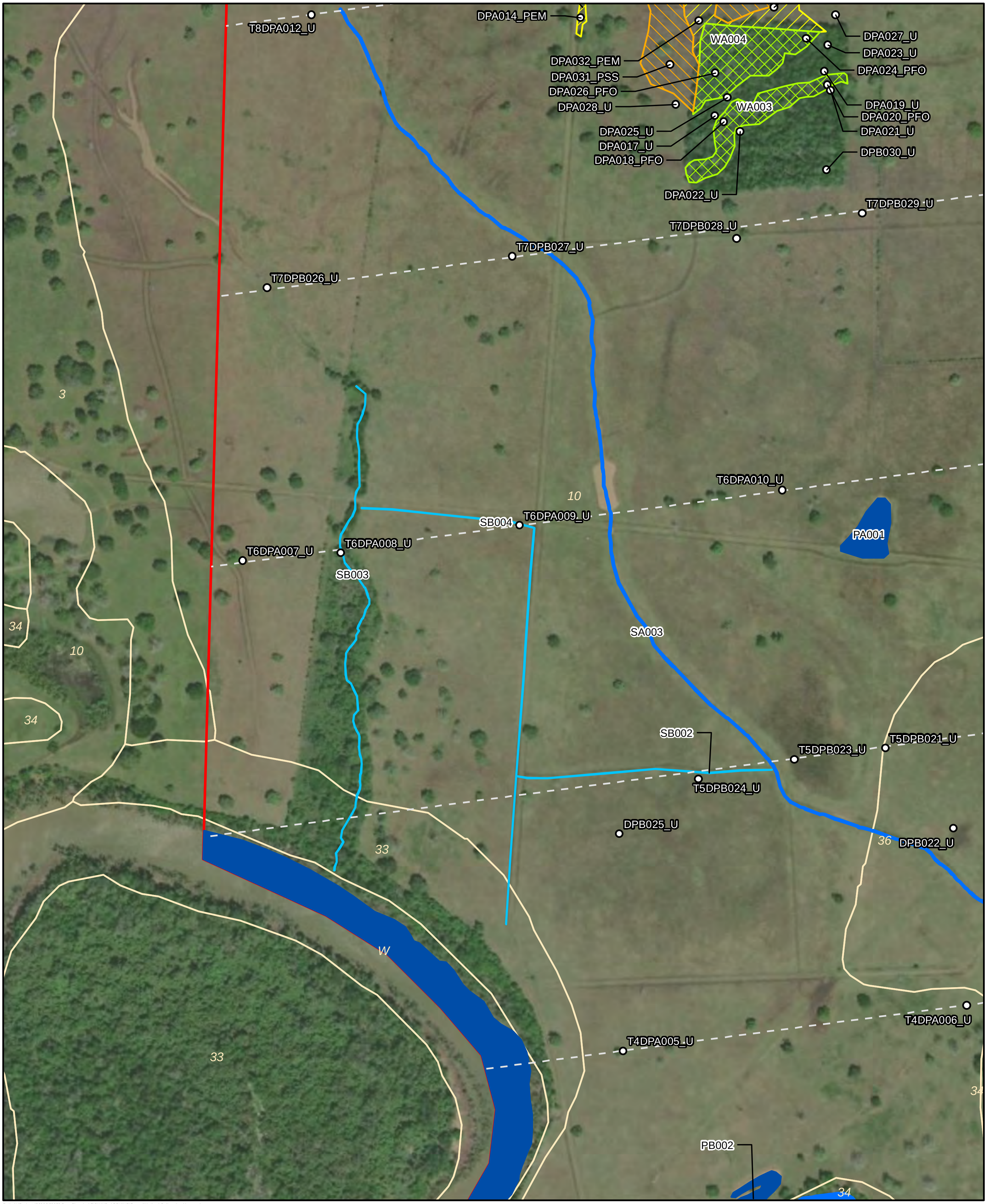


SWCA ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESEVOIR EXPANSION PROJECT

WETLAND DELINEATION MAP
BRAZORIA COUNTY, TEXAS

FIGURE 3 - SHEET 5 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

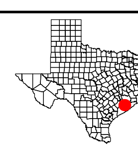
SWCA ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESEVOIR EXPANSION PROJECT

WETLAND DELINEATION MAP
BRAZORIA COUNTY, TEXAS

FIGURE 3 - SHEET 6 of 12

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



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

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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
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

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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

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 9 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 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
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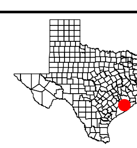
0 30 60 90 120 150 Meters



SWCA ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESEVOIR EXPANSION PROJECT

WETLAND DELINEATION MAP
BRAZORIA COUNTY, TEXAS

FIGURE 3 - SHEET 11 of 12

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

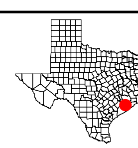
SWCA ENVIRONMENTAL CONSULTANTS

DOW CHEMICAL HARRIS RESEVOIR EXPANSION PROJECT

WETLAND DELINEATION MAP
BRAZORIA COUNTY, TEXAS

FIGURE 3 - SHEET 12 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
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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 G

Conceptual Compensatory Mitigation Plan

Harris Reservoir Expansion Environmental Impact Statement Conceptual Compensatory Mitigation Plan, Brazoria County, Texas

MARCH 2022

PREPARED FOR

The Dow Chemical Company, Inc.

PREPARED BY

SWCA Environmental Consultants

HARRIS RESERVOIR EXPANSION ENVIRONMENTAL IMPACT STATEMENT CONCEPTUAL COMPENSATORY MITIGATION PLAN, 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
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SWG-2016-01027

SWCA Project No. 52872

March 2022

CONTENTS

Appendices

Tables

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1 INTRODUCTION

To comport with the mitigation at the request The Dow Chemical Company (Dow), SWCA Environmental Consultants (SWCA) prepared this conceptual compensatory mitigation plan (Plan) in accordance with the U.S. Army Corps of Engineers (USACE) Regulatory Program regulations 33 Code of Federal Regulations (CFR) 320-331 and 40 CFR 230 for the compensation of unavoidable impacts to Waters of the United States (WOTUS) associated with the proposed Harris Reservoir Expansion Project (proposed project), in Brazoria County, Texas. This Plan is intended as a supplement to the Environmental Impact Statement (EIS) to be submitted for the project to USACE Galveston District (District).

As part of the EIS, SWCA completed a wetland delineation and functional assessment for the properties associated with the proposed project. Although the findings of wetland delineation were accepted by USACE, the application for an approved jurisdictional determination was officially withdrawn by Dow. Based on a memorandum for record approved by USACE on October 22, 2019, USACE verified the accuracy of the wetland delineation findings.

1.1 Project Description

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 (Figure A-1, Appendix A). A full description of the project purpose is provided in the Dow application for a standard permit (SWG-2016-01027) from the 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 existing Harris and Brazoria reservoirs. 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 approximate center of the project is located at (29.267725˚N, 95.543750˚W). The combined floodplain of Oyster Creek and Brazos River covers the agricultural fields in this area with elevations ranging from 0 feet (ft) to 50 ft above mean sea level. The hydrologic unit codes (HUC) associated with the proposed project are the Austin-Oyster (HUC 12040205) and Lower Brazos (HUC 12070104) watersheds.

1.2 Existing Resources

SWCA conducted a wetland delineation survey during June and July 2019, to assess previously delineated features. Through this delineation, SWCA identified three wetland vegetation community types within the project area including palustrine emergent (PEM) wetlands, palustrine scrub-shrub (PSS) wetlands, and palustrine forested (PFO) wetlands totaling approximately 21.380 acres (i.e., 9.624 acres of PEM, 4.933 acres of PSS, and 6.823 acres of PFO). A wetland delineation map is provided is Figures A-2 and A-3 of Appendix A exhibiting the location of each wetland feature. The following descriptions identify the general vegetation communities associated with the property.

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.

Furthermore, SWCA identified 41 waterbodies including 11 streams, 5 ditches, 22 agricultural ditches, and 3 ponds within the project area (see Figures A-2 and A-3, Appendix A). These waterbodies total 109,338 linear feet of linear waterbodies (26,250 feet of ephemeral waterbodies, 26,916 feet of intermittent waterbodies, and 56,172 feet of perennial waterbodies).

2 DETERMINATION OF IMPACTS

During the design of the project, the applicant attempted to minimize the project’s impacts to the extent practicable. This involved evaluating multiple project layouts, construction of alternate channels for intake and discharge, and related techniques to eliminate the permanent loss of wetlands, reduce the acreage of wetlands and waterbodies to be impacted, and reduce the temporary work areas to the extent practicable. Despite this effort, the applicant could not avoid all impacts to WOTUS.

2.1 Existing Features

Attachment B provides a detailed calculation of the functional assessments for the wetlands. Table 1 provides a summary of the overall wetland impacts associated with the project’s proposed construction.

Table 1. Summary of Assessment Findings for Wetlands that will be Impacted by the Dow Harris Reservoir Expansion

		TSSW (physical)		MPAC (biological)		RSEC (chemical)	
Wetland Type	**Total Acreage**	**FCI**	**FCU**	**FCI**	**FCU**	**FCI**	**FCU**
Palustrine Emergent	7.048	0.540-0.602	4.036	0.533-0.667	4.249	0.543-0.583	3.947
Palustrine Scrub/Shrub	4.701	0.564-0.638	2.988	0.583-0.750	3.500	0.617-0.633	2.902
Palustrine Forested	6.804	0.669-0.712	4.776	0.663-0.750	4.893	0.667-0.733	4.883
Total non-forested total	**11.749**		**7.024**		**7.749**		**6.849**
Total forested total	**6.804**		**4.776**		**4.893**		**4.883**

Similarly, SWCA assessed streams associated with the project area using the USACE Galveston District's Level I and Level II Stream Condition Assessment protocols (USACE 2013). The results of these assessments are provided in Table 2. Attachment C provides a detailed calculation of the stream assessments for the impacted streams.

Table 2. Summary of Assessment Findings for Waterbodies that will be Impacted by the Dow Harris Reservoir Expansion

Channel Type	Stream Reach	Total Length	Acreage
Ephemeral Stream	SB003, SB007, SB013	3,226	0.206
Intermittent Stream	SA001, SA003, SX014	26,912	12.867
Perennial Stream	SC001, SX002, SX024	13,718	11.272
	Total	**43,856**	**24.345**

Full wetland and stream functional reports were prepared by SWCA (SWCA 2019, 2021).

2.2 Project Impacts

Drawing from the project's design plans, the delineated wetlands summarized above were identified within the project footprint (SWCA 2021) (Figure A-4, Appendix A). These wetlands were generally associated with three main impact areas: the reservoir footprint, temporary workspaces, and habitat restoration areas (Table 3).

Table 3. Summary of Potential Wetland Functional Values Associated with the Dow Harris Reservoir Expansion

WAA ID	Impact Area	Wetland Type	Acreage	TSSW	MPAC	RSEC
WA002_PEM	Reservoir	PEM	0.186	0.108	0.115	0.104
WA003_PFO	Reservoir	PFO	2.100	1.495	1.575	1.539
WA004_PEM	Reservoir	PEM	2.437	1.467	1.625	1.389
WA004_PSS	Reservoir	PSS	4.547	2.901	3.410	2.805
WA004_PFO	Reservoir	PFO	3.120	2.221	2.237	2.287
WB004_ PEM	Reservoir	PEM	0.640	0.371	0.395	0.358
WC001_PEM	Reservoir	PEM	0.097	0.055	0.057	0.054
WC002_PEM	Reservoir	PEM	0.217	0.122	0.127	0.127
WC003_PFO	Temporary Workspace	PFO	1.551	1.038	1.059	1.035
WC004_PEM	Temporary Workspace	PEM	0.031	0.017	0.017	0.017
WC005_PEM	Reservoir	PEM	0.008	0.005	0.005	0.004
WC005_PEM	Temporary Workspace	PEM	0.34	0.197	0.210	0.190
WC005_PFO	Temporary Workspace	PFO	0.033	0.022	0.022	0.022
WC006_PEM	Habitat Restoration Area	PEM	0.457	0.247	0.244	0.262
WC007_PSS	Habitat Restoration Area	PSS	0.154	0.087	0.090	0.097
WD001_PEM	Reservoir	PEM	0.464	0.269	0.286	0.260

WAA ID	Impact Area	Wetland Type	Acreage	TSSW	MPAC	RSEC
WD002_PEM	Habitat Restoration Area	PEM	0.144	0.084	0.089	0.081
WD003_PEM	Habitat Restoration Area	PEM	2.027	1.095	1.080	1.101
	Reservoir	**PEM**	**3.409**	**2.026**	**2.215**	**1.938**
		PSS	**4.547**	**2.901**	**3.410**	**2.805**
		PFO	**5.220**	**3.716**	**3.812**	**3.826**
	Temporary Workspace	**PEM**	**0.371**	**0.214**	**0.227**	**0.207**
		PFO	**1.584**	**1.060**	**1.081**	**1.057**
	Habitat Restoration Area	**PEM**	**2.628**	**1.426**	**1.413**	**1.444**
		PSS	**0.154**	**0.087**	**0.090**	**0.097**

Many waterbodies identified within the property are within the construction footprint of the project (SWCA 2019). However, based on current USACE Galveston District guidance, ditches and ponds that are constructed entirely from uplands are not jurisdictional and do not require mitigation, if filled. Considering that the majority of waterbodies within the project area are roadside ditches, agricultural ditches, and man-made ponds, mitigation will only be required for natural waterbodies and modified waterbodies that will be impacted by the project. These waterbodies were generally associated with four main impact areas: the reservoir footprint, temporary workspaces, habitat restoration areas, and temporary workspace (Table 4).

Table 4. Summary of Potential Waterbody Values Associated with the Dow Harris Reservoir Expansion

Waterbody	Type	Flow	USGS Name	Impact Area	Length (feet)
SA001	Modified Stream	Intermittent	Jennings Bayou	Reservoir	13,496
SA003	Modified Stream	Intermittent	N/A	Reservoir	6,130
SB003	Modified Stream	Ephemeral	N/A	Reservoir	2,590
SB007	Modified Stream	Ephemeral	N/A	Reservoir	520
SB013	Modified Stream	Ephemeral	N/A	Reservoir	116
SC001	Modified Stream	Perennial	Oyster Creek	Habitat Restoration Area	8,080
				Temporary Workspace	1,874
SX002	Natural Stream	Perennial	Brazos River	Pump Station	415
				Temporary Workspace	3,195
SX014	Modified Stream	Intermittent	N/A	Reservoir	7,286
SX024	Natural Stream	Perennial	Oyster Creek	Habitat Restoration Area	154
				Reservoir Subtotal	*30,138*
				Temporary Workspace Subtotal	*8,324*
				Pump Station Subtotal	*415*
				Habitat Restoration Area Subtotal	*8,234*
				Total	**43,856**

3 MITIGATION CALCULATION

3.1 Wetland Mitigation Requirement

Wetlands that are to be placed within the footprint of the reservoir will be considered to be completely impacted. Therefore, these wetlands will require mitigation for their full value. Wetlands in the temporary workspace will require clearing of trees but will otherwise be kept intact because these areas will be restored to pre-construction contours. This will result in the conversion of forested wetlands to non-wetlands habitats. Considering the potentially long-term construction timeline of the project, converted forested wetlands will be treated as a permanent impact. Wetlands within the restoration area will augment stream functional values and, therefore, will count as neither wetland impact nor impact minimization.

Permanent impacts to non-forested wetlands within the proposed project footprint will require 7.024, 7.749, and 6.849 credits of non-forested TSSW, MPAC, and RSEC, respectively. Likewise, temporary and permanent impacts to forested wetlands within the proposed project footprint will require 4.776, 4.893, and 4.883 credits of forested TSSW, MPAC, and RSEC, respectively.

3.2 Waterbody Mitigation Requirement

As with the wetland impacts, waterbodies within the proposed footprint will be converted to a reservoir and, therefore, lost in their current state. Likewise, impacts associated with the planned pump station will permanently impact the shoreline of the Brazos River. Based on this, streams within the reservoir and pump station footprints will require mitigation for 43,856 linear feet of impacts.

Typically, the USACE Galveston District recommends the use of the Stream Condition Assessment (SCA) standard operating procedure to develop a baseline, qualitative assessment of a stream to determine the degree of impact associated with proposed project. This approach is most appropriate for impacts that alter a stream, but do not result in total loss of streams. For a project that proposes to eliminate streams altogether, the SCA is limited and additional data analyses may be necessary. Based on data collected and consultation with USACE, stream mitigation will be achieved through implementations of several stream restoration and enhancement projects.

4 CONCEPTUAL MITIGATION PLAN

The proposed project is located within the primary and secondary service areas of multiple mitigation banks; therefore, this option was selected for mitigation of loss of wetlands within the project area. However, the project area is outside of 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 (off-site) was selected for stream mitigation in this Plan.

Following coordination and advisement, the Galveston District provided a memorandum explaining that while the Galveston District USACE Stream Condition Assessment Standard Operating Procedure is an important tool in evaluating the need for stream mitigation, it is limited in assessing compensatory mitigation in this complex proposed project where in-kind mitigation is not attainable (USACE 2013). Numerous quantitative methods, specifically the U.S. Environmental Protection Agency’s BASINS and HSPF modeling of the hydrology and hydraulics of the Oyster Creek and Big Slough, have been employed to supplement the District's evaluation. These strategies provide the District approved compensation to lost ecological functions at the project area and are consistent with District guidance.

4.1 Proposed On-Site Mitigation

On-site locations were evaluated to assess the potential to meet the proposed project's compensatory mitigation goals for impacts to streams within the project area. Priority was given to on-site mitigation that would provide the most direct compensation for project impacts.

The goals of the mitigation strategies proposed to be implemented on-site include re-establishment, enhancement, and preservation of the ecological functions of the aquatic resources at the project site so that the resources will increase their values within the surrounding watershed and the Oyster Creek corridor. The mitigation strategies will accomplish the following:

- Rehabilitate or enhance ecological functions of a stable bank and riparian buffers to improve and support in-stream functions,
- Rehabilitate or enhance ecological functions through sustainable mitigation designs including streambank planting, and
- Preservation of Oyster Creek and its riparian buffer up to 200 feet.

The on-site mitigation efforts were split into two distinct projects: Oyster Creek Project 1 and Oyster Creek Project 2. The locations and features of both on-site mitigation projects are exhibited in Figure A-5 of Appendix A.

4.1.1 Oyster Creek Project 1

Oyster Creek Project 1 begins in northern reaches of Oyster Creek and rehabilitates and enhances the northwestern reach of Oyster Creek. This segment of Oyster Creek currently has a mature riparian buffer out to approximately 100 feet and has instream structure in the form of vegetation and root wads. Oyster Creek Project 1 activities will include bankfull benching, streambank plantings, buffer preservation of the existing 100-foot buffer, and buffer re-establishment out to 200 feet (see Figure A-5, Appendix A).

4.1.2 Oyster Creek Project 2

Oyster Creek Project 2 begins immediately south of Oyster Creek Project 1 and rehabilitates and enhances the southeastern reach of Oyster Creek. This segment of Oyster Creek currently has a mature riparian buffer out to 100 feet within its northern portion and is heavily impacted by farming activities in the southern portion with a much narrower riparian buffer. Oyster Creek Project 2 activities will include bankfull benching, streambank plantings, buffer preservation of the existing 100-foot buffer, and buffer re-establishment out to 200 feet where possible (see Figure A-5, Appendix A).

4.2 Proposed Off-Site Mitigation

The applicant will restore a portion of Big Slough located off-site in Brazoria County, Texas, approximately 7 miles east of Lake Jackson and approximately 17.5 miles southeast of the proposed project area (Figures A-6 and A-7, Appendix A). The Big Slough stream restoration area is located in the Austin-Oyster watershed and encompasses approximately 1,113 acres consisting of a 600-foot buffer surrounding Big Slough. Big Slough currently has a mature riparian buffer out to 100 feet and has instream structure in the form of vegetation; however, grade control structures within this tract have essentially converted Big Slough to a linear detention basin. Mitigation activities within the Big Slough will include bankfull benching, streambank plantings, buffer preservation of the existing 100-foot buffer, buffer re-establishment out to 200 feet, and enhancing natural flow by removing eight earthen dams (see Figure A-7, Appendix A).

4.3 Native Vegetation Plantings

Native vegetation plantings will occur within the on-site restoration, enhancement, and reestablishment projects described in Section 4.1 as well as within the off-site mitigation in Section 4.2.

Following the selective removal of invasive species and slope stabilization, re-establishment of the riparian buffers will occur through plantings of desirable native plant species. Tree and shrub species will include species native to the local forested riparian habitat, along with less-common species, to increase the overall species diversity of the riparian buffer and to provide increased benefits to wildlife species. Native species plantings will include various size classes planted at densities appropriate for developing stable vegetation stratum, reducing erosion, and improving overall habitat. The range of size classes of planted trees will produce an uneven aged forest canopy when mature. These planted communities should reach maturity within 15 to 30 years.

The proposed plant species for afforestation have a wetland indicator status of facultative (“FAC”), facultative wetland (“FACW”), or obligate (“OBL”) per the Regional Wetland Plant List for the Atlantic and Gulf Coastal Plain (“AGCP”) Region. Species selected either occur in or have a native range encompassing Brazoria County or adjacent counties. The planting effort will integrate fast-growing soft mast species with slower-growing hard mast species to allow for greater vertical structural diversity, which is a necessary habitat for forest breeding birds. The exact species and quantities for planting will be determined by the availability of the species from commercial nurseries providing seedling.

4.4 Invasive and Noxious Species

Invasive plant species such as Chinese tallow (*Triadica sebifera*) and Johnson grass (*Sorghum halepense*) readily occur throughout the on-site and off-site mitigation areas particularly in disturbed areas and throughout the riparian corridor. Invasive plant species will be selectively removed and controlled using chemical methods. Herbicides will be selected based on the type of application procedure and will be in accordance with federal regulations. The invasive plant removal and follow-up herbicide applications will be conducted by experienced contracted personnel.

4.5 Ecological Functions and Values Gained

The restoration of forested riparian habitats along Oyster Creek and Big Slough will provide increases in function and value to their wildlife habitats to benefit their respective wildlife communities. Protection of these areas will maintain existing wildlife habitats keeping them from being lost from future conversions to development or agricultural land uses. Rehabilitation and enhancement of the forested riparian habitats, and the re-establishment of degraded stream reach will provide wildlife corridors, nesting, and foraging opportunities.

4.6 Summary of Stream Impacts and Stream Improvements

Following coordination and advisement of the Galveston District, described in Section 4.0, Dow determined its compensatory mitigation by stream lengths. Table 5 exhibits the comparison of the proposed project's stream impacts to the potential stream improvements proposed as compensatory mitigation.

Table 5. Summary of Stream Impacts and Stream Improvements for the Dow Harris Reservoir Expansion

Stream Impact / Improvement	Total Stream Length (Linear Feet)
Proposed Project Stream Impacts	43,856
Oyster Creek Project 1 Stream Improvements	3,621
Oyster Creek Project 2 Stream Improvements	12,868
Big Slough Stream Improvements	33,900
Total Stream Impact	**43,856**
Total Stream Improvement	**50,389**

5 LITERATURE CITED

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

———. 2021. *Interim Hydrogeomorphic Functional Assessment Report for the Dow Harris Reservoir Expansion Project in Brazoria County, Texas*. Houston, Texas: SWCA Environmental Consultants. October 2021.

U.S. Army Corps of Engineers (USACE). 2013. *Level 1 – Stream Condition Assessment for All Ephemeral and Intermittent Streams and for Impacts Less Than 500 Linear Feet to Intermittent Streams with Perennial Pools, Perennial Streams, and Wadeable Rivers*. USACE – Galveston District. Published June 2013. Available at: www.swg.usace.army.mil/Portals/26/Level%201%20June%202013.pdf. Accessed January 2022.

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APPENDIX A

Project Maps

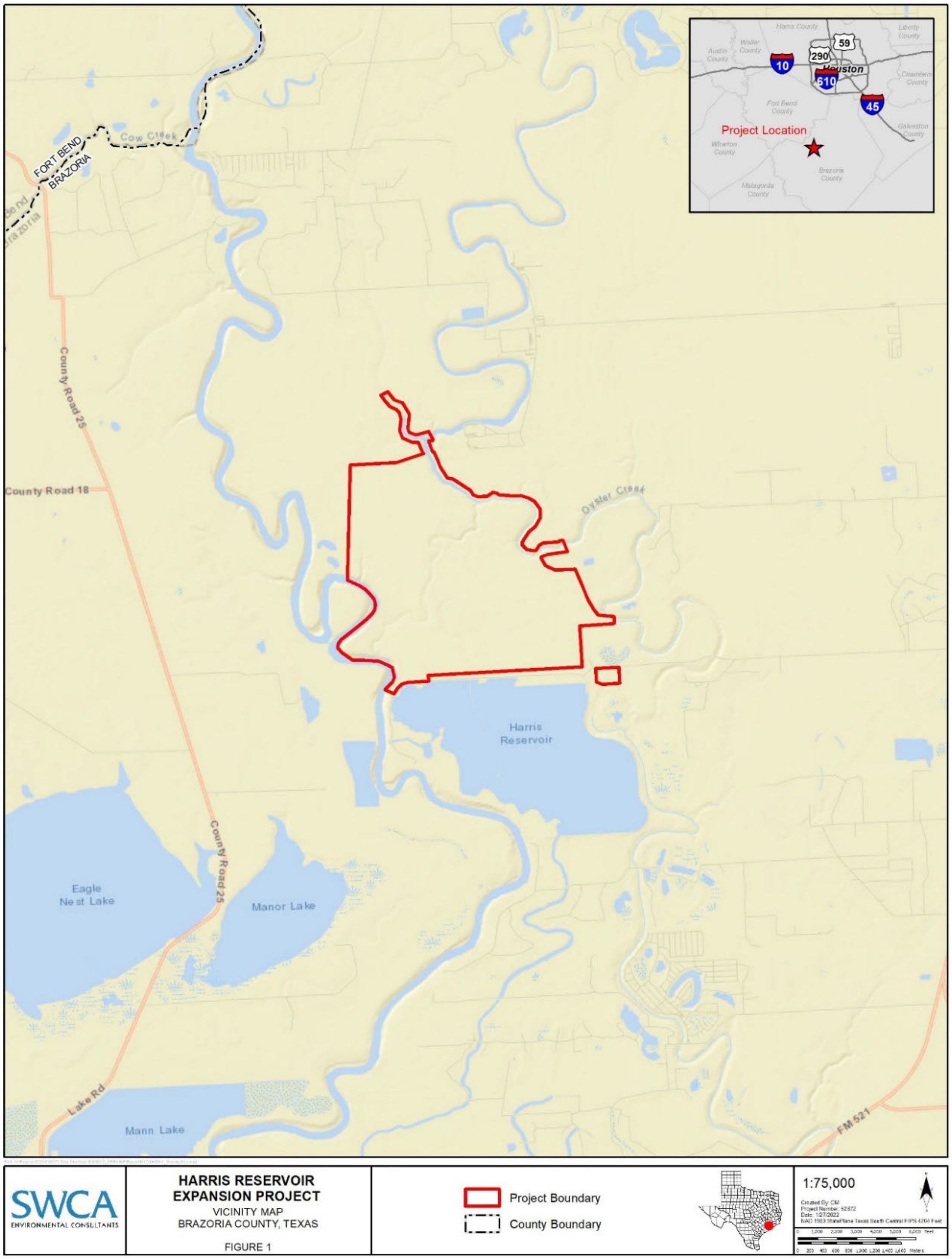

Figure A-1. Vicinity map.

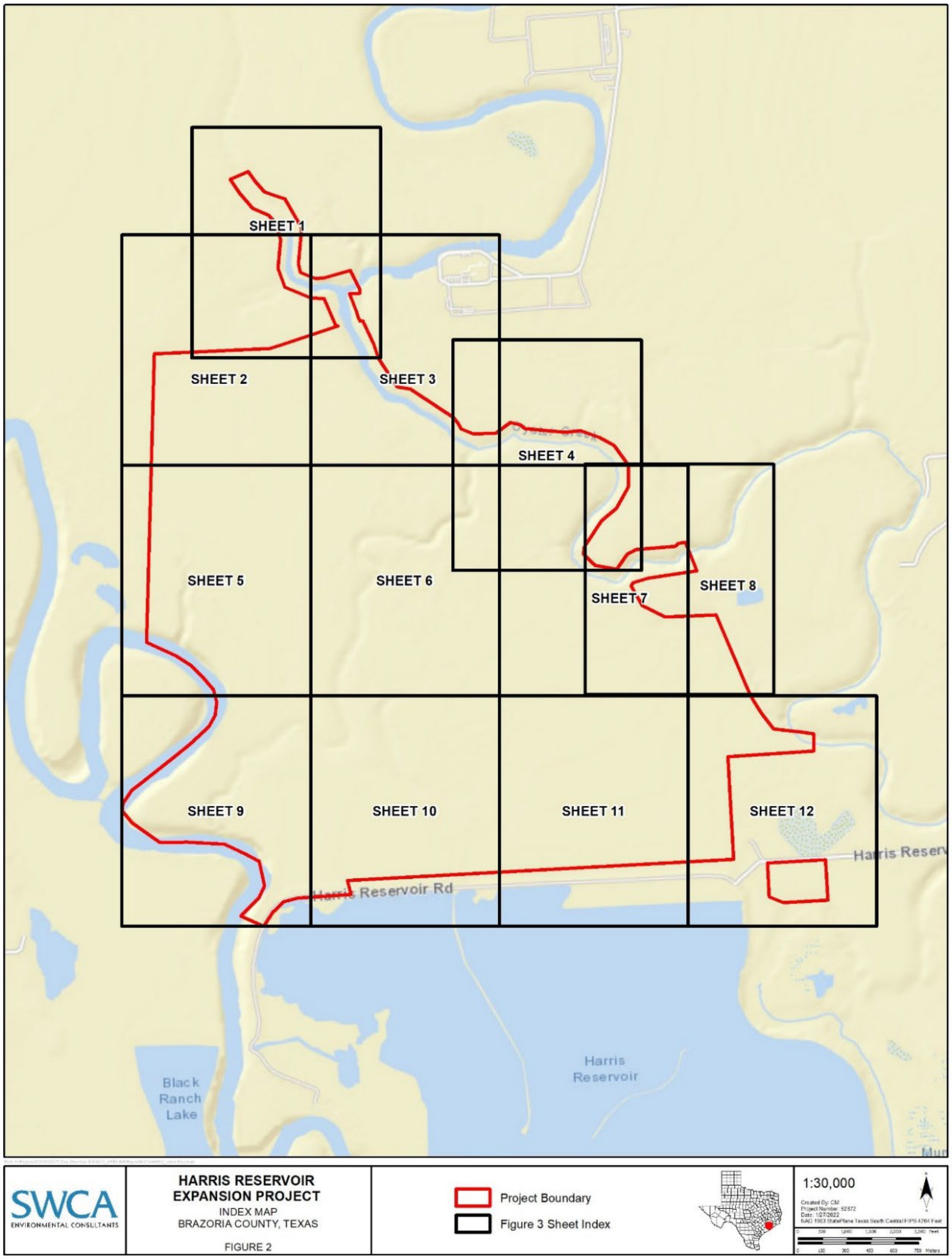

Figure A-2. Index map.

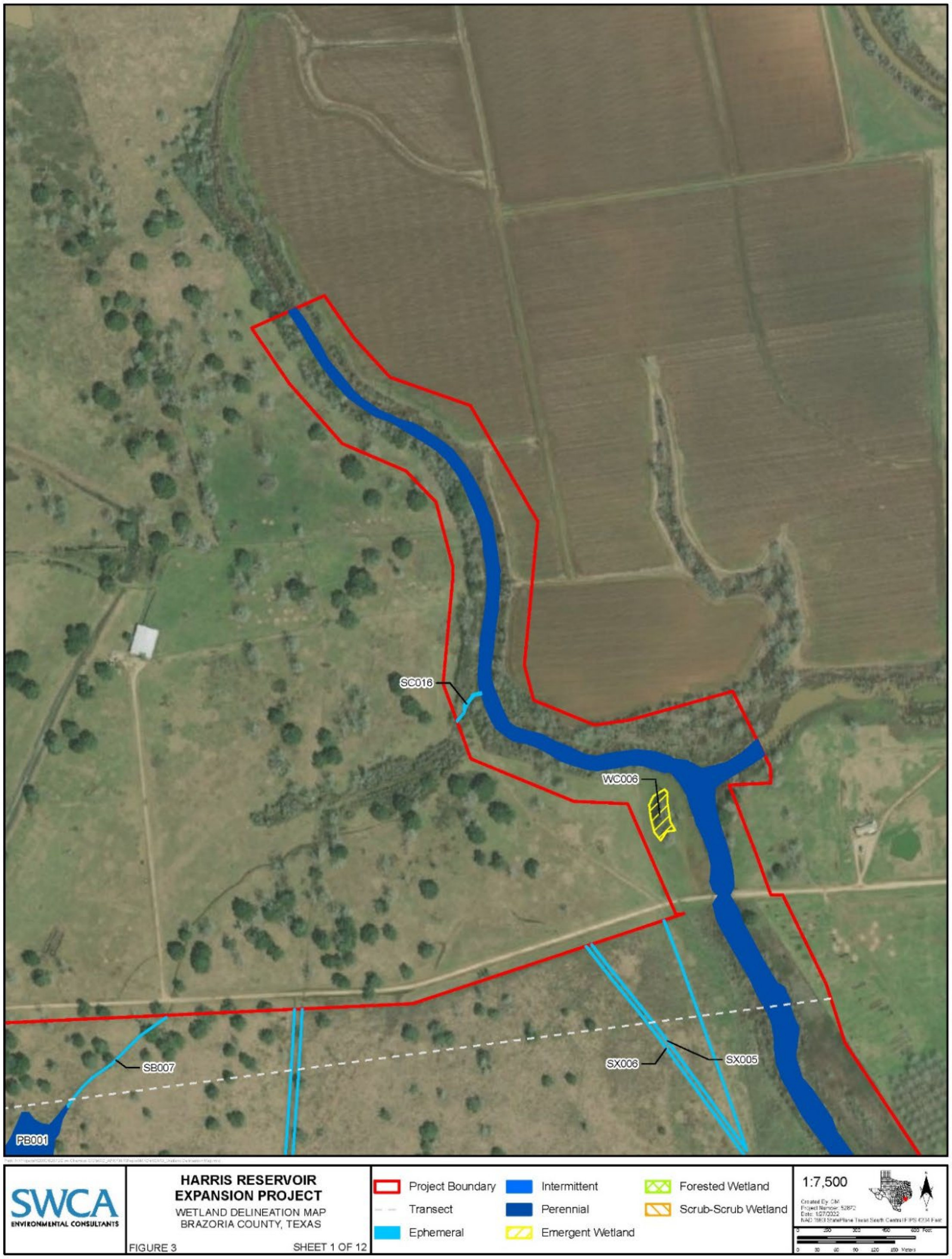

Figure A-3a. Wetland delineation map (map 1 of 12).

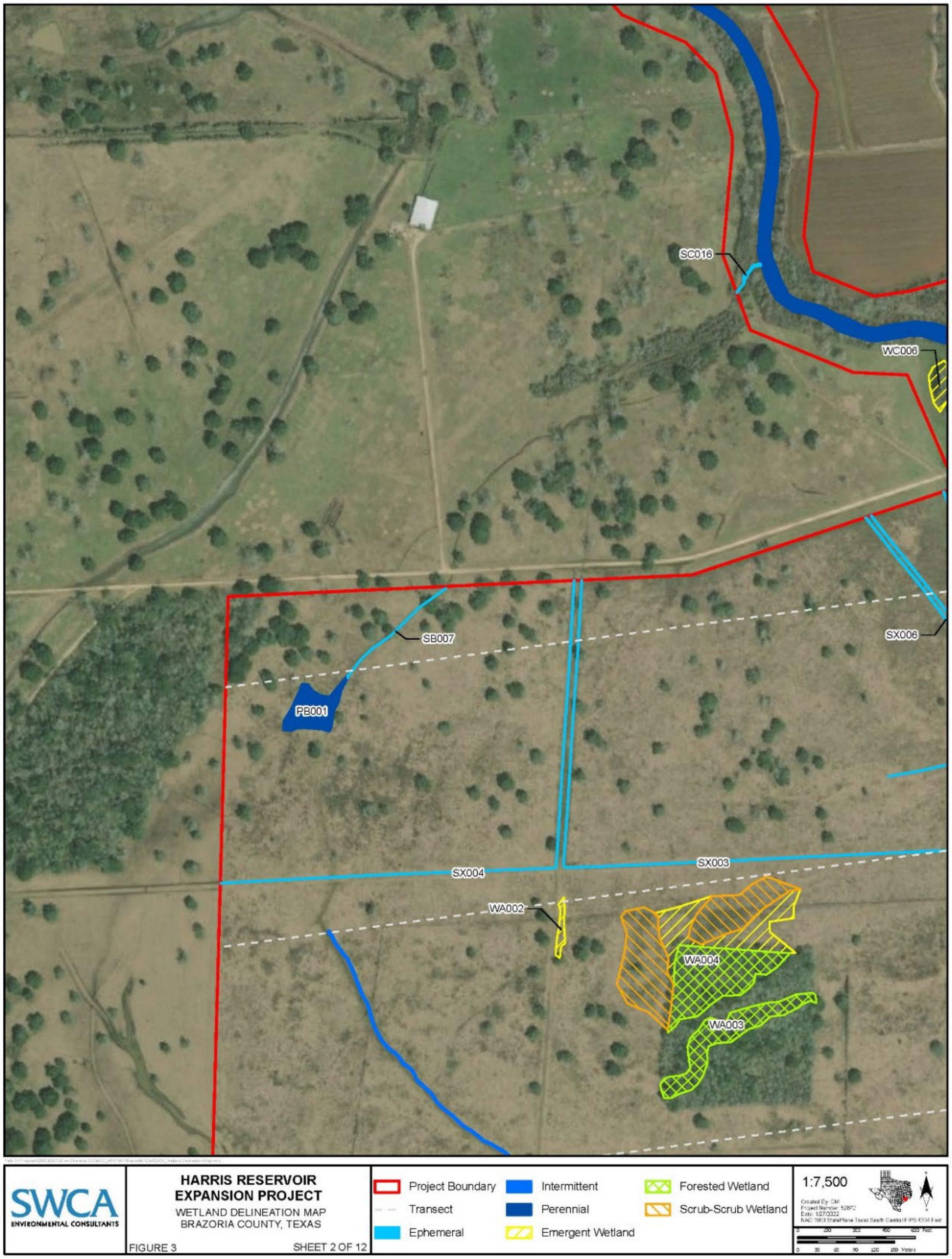

Figure A-3b. Wetland delineation map (map 2 of 12).

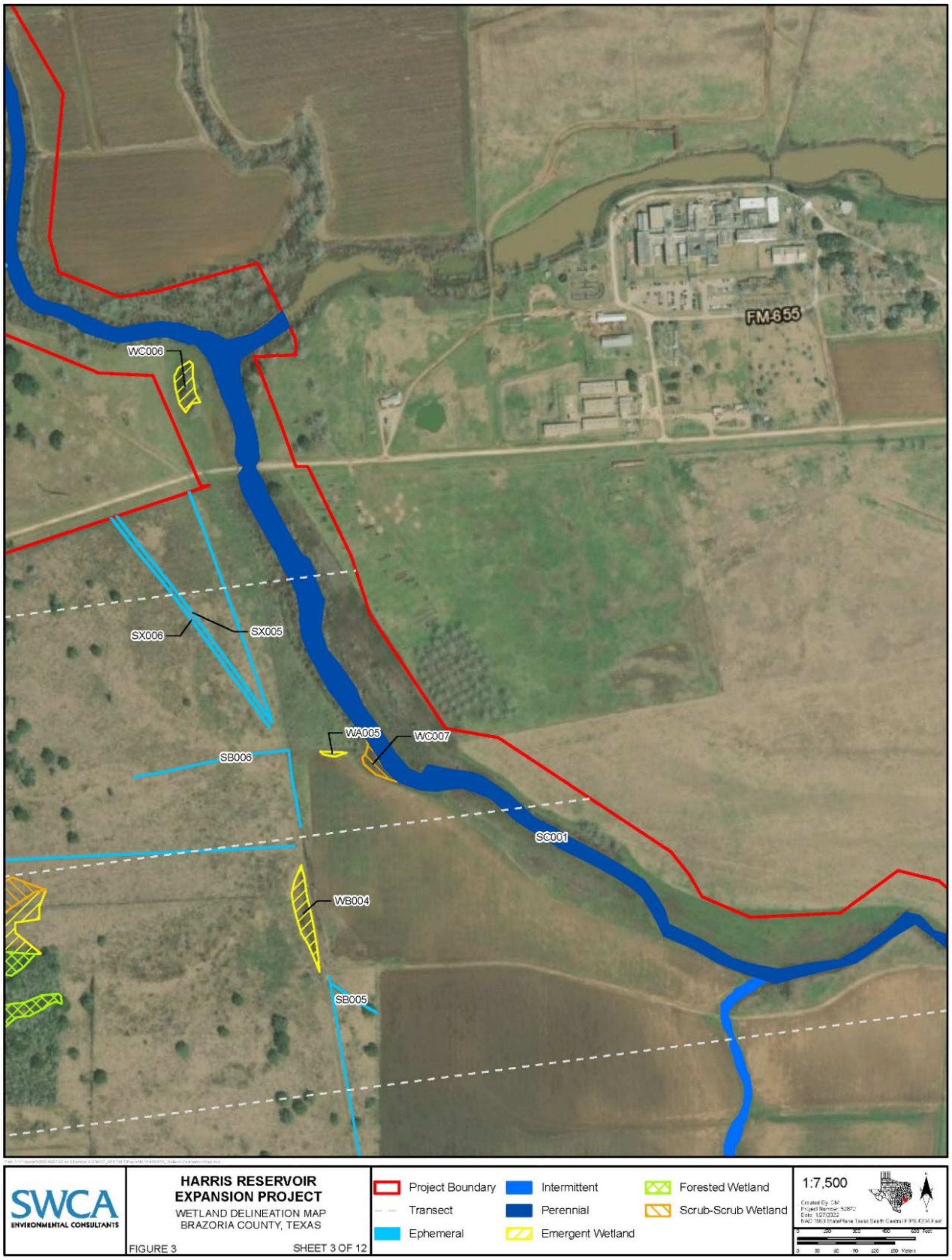

Figure A-3c. Wetland delineation map (map 3 of 12).

Figure A-3d. Wetland delineation map (map 4 of 12).

Figure A-3e. Wetland delineation map (map 5 of 12).

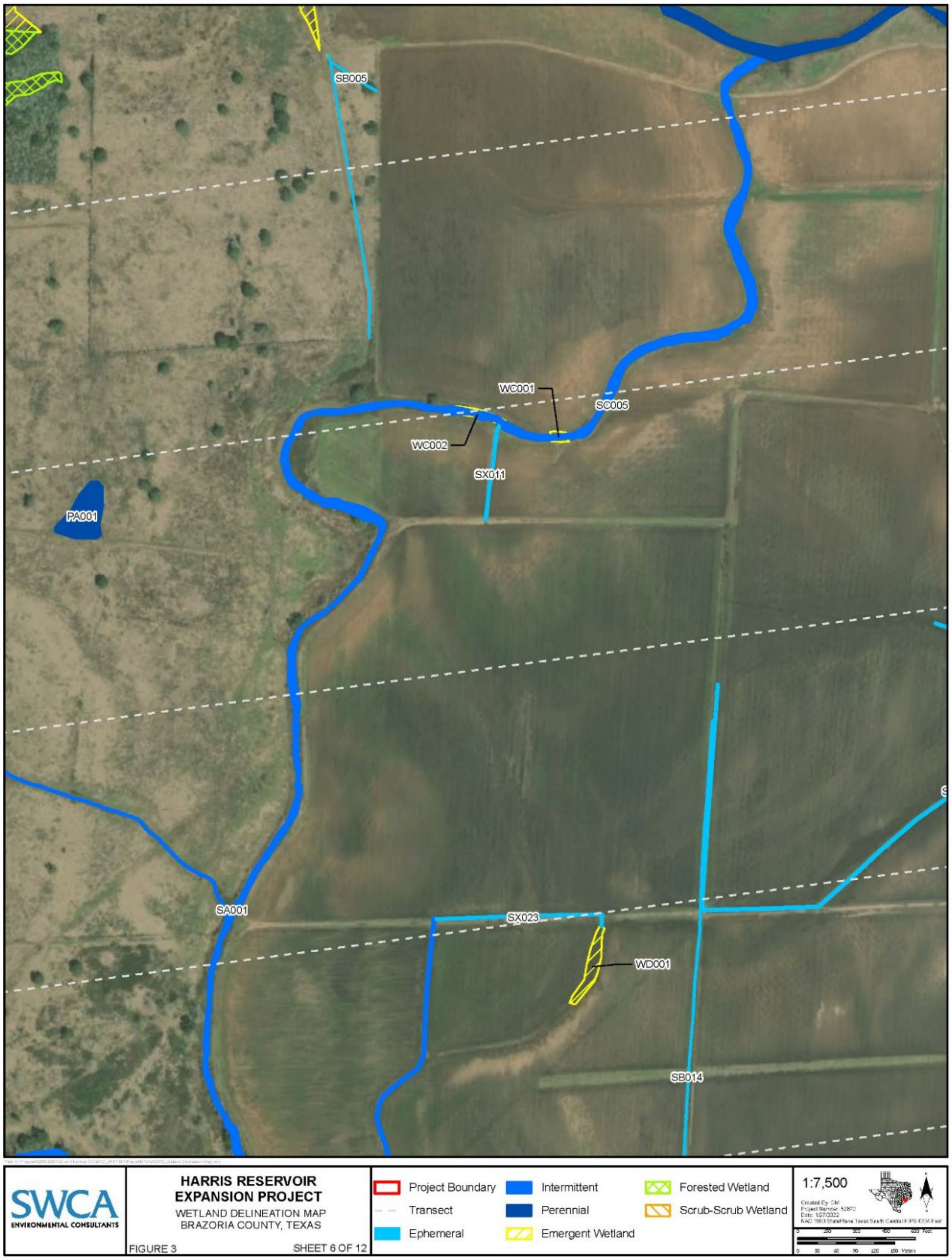

Figure A-3f. Wetland delineation map (map 6 of 12).

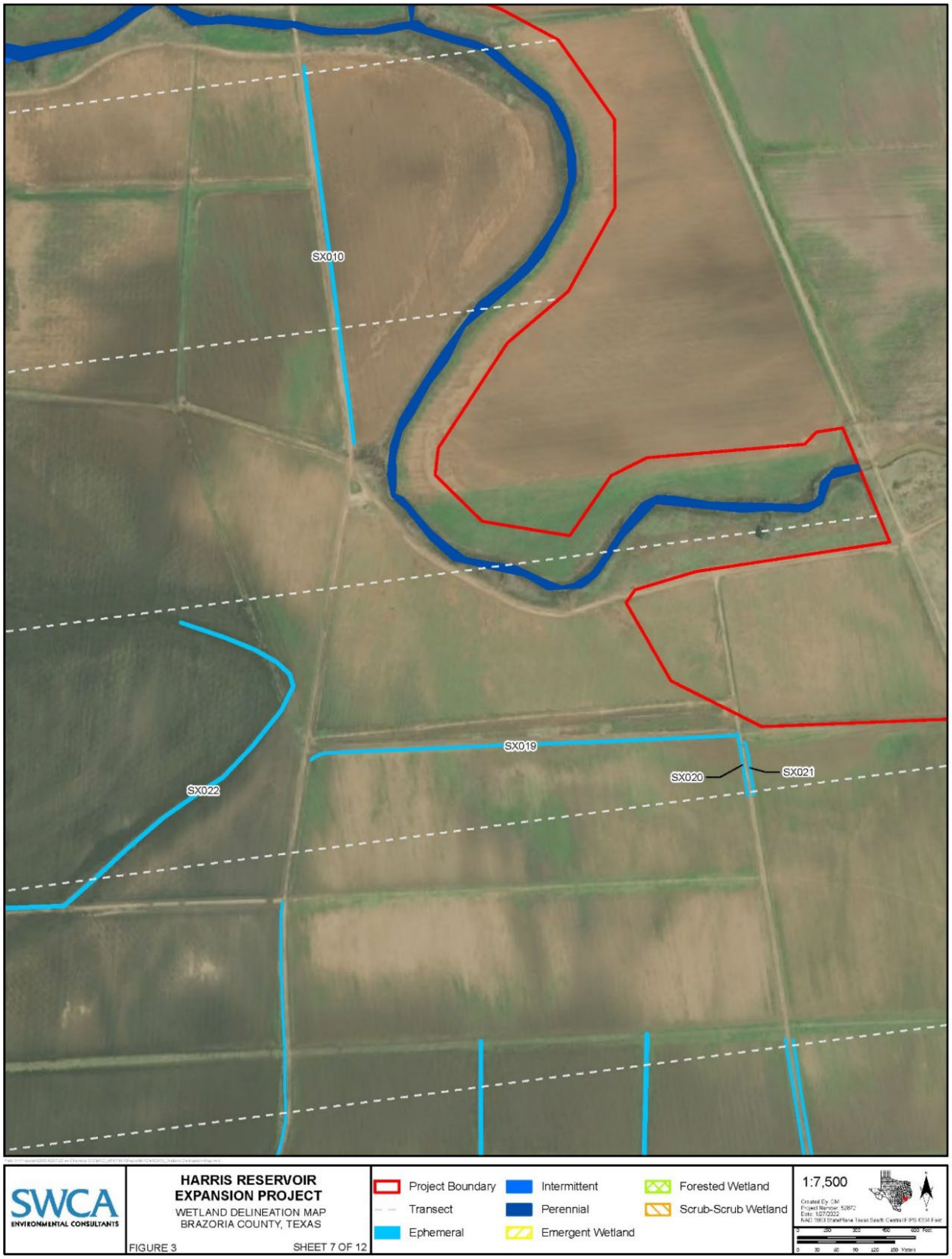

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Figure A-3g. Wetland delineation map (map 7 of 12).

Figure A-3h. Wetland delineation map (map 8 of 12).

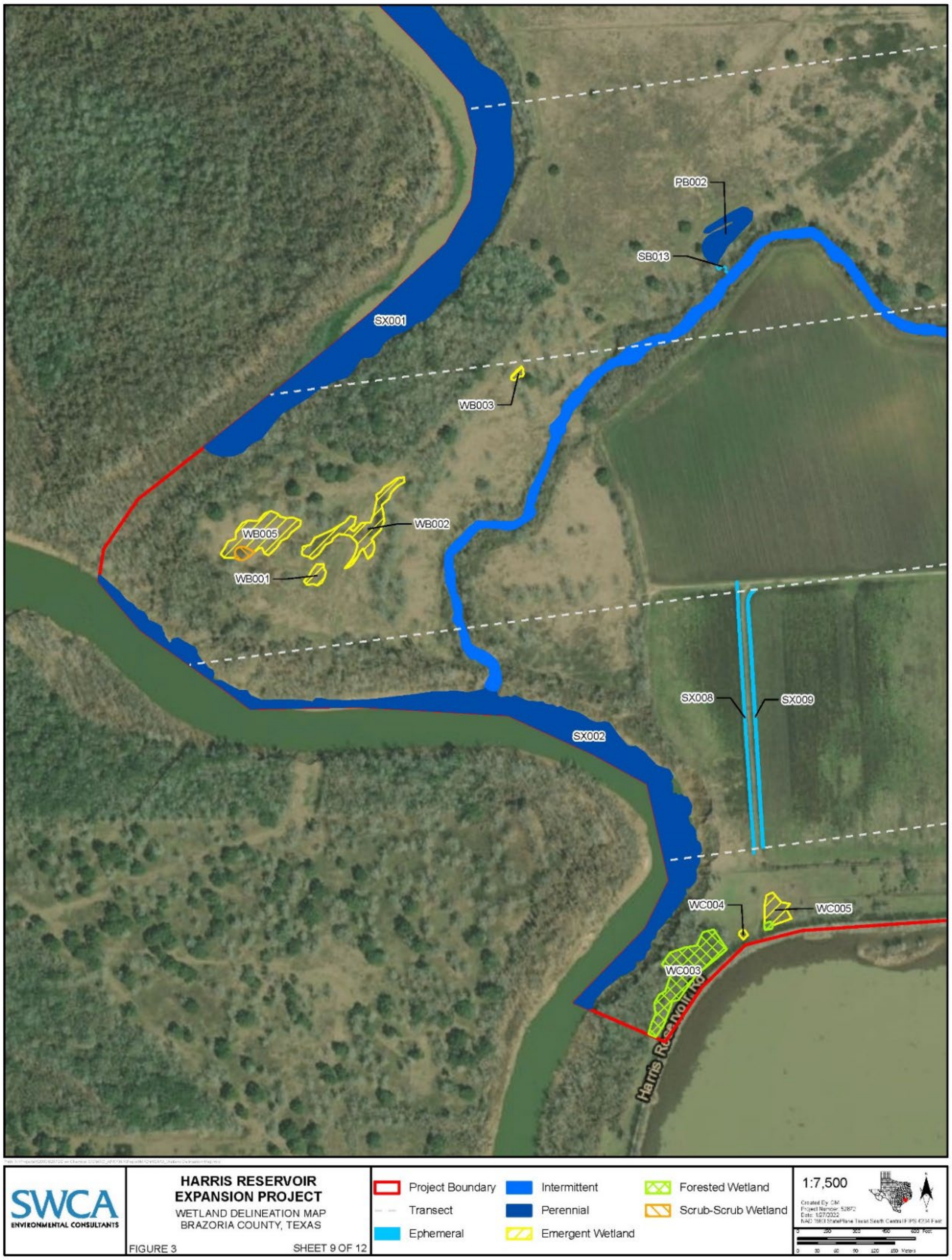

Figure A-3i. Wetland delineation map (map 9 of 12).

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Figure A-3j. Wetland delineation map (map 10 of 12).

Figure A-3k. Wetland delineation map (map 11 of 12).

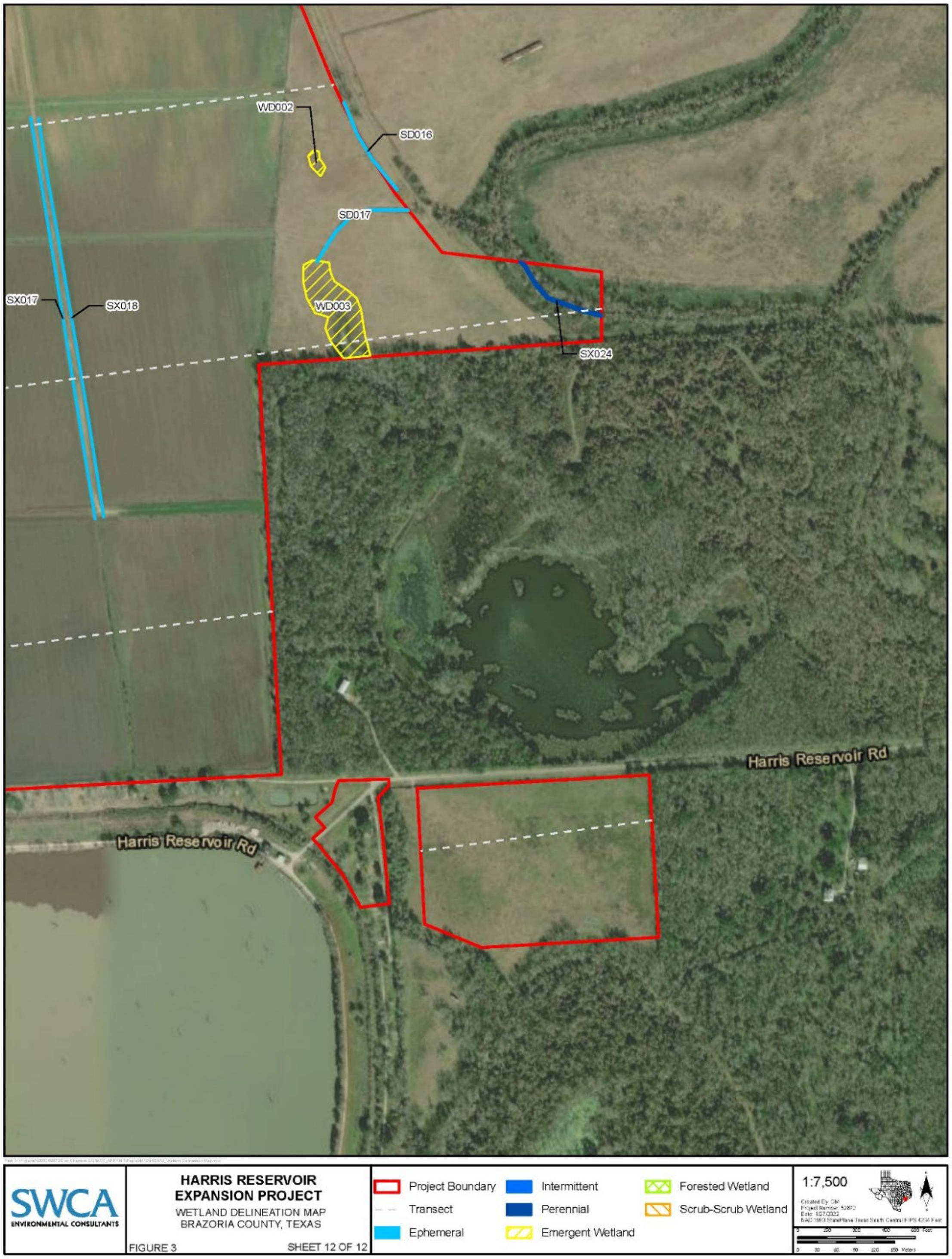

Figure A-3l. Wetland delineation map (map 12 of 12).

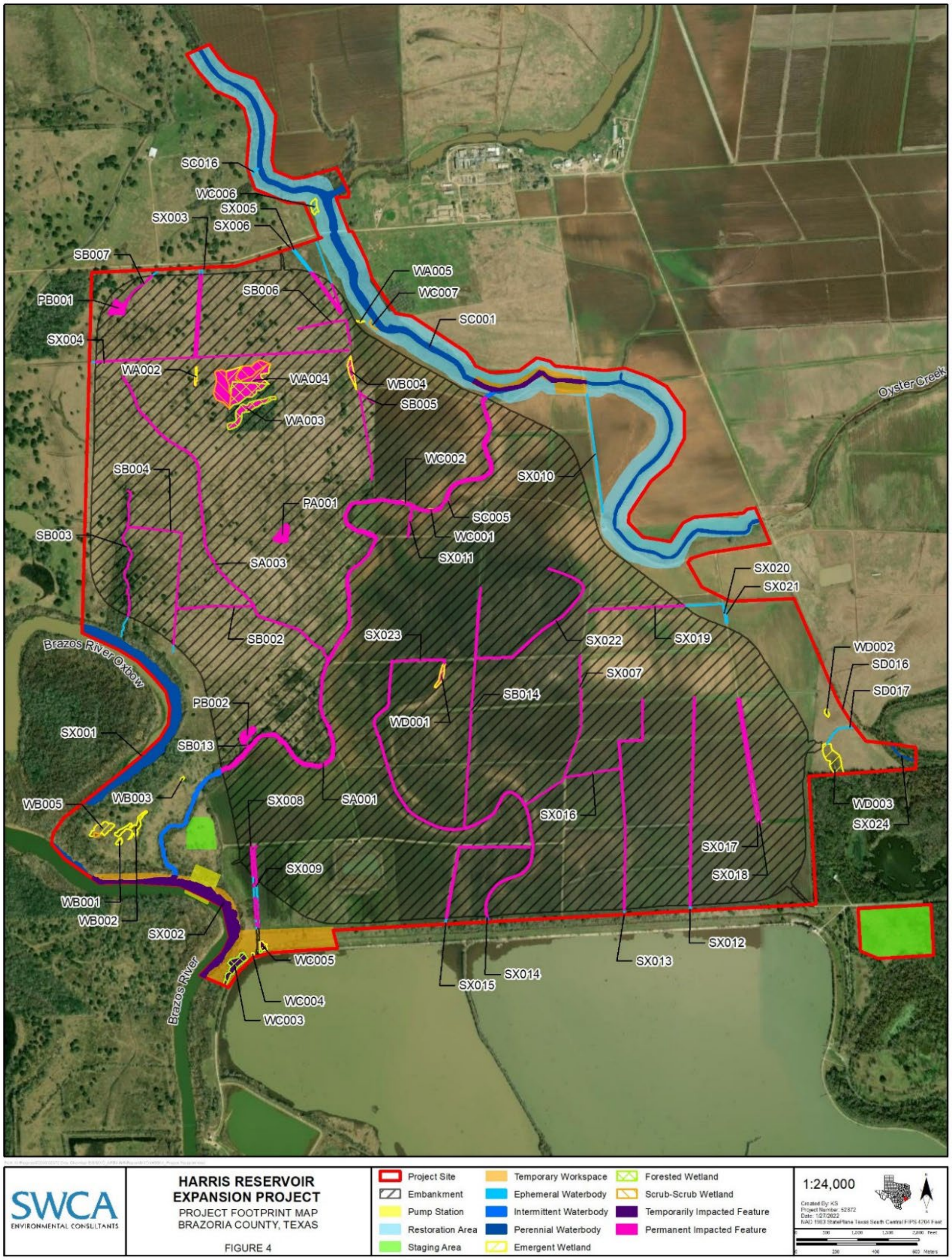

Figure A-4. Project footprint map.

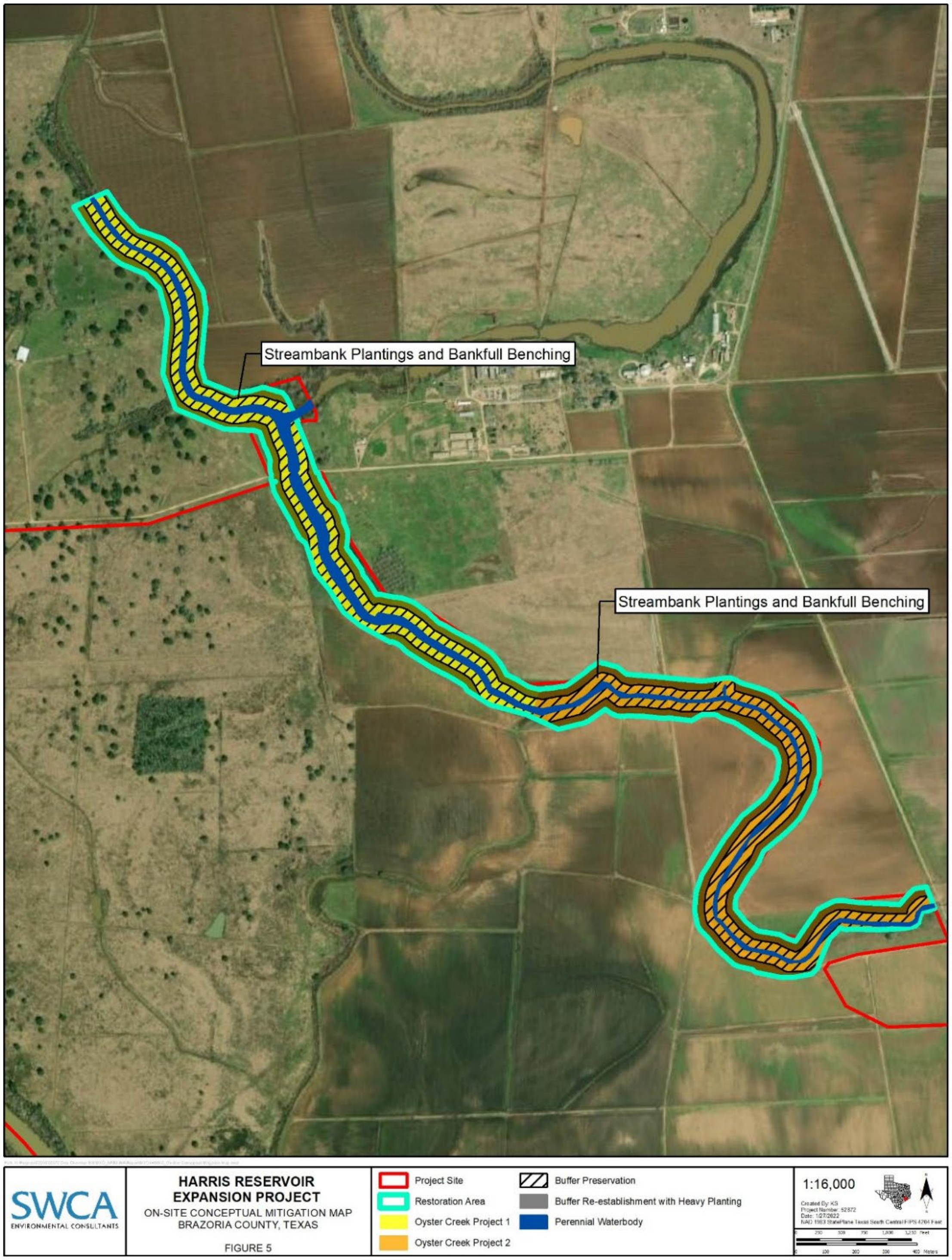

Figure A-5. On-site conceptual mitigation map.

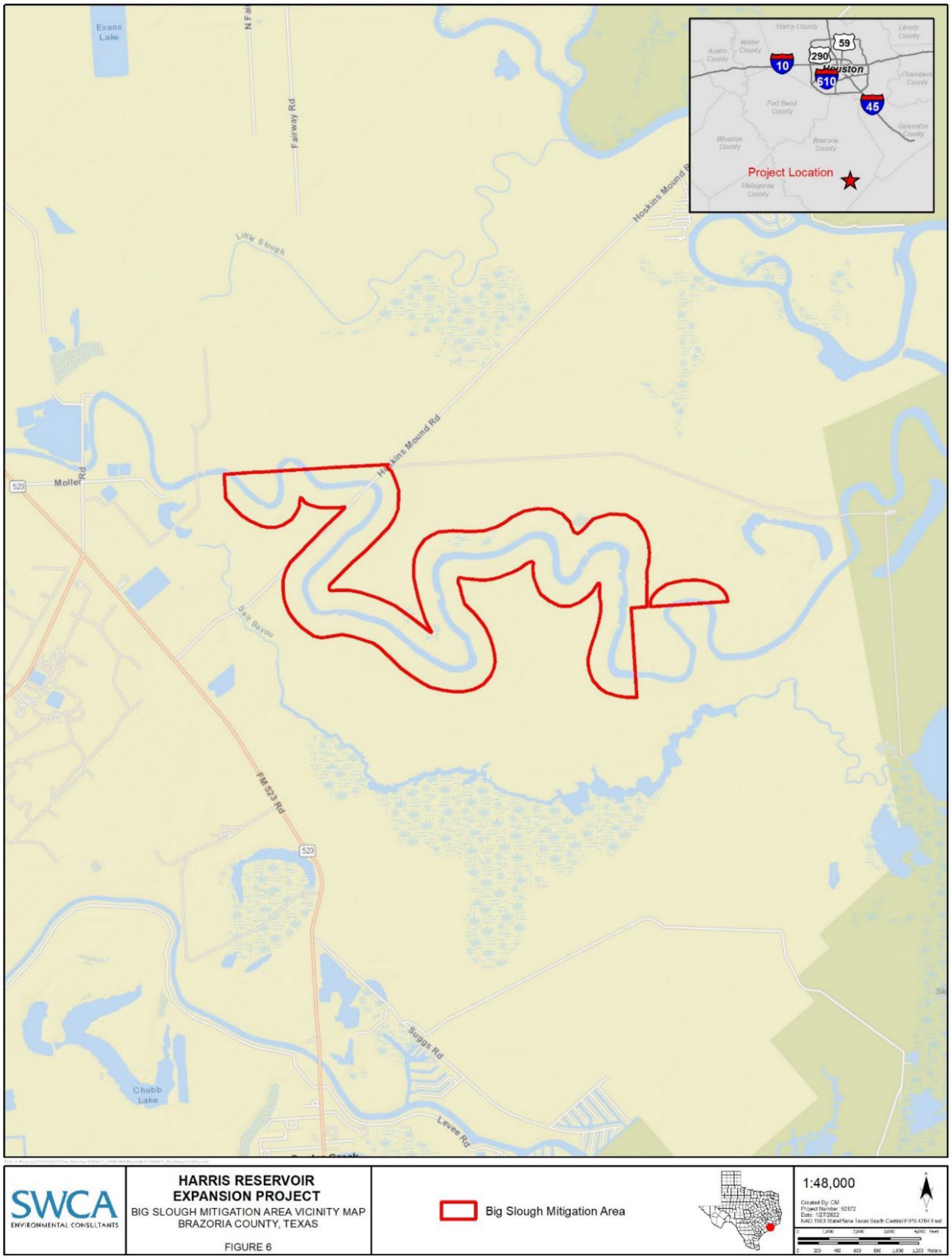

Figure A-6. Big Slough mitigation area vicinity map.

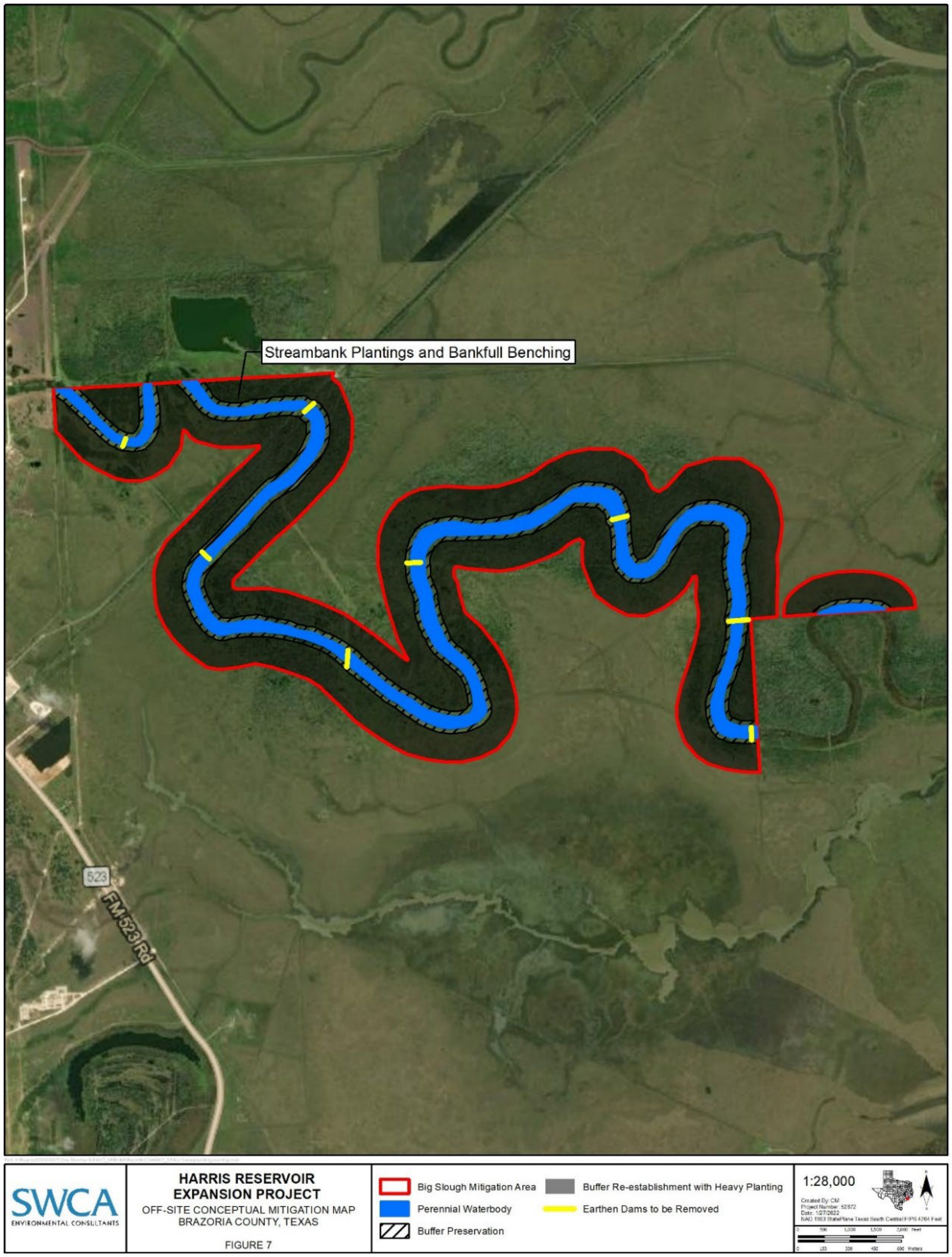

Figure A-7. Off-site conceptual mitigation map.

APPENDIX B

Wetland Functional Values

Table B-1. PEM Wetlands and Functional Values to be Impacted by the 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
WB004_ PEM	0.640	0.580	0.371	0.617	0.395	0.560	0.358
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	0.340	0.580	0.197	0.617	0.210	0.560	0.190
WC005_PEM	0.008	0.580	0.005	0.617	0.005	0.560	0.004
WC006_PEM	0.457	0.540	0.247	0.533	0.244	0.573	0.262
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	2.027	0.540	1.095	0.533	1.080	0.543	1.101
Total	**7.048**		**4.036**		**4.249**		**3.947**

Table B-2. PSS Wetlands and Functional Values to be Impacted by the Project

WAA ID	Acreage	TSSW (physical)		MPAC (biological)		RSEC (chemical)	
		FCI	FCU	FCI	FCU	FCI	FCU
WA004_PSS	4.547	0.638	2.901	0.750	3.410	0.617	2.805
WC007_PSS	0.154	0.564	0.087	0.583	0.090	0.633	0.097
Total	**4.701**		**2.988**		**3.500**		**2.902**

Table B-3. PFO Wetlands and Functional Values to be Impacted by the 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	1.551	0.669	1.038	0.683	1.059	0.667	1.035
WC005_PFO	0.033	0.669	0.022	0.663	0.022	0.667	0.022
Total	**6.804**		**4.776**		**4.893**		**4.883**

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APPENDIX C

Stream Assessment Values

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

Channel ID	Transect	CV	BV	UV	AV	CI	RCI
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	
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

Notes: CV = Channel Condition, BV = Riparian Buffer, UV = Aquatic Use, AV = Channel Alteration, CI = Condition Index, RCI = Reach Condition Index

Table C-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	

Channel ID	Transect	CV	BV	AV	MV	FV	CI	RCI
	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	
	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	
SC001	1	5.00	4.05	4.50	5.00	5.00	4.71	4.47
	2	5.00	3.86	4.50	5.00	5.00	4.67	
	3	5.00	3.79	4.50	5.00	5.00	4.66	
	4	5.00	4.20	4.50	5.00	5.00	4.74	
	5	5.00	4.43	4.50	5.00	5.00	4.79	
	6	5.00	4.43	4.50	5.00	5.00	4.79	
	7	5.00	3.94	4.50	5.00	5.00	4.69	
	8	5.00	3.30	4.50	5.00	5.00	4.56	
	9	5.00	3.90	4.50	5.00	5.00	4.68	
	10	5.00	1.95	4.50	5.00	5.00	4.29	
	11	5.00	4.20	4.50	5.00	5.00	4.74	
	12	5.00	4.20	4.50	5.00	5.00	4.74	

Channel ID	Transect	CV	BV	AV	MV	FV	CI	RCI
	13	5.00	4.20	4.50	5.00	5.00	4.74	
	14	4.00	2.96	4.50	5.00	5.00	4.29	
	15	5.00	3.23	4.50	5.00	5.00	4.55	
	16	4.00	3.23	4.50	5.00	5.00	4.35	
	17	4.00	2.60	4.50	5.00	5.00	4.22	
	18	4.00	2.75	4.50	5.00	5.00	4.25	
	19	4.00	4.13	4.50	5.00	5.00	4.53	
	20	4.00	3.50	4.50	5.00	5.00	4.40	
	21	5.00	90	4.50	5.00	5.00	4.68	
	22	4.00	3.78	3.00	5.00	5.00	4.16	
	23	4.00	3.15	4.50	5.00	5.00	4.33	
	24	4.00	2.60	4.50	5.00	5.00	4.22	
	25	4.00	2.75	4.50	5.00	5.00	4.25	
	26	4.00	1.90	4.50	5.00	5.00	4.08	
	27	4.00	2.40	4.50	5.00	5.00	4.18	
	28	4.00	2.75	4.50	5.00	5.00	4.25	
	29	4.00	2.75	4.50	5.00	5.00	4.25	
	30	4.00	2.80	4.50	5.00	5.00	4.26	
	31	4.00	4.41	4.50	5.00	5.00	4.58	
	32	4.00	3.75	4.50	5.00	5.00	4.45	
	33	5.00	4.50	4.50	5.00	5.00	4.80	
	34	4.00	3.00	4.50	5.00	5.00	4.30	
	35	4.00	3.75	4.50	5.00	5.00	4.45	
SX002	1	4.00	4.50	5.00	5.00	5.00	4.70	4.83
	2	5.00	4.50	5.00	5.00	5.00	4.90	
	3	5.00	4.50	5.00	5.00	5.00	4.90	
	4	5.00	4.50	5.00	5.00	5.00	4.90	
	5	5.00	4.50	5.00	5.00	5.00	4.90	
	6	4.00	4.50	5.00	5.00	5.00	4.70	
	7	4.00	4.50	5.00	5.00	5.00	4.70	
	8	5.00	4.50	5.00	5.00	5.00	4.90	
	9	5.00	4.50	5.00	5.00	5.00	4.90	
SX024	1	3.00	3.00	3.00	3.00	3.00	3.00	3.00

Notes: 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

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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

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SWG- SWG–2016–01027

SWCA Project No. 52872

October 2021

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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.

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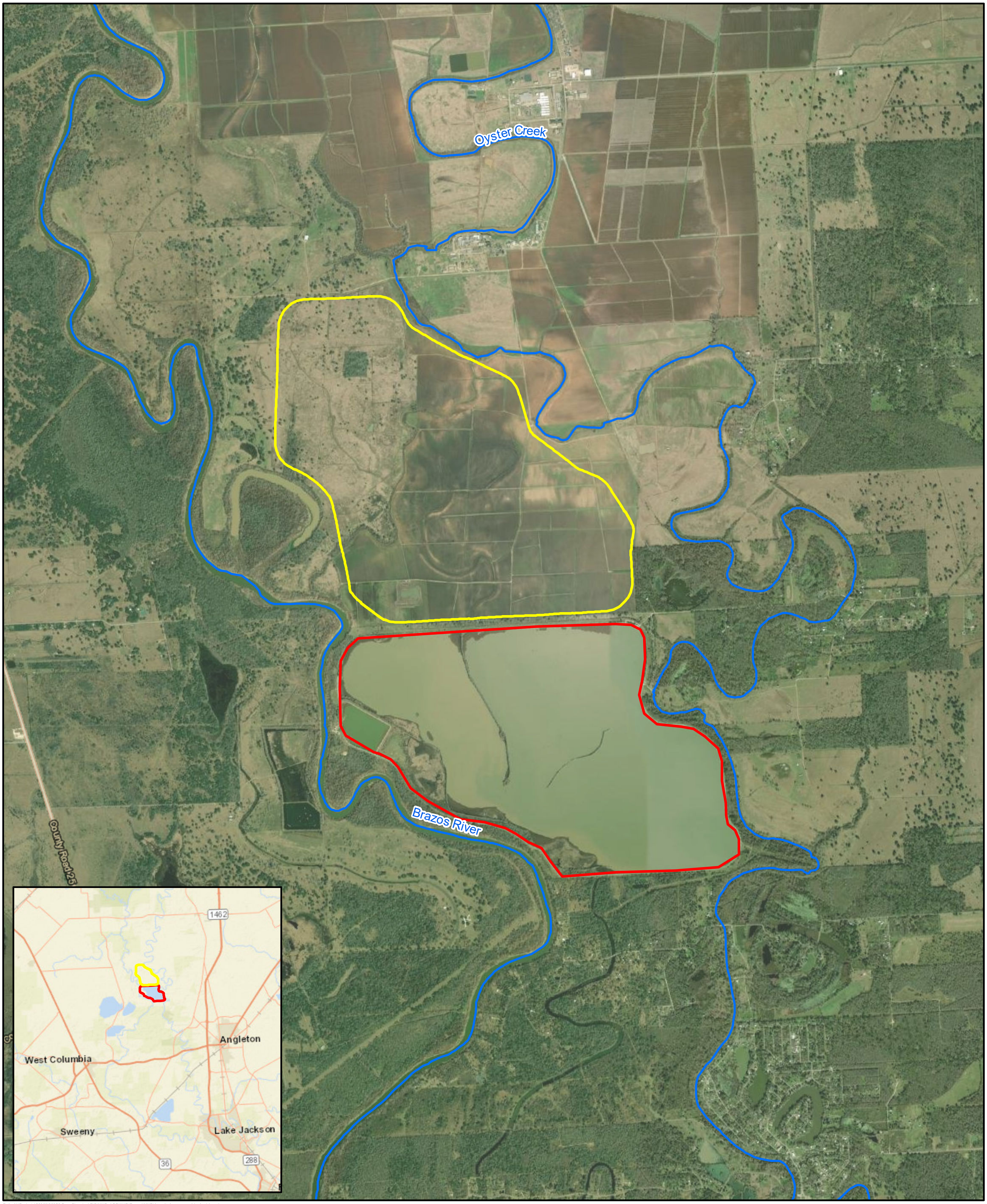
APPENDIX A

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

SWCA
ENVIRONMENTAL CONSULTANTS

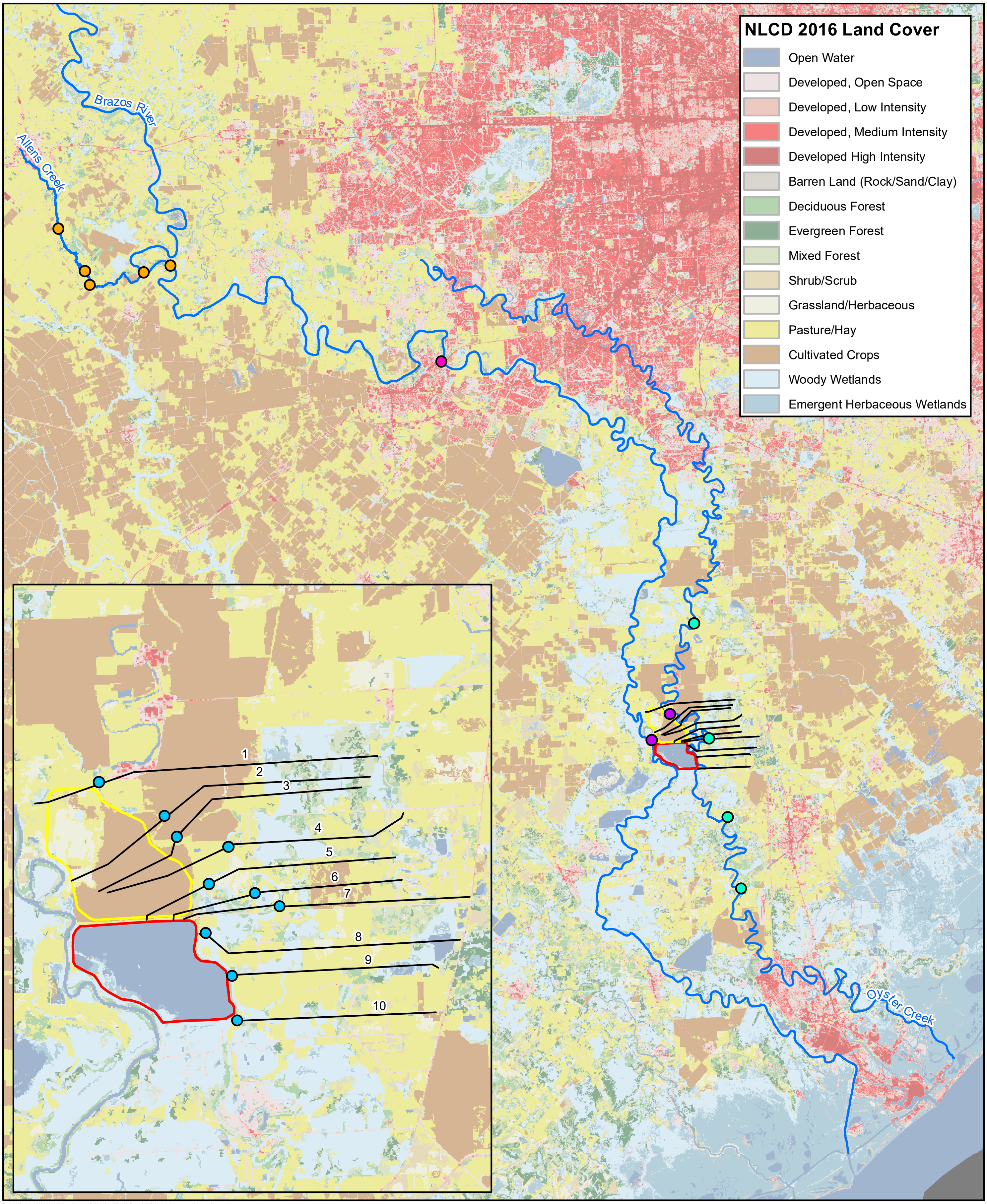
HARRIS RESERVOIR EXPANSION PROJECT
TOPOGRAPHIC MAP
BRAZORIA COUNTY, TEXAS
EXHIBIT 2

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

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

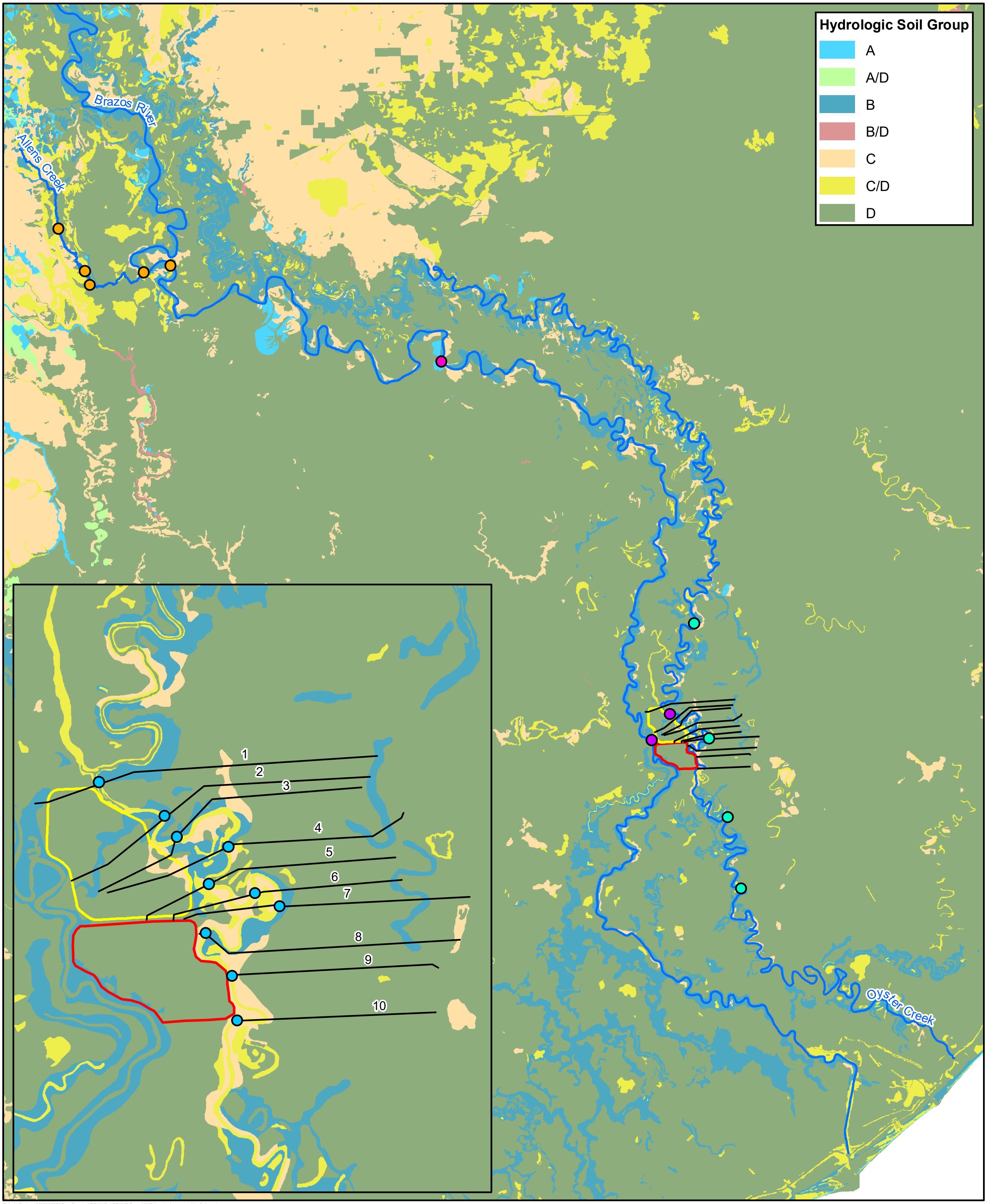
Proposed Harris Reservoir Expansion
Existing Harris Reservoir
Stream
Transects

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



HARRIS RESERVOIR EXPANSION PROJECT

HYDROLOGIC SOIL GROUP MAP
BRAZORIA COUNTY, TEXAS
EXHIBIT 4

SWCA ENVIRONMENTAL CONSULTANTS

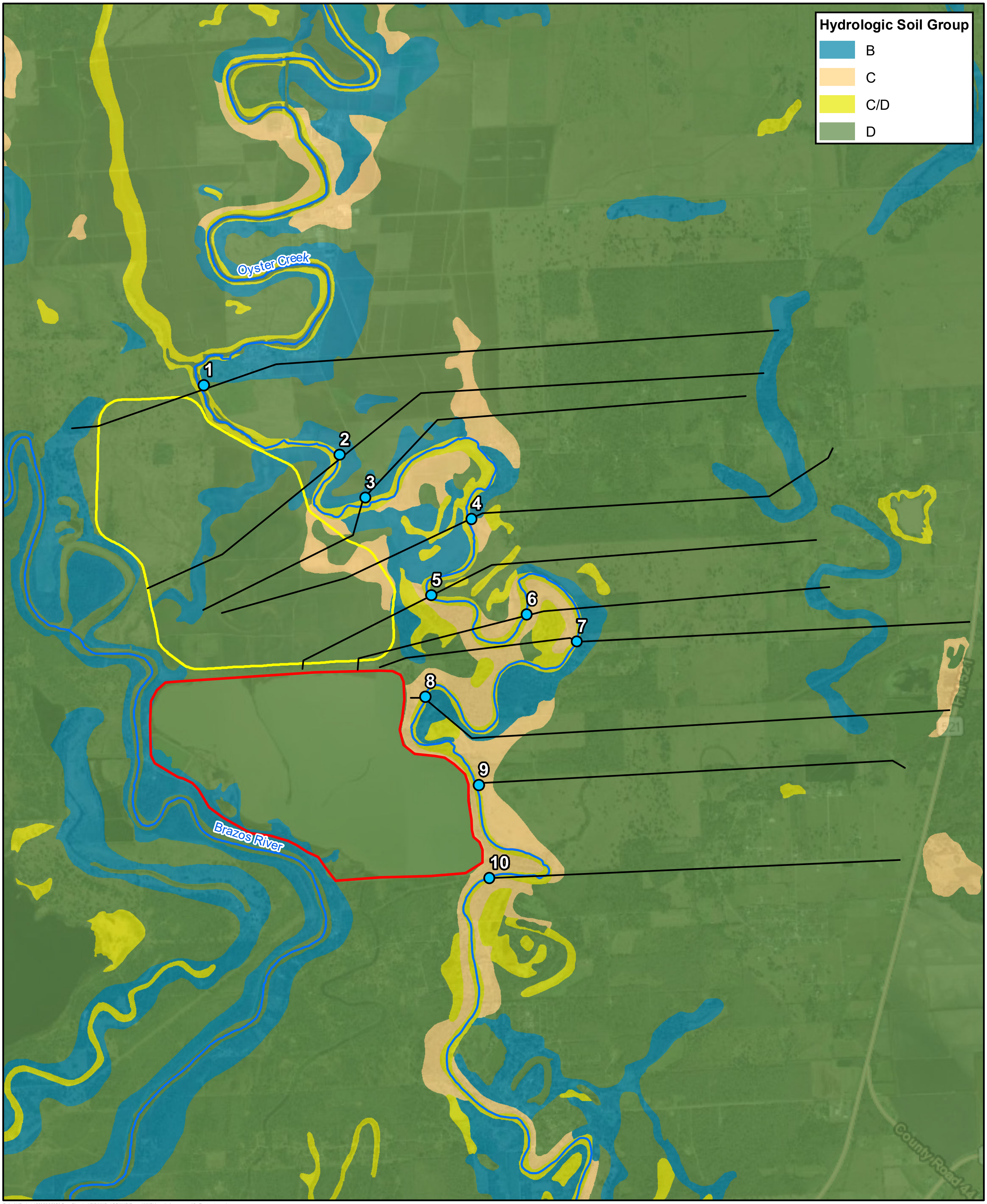
Proposed Harris Reservoir Expansion
Existing Harris Reservoir
Stream
Transects
1987 Sampling Sites
1993 Sampling Sites
2007 Sampling Sites
2019 Sampling Sites

1:475,000

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

N
S

0 2.5 5 Miles
0 2.5 5 7.5 Kilometers



HARRIS RESERVOIR EXPANSION PROJECT
TRANSECTS MAP
BRAZORIA COUNTY, TEXAS
EXHIBIT 5

SWCA ENVIRONMENTAL CONSULTANTS

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 J

Biological Assessment

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

DRAFT MARCH 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

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SWCA Project No. 52872

Draft March 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*). Although USACE is not required to consult with USFWS on candidate species per 50 CFR 402.12, this species is included in this BA because the USFWS may decide to list the species within the construction timeline of the proposed Project. The proposed Project may affect but is not likely to adversely affect the whooping crane, the Texas fawnsfoot, or the monarch butterfly. 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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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)).

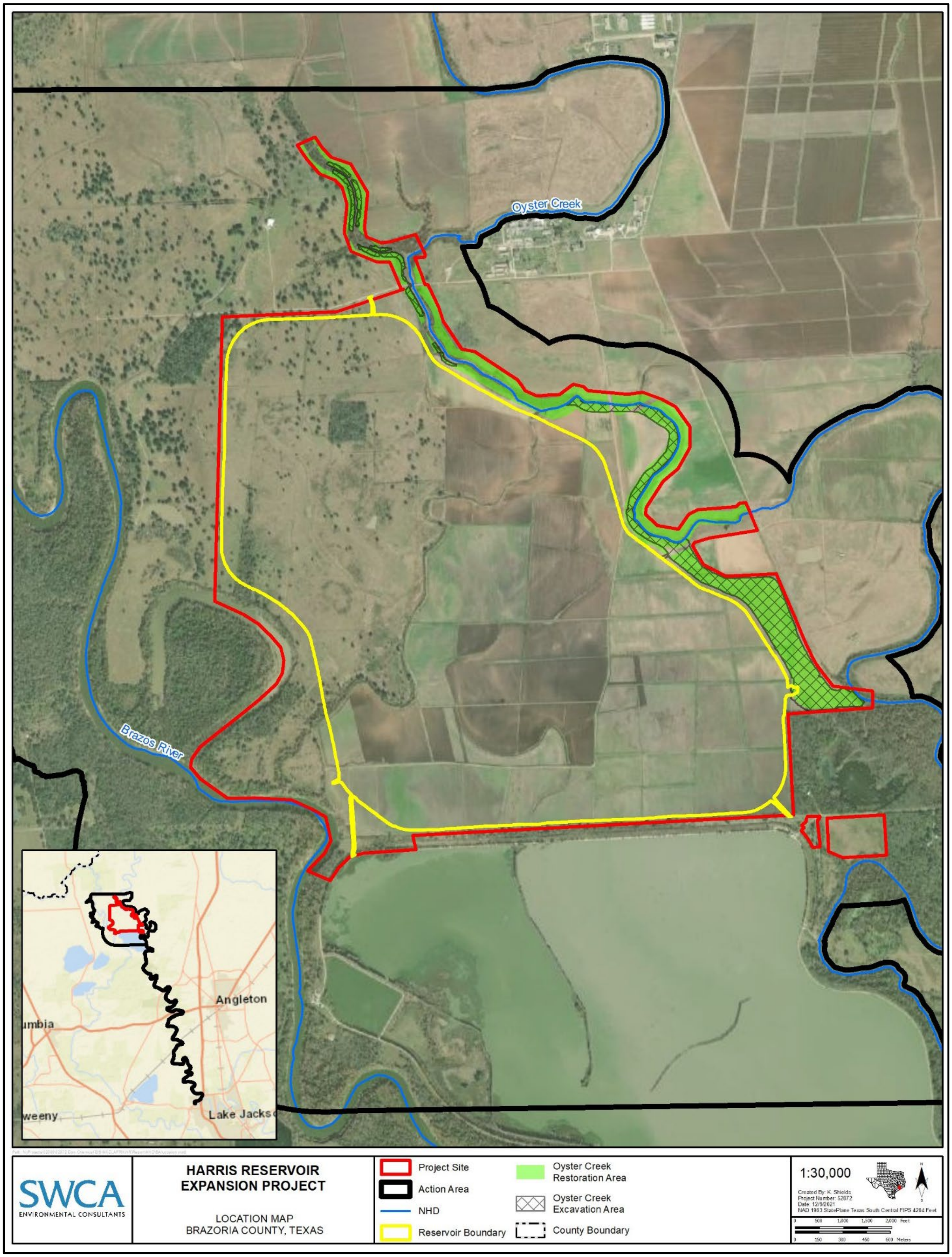

Figure 1. Project location.

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**

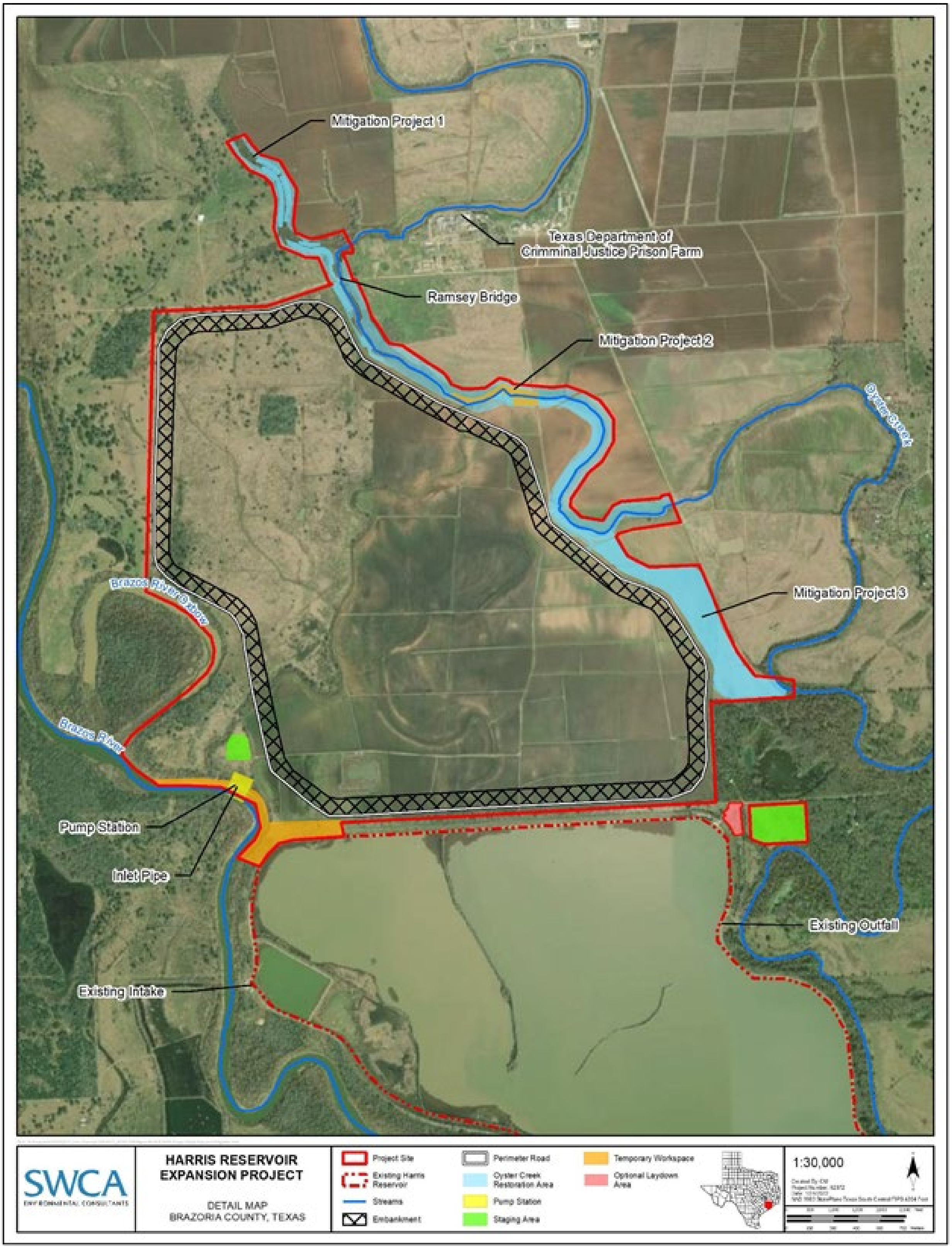

Figure 2. Project components.

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

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.

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.

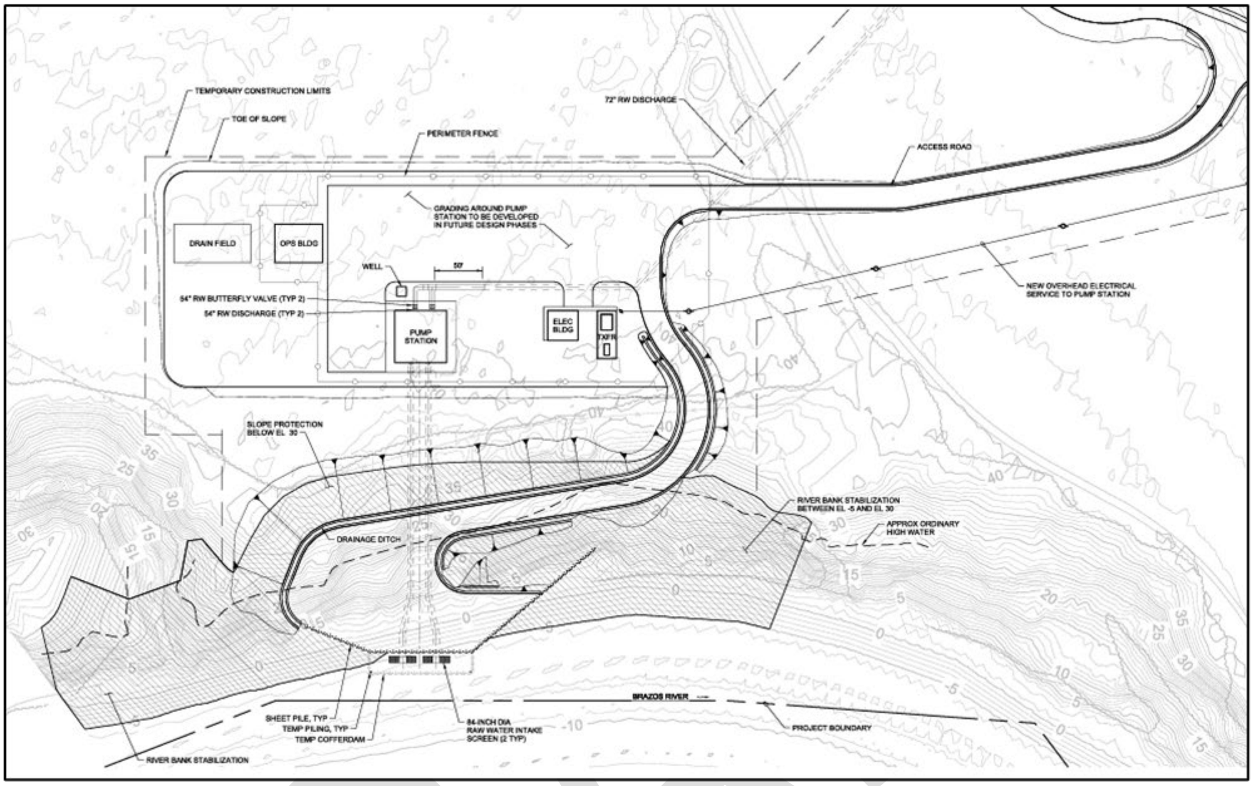

Figure 3. River intake and pump station.

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.

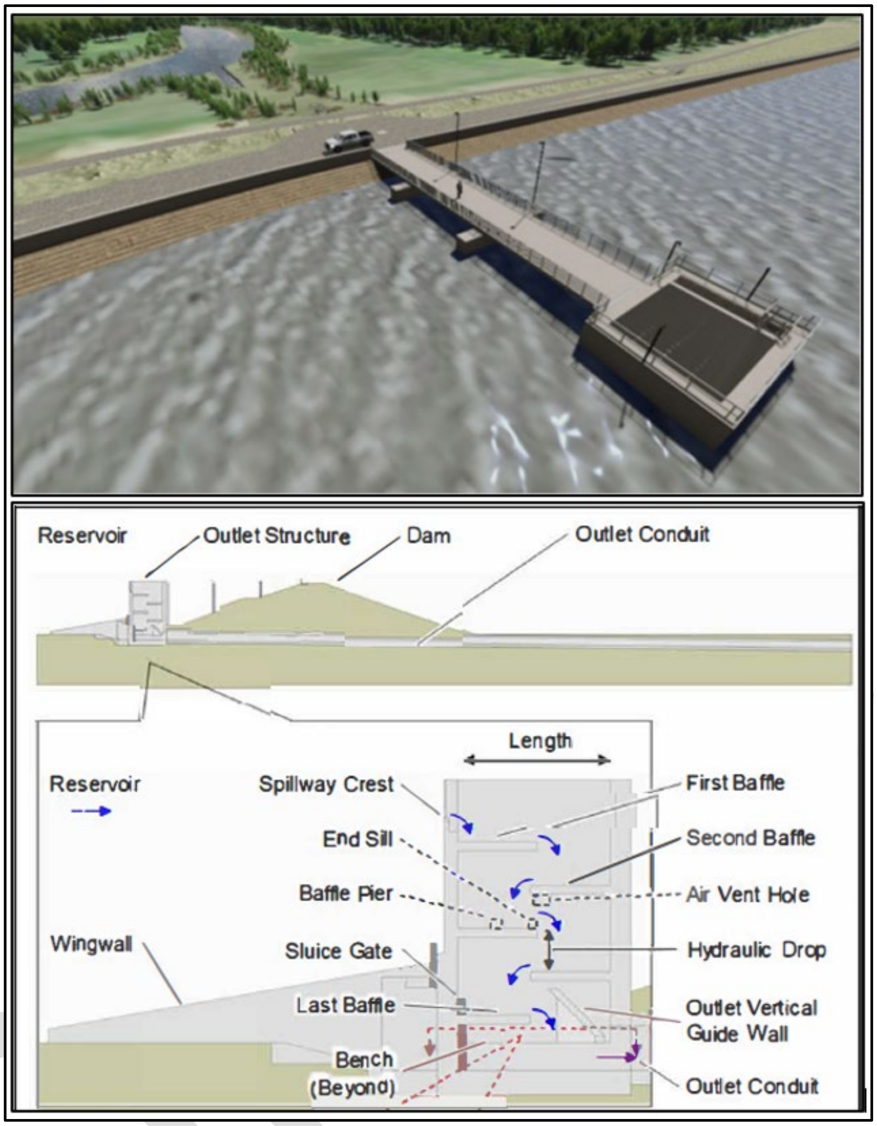

Figure 4. Reservoir outlet and emergency spillway.

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).

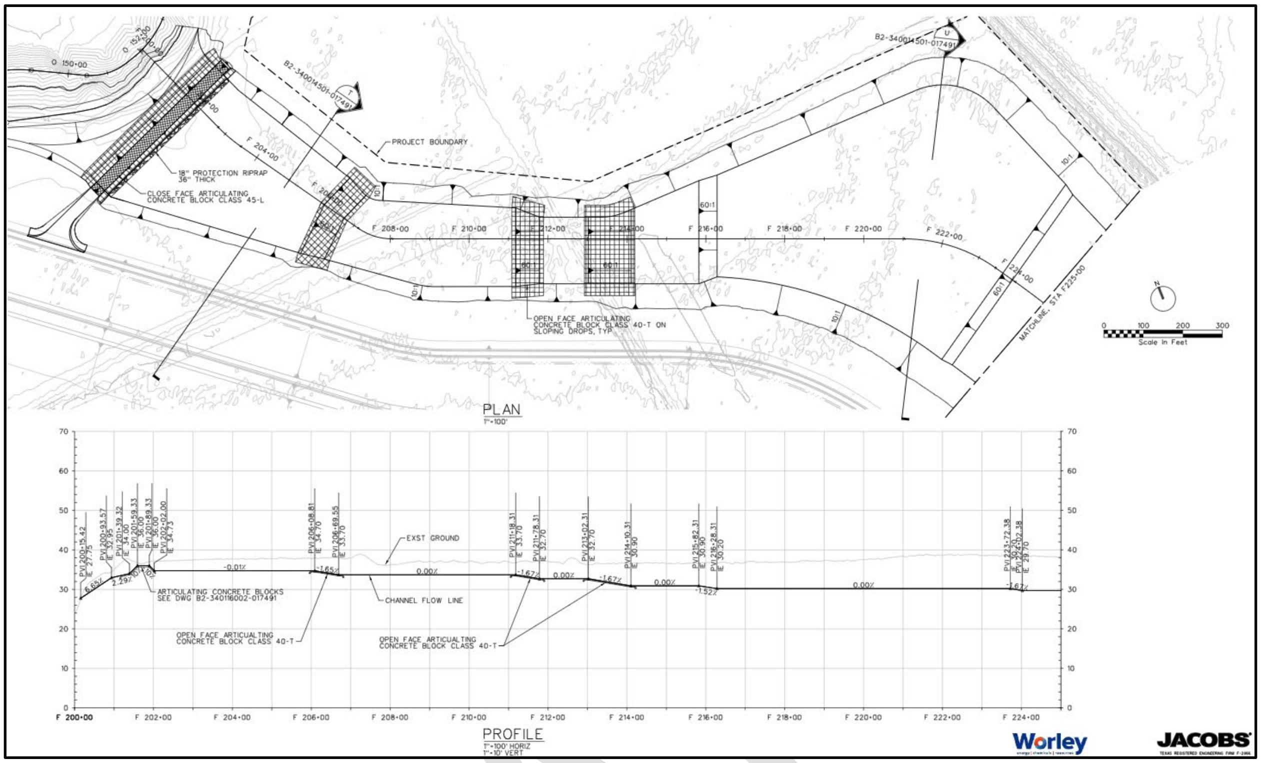

Figure 5. Oyster Creek Project 3.

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.

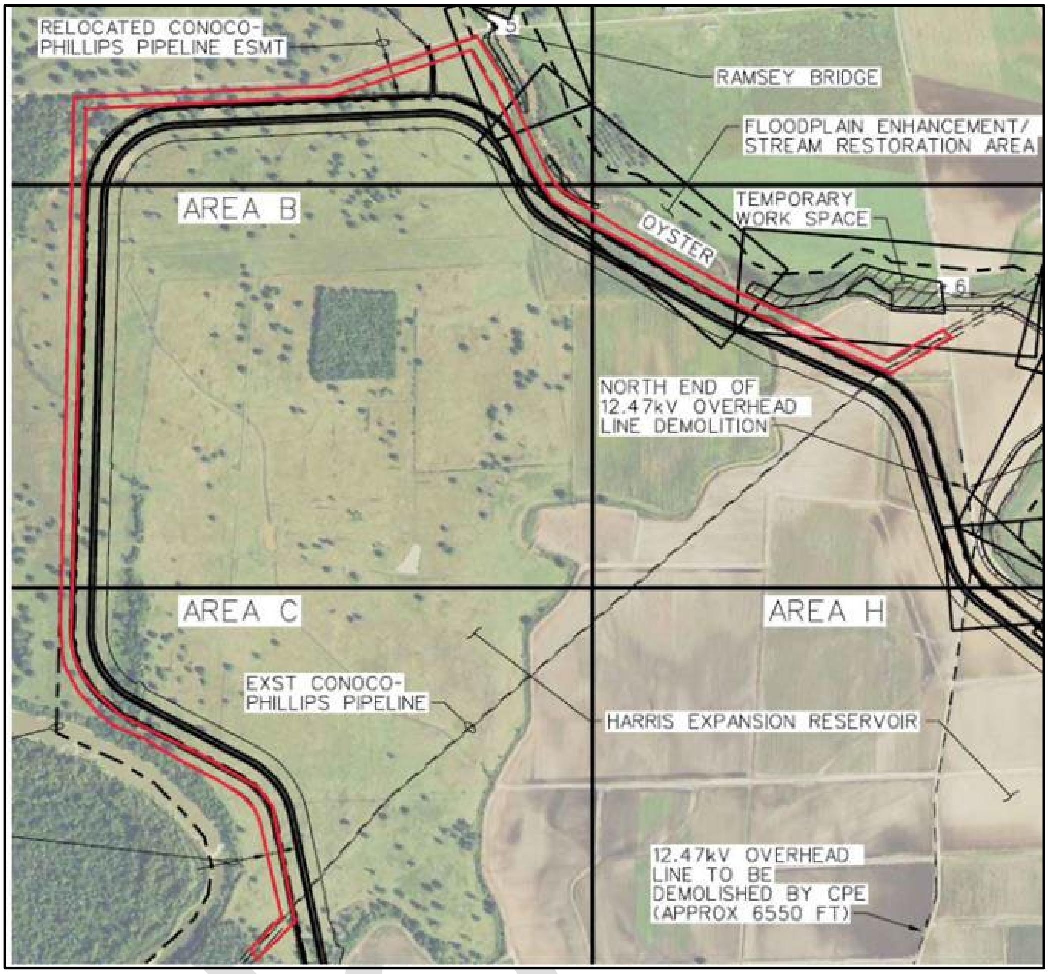

Figure 6. Existing ConocoPhillips pipeline and proposed route (Jacobs 2018).

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.

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 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;

[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.

- 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 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).

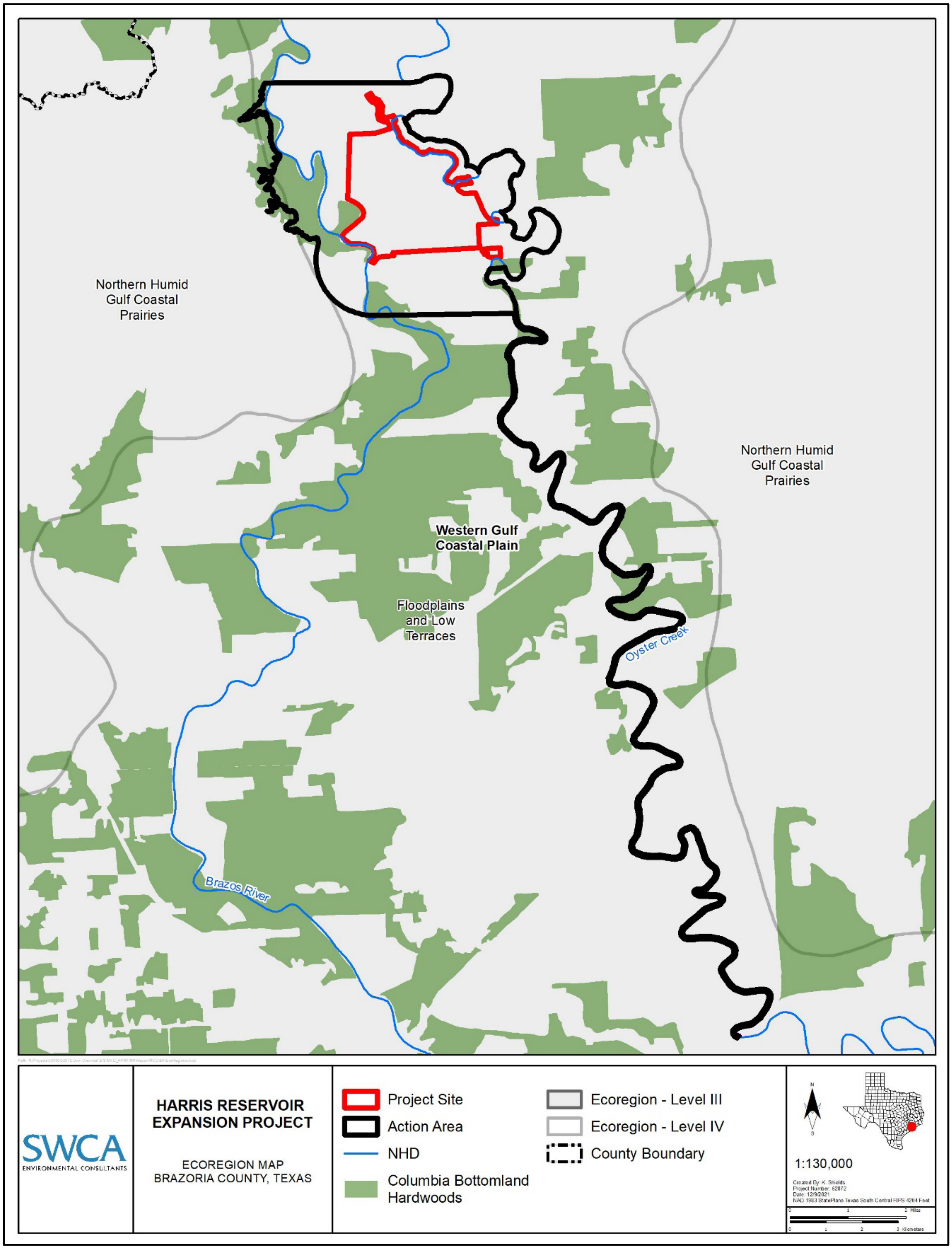

Figure 8. Ecoregions and Columbia bottomland hardwood areas within the Action Area.

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 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.

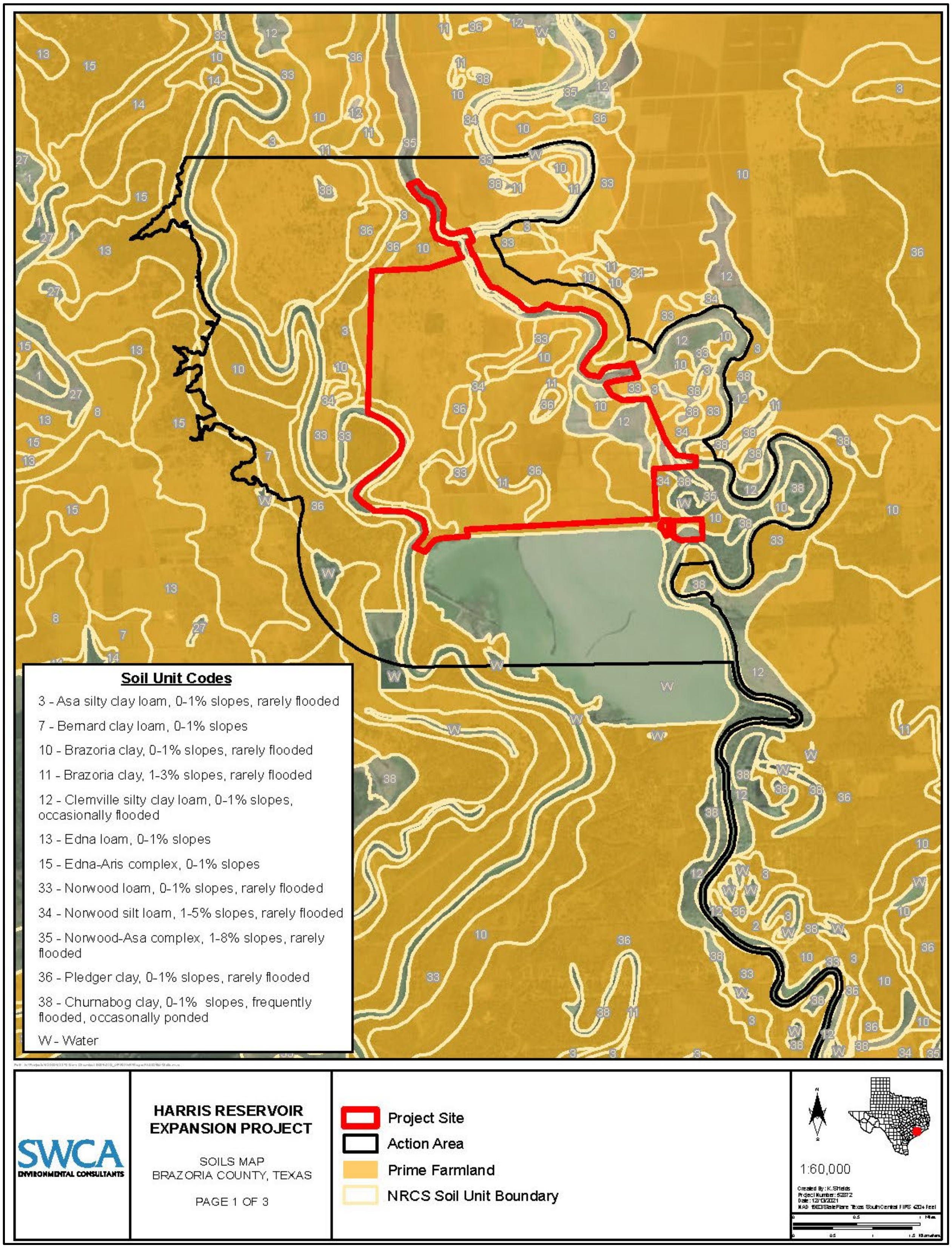

Figure 9. Soil map units in the Action Area (page 1).

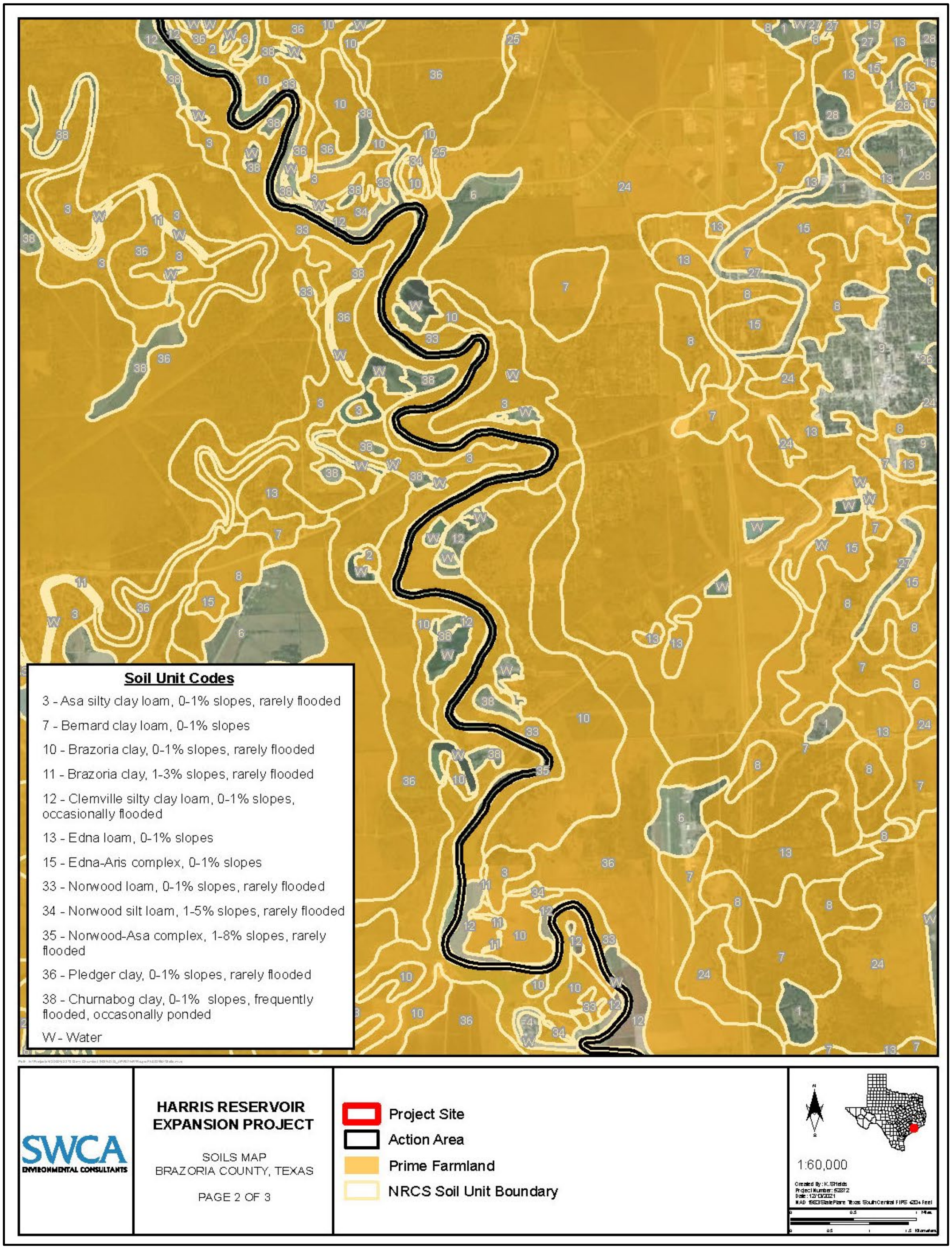

Figure 10. Soil map units in the Action Area (page 2).

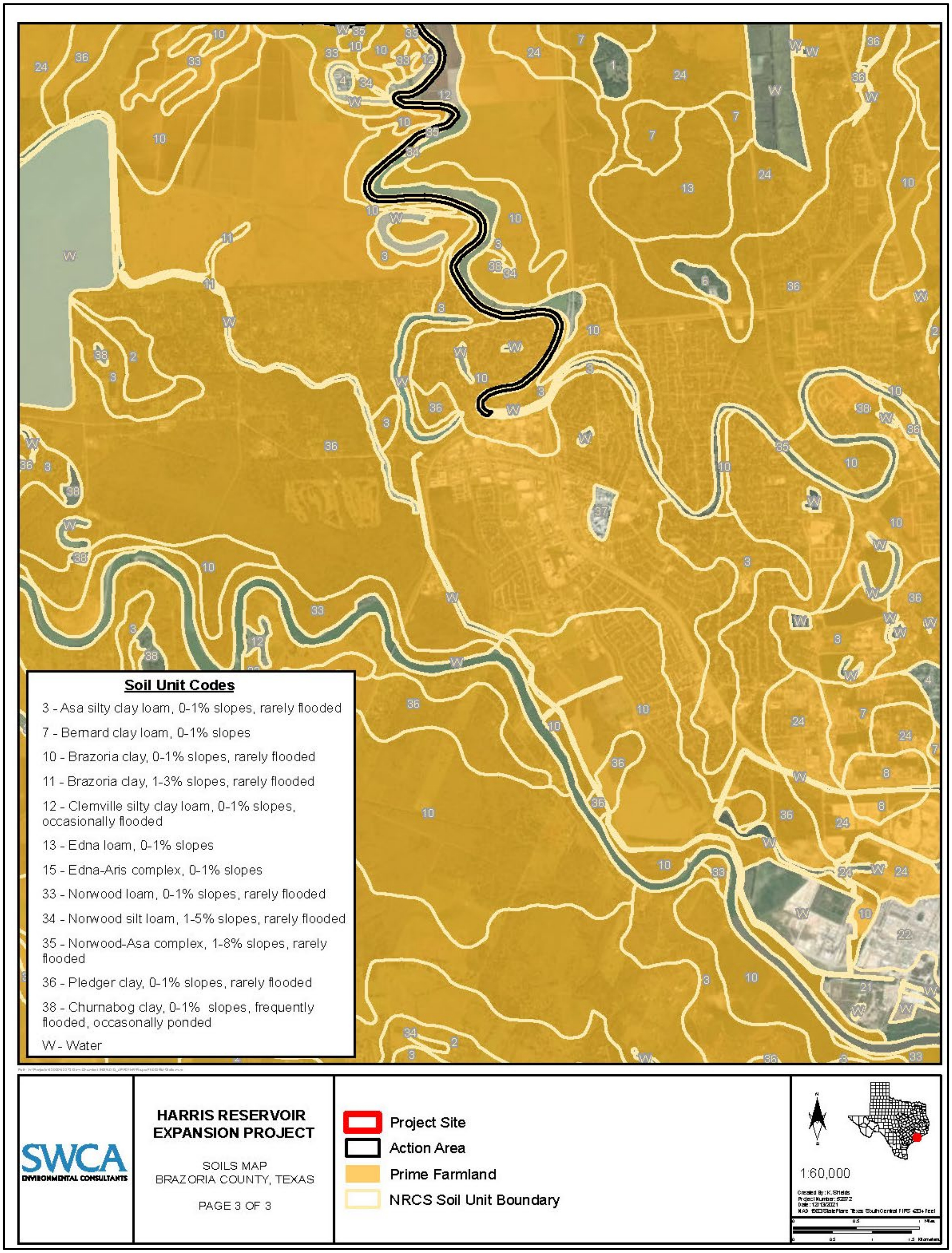

Figure 11. Soil map units in the Action Area (page 3).

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).

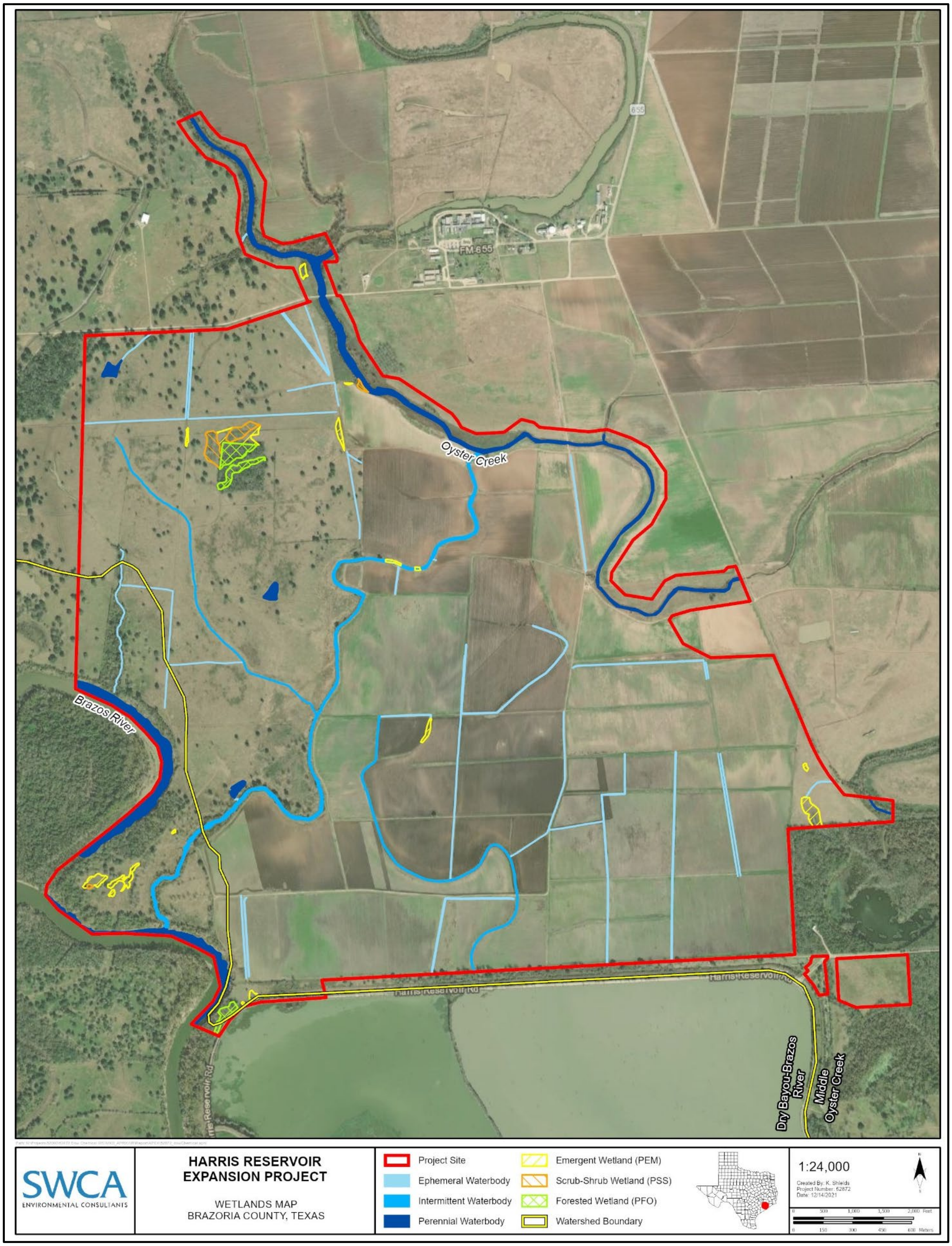

Figure 12. Delineated wetlands and waterbodies in the proposed Project site.

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).

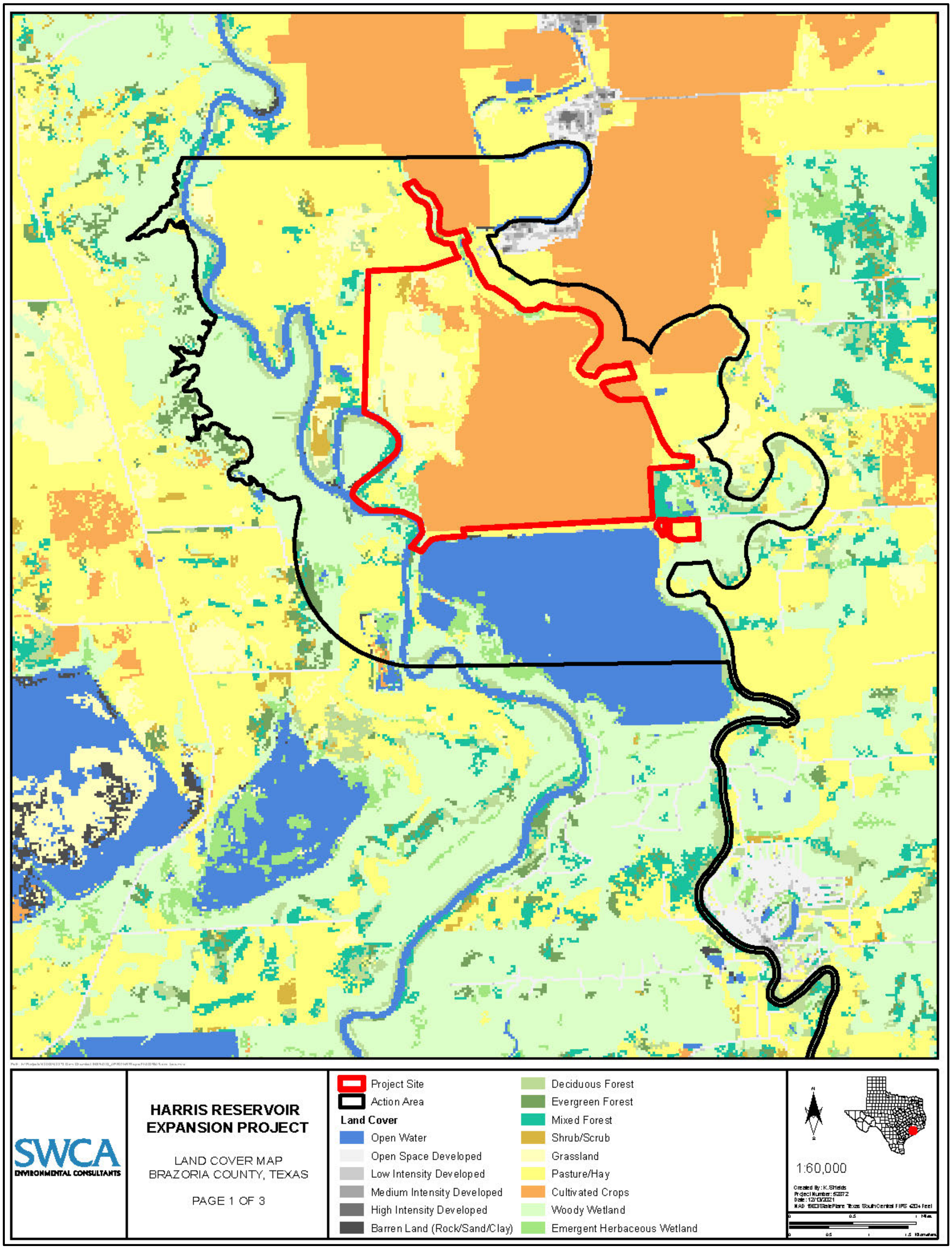

Figure 13. Land use and land cover in the Action Area (map 1 of 3).

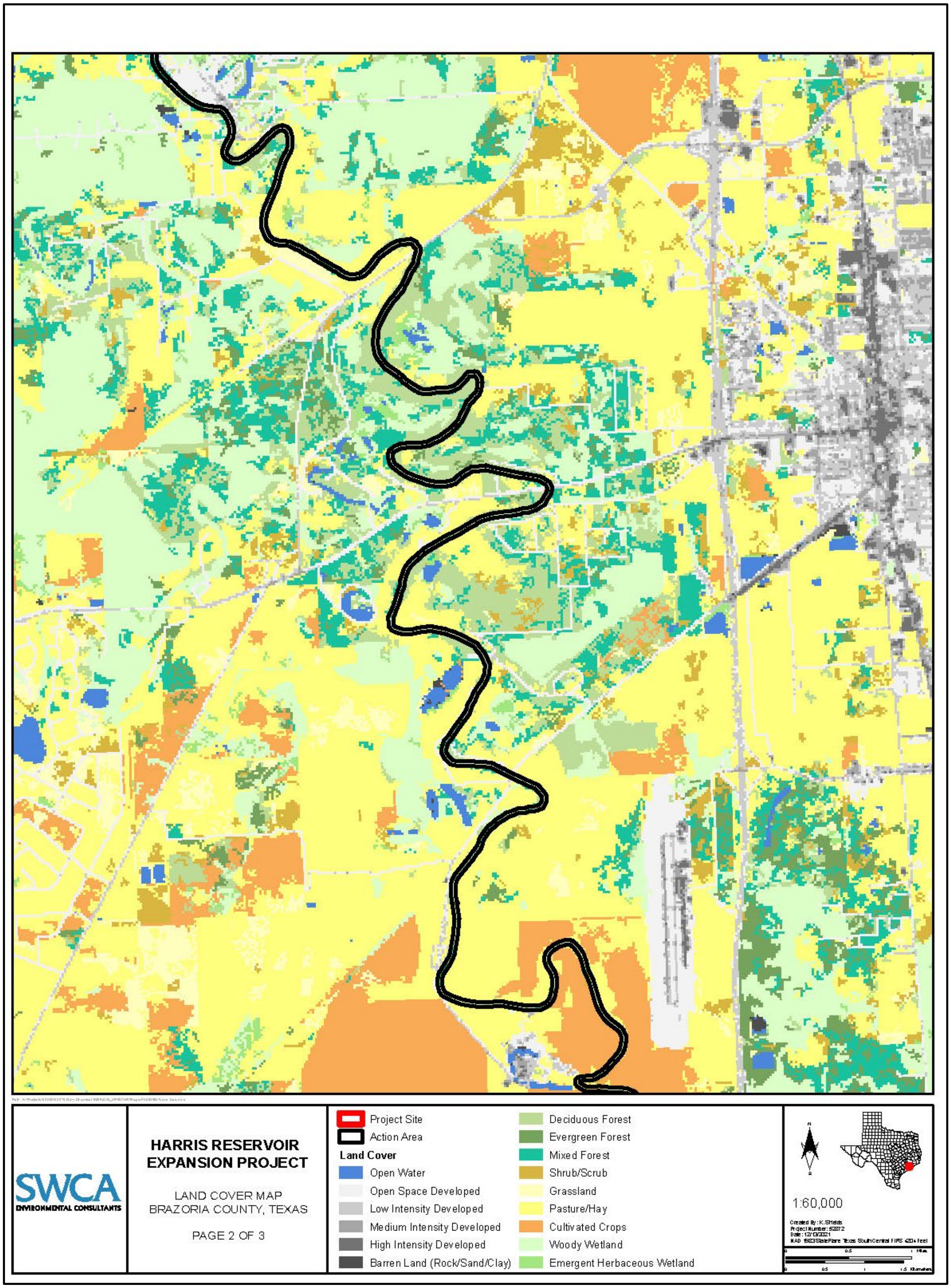

Figure 14. Land use and land cover in the Action Area (map 2 of 3).

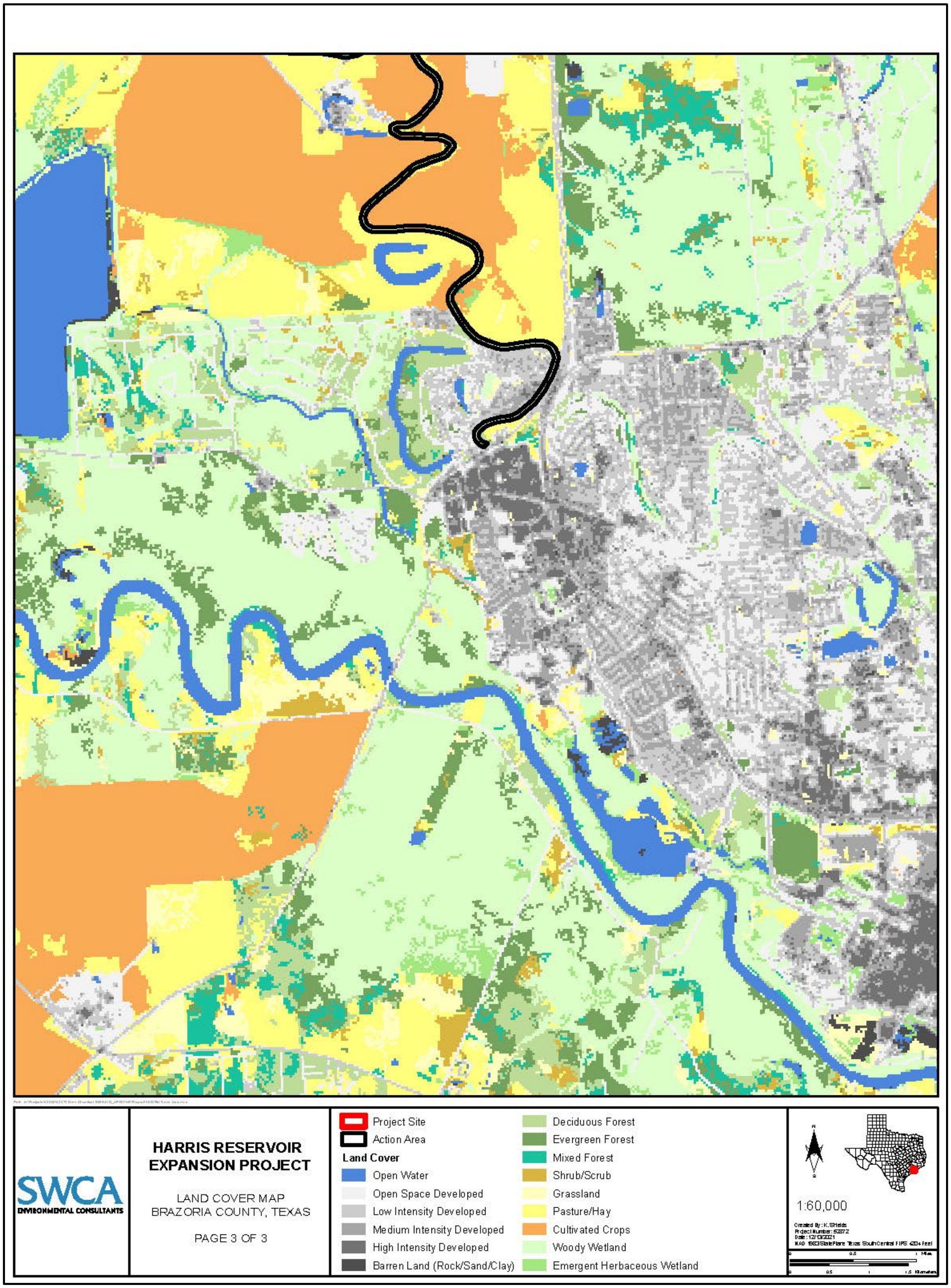

Figure 15. Land use and land cover in the Action Area (map 3 of 3).

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 (*Truncilla macrodon*), a freshwater mussel a species proposed for federal listing as threatened, and the monarch butterfly (*Danaus plexippus*), a species that is a candidate for future listing, in their official species list (USFWS 2021b). The USFWS published a proposed rule to list the Texas fawnsfoot as threatened with a 4(d) rule, and proposed Designated Critical Habitat on August 26, 2021 (Federal Register 86:47916). The monarch butterfly is included in the USFWS National Domestic Listing Workplan for the fiscal years 2021 to 2025 and plans to make a decision on the proposed listing of the monarch butterfly in the 2024 fiscal year (USFWS 2021d). Although federal agencies have no obligation to consult with USFWS on potential effects of the action on candidate species (50 CFR 402.12), with the current construction timeline for the proposed Project estimated to occur into 2026 (see Section 1.2.5), there is a possibility that the monarch butterfly may become a Listed Species during the proposed Project lifetime. Both the monarch butterfly and the Texas fawnsfoot are considered further in Table 7.

Table 7 includes an initial effects determination of "no effect" or "may affect" for each of the Listed Species, one proposed species, and one candidate 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). 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.

Common Name (*Scientific Name*) or Designated Critical Habitat	Federal Status*	Known Range, Distribution, and Habitat Requirements	Initial Effects Determination	Rationale for Initial Effects Determination
Insects				
Monarch Butterfly (*Danaus plexippus*)	C	Monarch butterfly migrates and breeds throughout Texas, including Brazoria County. The species requires milkweed as an obligate host plant (primarily *Asclepias* spp.), which is an essential component of habitat required for reproduction and survival of the species (USFWS 2020c).	May Affect	Due to the presence of an estimated 756 acres of potentially suitable habitat and occurrence records near the Action Area, monarch butterflies have potential to occur in the Action Area and in the proposed Project site. Activities associated with the construction of the proposed Project may remove or modify potentially suitable breeding or foraging habitat and may affect the monarch butterfly. The monarch butterfly and potentially suitable breeding habitat for the species has been documented in the vicinity of the Action Area, approximately 1.5 miles west, in the Nash Prairie Preserve (iNaturalist 2021). No monarch butterflies nor species of milkweed plants, including antelope horn (*Asclepias asperula*), zizotes (*A. oenotheroides*), or green milkweed (*A. virids*), were documented in the proposed Project site during the 2019 wetland delineation that included surveys along transects traversing upland herbaceous vegetation communities (SWCA 2019a). The Action Area occurs within the migratory pathway and breeding range for the monarch butterfly (USFWS 2020c).
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.
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.

Common Name (*Scientific Name*) or Designated Critical Habitat	**Federal Status***	**Known Range, Distribution, and Habitat Requirements**	**Initial Effects Determination**	**Rationale for Initial Effects Determination**
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.
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.

Common Name (*Scientific Name*) or Designated Critical Habitat	Federal Status*	Known Range, Distribution, and Habitat Requirements	Initial Effects Determination	Rationale for Initial Effects Determination
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; Randkllev 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).	May Affect	Due to the presence of potentially suitable habitat in the Action Area and overlap of the species' range with the Action Area, there is potential for the Texas fawnsfoot to occur in the Action Area. The Texas fawnsfoot has low potential for to occur in the proposed Project site. No Texas fawnsfoot individuals were detected during the 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 a freshwater mussel survey located approximately 560 feet downstream of the existing Harris Reservoir water intake structure (HDR Engineering 2012). Additional mussel surveys will occur in the proposed Project site in spring 2022. 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). Activities associated with construction of the proposed Project may affect the water quality of aquatic habitats in the Action Area and may affect the Texas fawnsfoot.
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.
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.

4 EFFECTS OF THE ACTION

The initial analysis identified one federally Listed Species, one species proposed for federal listing, and one candidate species that have the potential to occur in the Action Area and may be affected by the activities of the proposed Project (Figure 16; see Table 7). The Listed Species include the endangered whooping crane (*Grus Americana*), Texas fawnsfoot, and the monarch butterfly. In this section, the BA includes background information on the biology, baseline status, and an evaluation of the potential effects and potential consequences on these three species 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 lands, thus large-scale conversion of grasslands is not expected to occur that would contribute to cumulative effects to the loss of breeding habitats for the monarch butterfly (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.

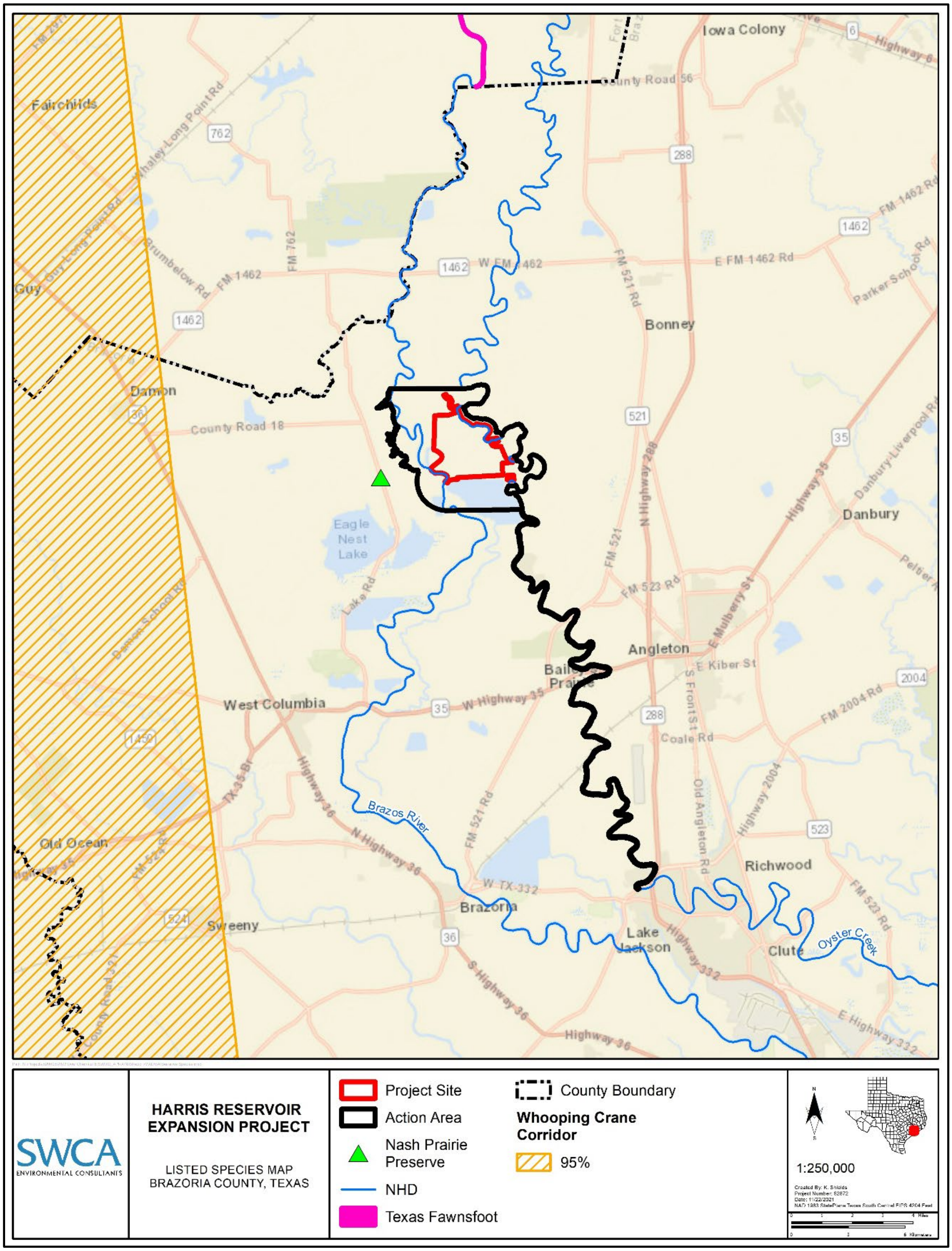

Figure 16. Documented occurrence of Texas fawnsfoot and the whooping crane migration corridor in the vicinity of the Action Area and proposed Project site. The monarch butterfly was detected in the Nash Prairie Preserve. There is no Designated Critical Habitat in the vicinity of the Action Area.

4.1 Texas Fawnsfoot

4.1.1 Biology, Life History, and Habitat

Texas fawnsfoot is a small- to medium-sized (2.4-inch [60-mm]) mussel with an elongate oval shell that may have green, yellow or brown hues, and markings arranged in rays, blotches, or zig-zag patterns (USFWS 2019b). The USFWS (2019b) describes the life-history of the species based on a synthesis of currently available scientific and commercial information. The Texas fawnsfoot has a larval life stage, a juvenile life stage, and an adult life stage. Larvae are obligate parasites of fishes, and for the Texas fawnsfoot, the host fish is assumed to be the freshwater drum (*Aplodinotus grunniens*). Juveniles detach from the host species, drop to the stream substrate, and burrow into interstitial spaces of the sediments and grow into adults. Adults reproduce via broadcast spawning in which males release sperm into the water column that is taken in by females through there siphon system. The female holds fertilized eggs in a chamber until they mature into larvae that are then released into the water column to attach to host fish. Juveniles and adults are sessile, thus dispersal and recruitment are mediated through the host's transport of larvae, and juvenile settlement into suitable substrates for growth and development into the adult life stage. Species of *Truncilla* are estimated to have a lifespan ranging from 8 years to 18 years.

The Texas fawnsfoot is a filter-feeder consuming phytoplankton, zooplankton, rotifers, protozoans, detritus, and dissolved organic matter that present in the water column (USFWS 2019b). Juveniles may also consume microorganisms available in the sediments (USFWS 2019b).

The Texas fawnsfoot are found in medium- to large-sized streams and rivers with flowing waters and substrates composed of mud, sand, and gravel substrates (Howells 2014; Randklev et al. 2017). Loose mud, unstable gravel deposits, and bedrock without large cracks are not likely to provide habitat for this species (Randklev et al. 2017). Flowing waters found in streams and rivers create the following habitat conditions that make them suitable for Texas fawnsfoot: oxygenation, nutrition, thermal conditions, and host-mediated dispersal and recruitment (USFWS 2019b). Adults are most often found in bank habitats and occasionally in backwater, riffle, and point bar habitats, with low to moderate velocities that appear to function as flow refuges during high flow events (Randklev et al. 2017). Streams and rivers subject to excessive flows may scour the substrates and make them unstable and consequently unsuitable for the Texas fawnsfoot (USFWS 2019b). Lentic environments, such as ponds, impoundments and reservoirs, and ephemeral streams, are not suitable habitats (USFWS 2019b).

The Texas fawnsfoot occurs in the lower reaches of the Colorado and Brazos Rivers, and in the Trinity River (Randklev et al. 2017) in seven populations: East Fork Trinity River, Middle Trinity River, Clear Fork Brazos River, Upper Brazos River, Middle/ Lower Brazos River, San Saba/Colorado Rivers, and Lower Colorado River (Federal Register 86:47916-48011; USFWS 2019b).

The Texas fawnsfoot is proposed for federal listing as threatened with a 4(d) rule (Federal Register 86:47916-48011). The USFWS (Federal Register 86:47916-48011) lists the following primary threats to the Texas fawnsfoot: drought and extremely high flow events, decreased water quality, and decreased substrate stability. For the Middle/Lower Brazos River population of the Texas fawnsfoot, primary threats are degradation of habitat from reduced flows, increased temperatures, and decreased water quality (Federal Register 86:47916-48011). Examples of decreased water quality include increased contaminants (e.g., pesticides, herbicides), nutrient loading (e.g., ammonia), increases in salinity, temperatures, and total suspended solids (USFWS 2019b).

4.1.2 Status in the Action Area

The Texas fawnsfoot inhabits the Lower Brazos River at low abundances (USFWS 2019b). The species has not been documented in Brazoria County (USFWS 2019b) but has been documented approximately 11 miles north of the Action Area, just south of the confluence between Cow Bayou and the Brazos River in Fort Bend County (Texas Natural Diversity Database 2021) (see Figure 16). No impoundments or other impediments occur between the documented occurrence of the Texas fawnsfoot and the portion of the Brazos River within the Action Area. Thus, the Texas fawnsfoot has potential to inhabit the Brazos River in the vicinity of the Action Area, currently or in the future. The segment of Oyster Creek that occurs in the Action Area has not previously been identified as being part of the historical or current distribution of the Texas fawnsfooot (USFWS 2019b), but it contains some areas of medium-sized stream with flowing water and substrates composed of mud, sand, and gravel substrates that may be suitable habitat for the Texas fawnsfoot (Howells 2014; Randklev et al. 2017). Currently, the amount of suitable habitat for Texas fawnsfoot in the Action Area is unknown and the Action Area is located outside the currently known distribution (USFWS 2019b). The historical distribution of the Texas fawnsfoot extends down to Lake Jackson (USFWS 2019b), including 6.8 river miles of the Brazos River and 38.2 river miles of Oyster Creek within the Action Area.

No populations of Texas fawnsfoot have been detected in the Action Area; however, additional surveys of the Brazos River and Oyster Creek along the Project site in 2022 will include species presence/absence and assessment of the amount of suitable habitat, if present. The results of the mussel habitat suitability assessment and presence/absence survey will be included in the final BA as a baseline to determine the effects of the action.

Previously, no live or dead shells of Texas fawnsfoot were found within a portion of the Brazos River approximately 1 mile downstream of the proposed intake during a mussel survey in 2012 (HDR 2012). Substrate appeared to be the primary limiting factor affecting the presence of mussels within the surveyed section of the river. Given that the historical distribution of the Texas fawnsfoot extends down to Lake Jackson (USFWS 2019b), the 6.8 river miles of the Brazos River and 38.2 river miles of Oyster Creek may contain suitable habitat. The intermittent and ephemeral streams within the proposed Project site are subject to high-flow velocities during high rainfall events (SWCA 2019a, 2019b) and therefore contain little habitat where the Texas fawnsfoot may seek refuge during high-flow events. Therefore, potential for this species to occur within these intermittent or ephemeral streams is rare to unlikely.

4.1.3 Effects of the Action

Approximately 6.8 river miles of the Brazos River are within the Action Area. It is unknown if suitable Texas fawnsfoot habitat is present within this segment of the Brazos River; however, 3,610 linear feet (0.7 river mile) would be temporarily affected for the pump station and temporary workspace (SWCA 2022). This is a small area compared to the 347.95 miles of occupied proposed Designated Critical Habitat for the Texas fawnsfoot in the Lower Brazos Unit (86 FR 47916) outside the Action Area.

Approximately 38.2 river miles of Oyster Creek are within the Action Area. It is unknown if suitable Texas fawnsfoot habitat is present within this segment of the creek; however, 10,108 linear feet (1.9 river miles) of Oyster Creek would be temporarily affected for temporary workspace and habitat restoration areas (SWCA 2022). Oyster Creek has not been identified as occupied proposed Designated Critical Habitat for the Texas fawnsfoot in the Lower Brazos Unit (86 FR 47916). Oyster Creek floodplain enhancement and habitat restoration projects are not likely to adversely affect the Texas fawnsfoot. USFWS (*Federal Register* 86:47916-48011) lists activities are unlikely to result in a violation of ESA Section 9, if these activities are carried out in accordance with existing regulations and permit requirements, and specifically lists provisions under 4(d) that include channel modifications and bank stabilization measures that enhance the habitat and water quality of the stream or river.

The proposed Project activities may affect habitats that could support the breeding, feeding, and sheltering behaviors of Texas fawnsfoot, if present, via changes in water quality (e.g., flow velocities, substrate stability, turbidity, temperatures) of the Brazos River or Oyster Creek. The proposed Project would temporarily affect the water quality of the Brazos River in the immediate vicinity of the intake structure. These effects would be localized and temporary; therefore, they are not expected to adversely affect known populations of the Texas fawnsfoot upstream of the proposed Project. Construction would involve excavation and pile driving that could increase the turbidity of the water via sedimentation and soil erosion. Turbidity increases associated with suspended sediments from construction are expected to be concentrated within 2,000 feet of the activity and dissipate with distance from the construction activities (NMFS and FHWA 2018). The Applicant would implement avoidance and minimization measures listed in Section 5 and in Appendix A to avoid and minimize temporary minor effects to water quality in the Brazos River.

Water quality would be affected in Oyster Creek downstream of the proposed Project during construction and operations. During construction, 10,108 linear feet of Oyster Creek would be temporarily affected for temporary workspace and habitat restoration areas (SWCA 2022). The proposed Project would only operate during drought conditions that would result in a wetting and drying cycle that could increase the bed and bank erosion when the sediment-deprived reservoir water is released (Watearth 2021a). This could cause channel incision and widening, thus increasing the sediment load farther downstream and result in impacts to water quality (Watearth 2021a). The increased flows during drought could also result in lower water temperatures (Watearth 2021a). The likelihood and magnitude of these potential impacts is unclear. The Applicant proposes a monitoring and adaptive management program to avoid and minimize water quality impacts in Oyster Creek.

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 proposed Project site.

Construction and operation of the proposed Project would affect 1,028 ac-ft (1%) of the floodplain storage of the Brazos River and Oyster Creek. The loss of floodplain storage would cause increased peak flows downstream of the proposed Project in Oyster Creek that would result in increased flow velocities, increase sedimentation, erosion, and reduced stability of soils that reduce the suitability of habitats for the Texas fawnsfoot, downstream of the Action Area. Watearth's (2021b) hydrologic modeling indicates the proposed Project would have no effect to hydrology or hydraulics of the Brazos River. The Applicant would avoid and minimize affects to the floodplain storage through the three on-site floodplain enhancement projects along Oyster Creek. These three projects would reduce the loss of floodplain storage to 1,028 ac-ft (1%) loss of floodplain storage during a 100-year storm event (Watearth 2021a, 2021b). The Applicant would also address the floodplain storage loss by implementing operational measures described in Dow's Operation and Maintenance Plan (Dow 2022). For example, full pool water surface elevation would be maintained at 68 feet, which would provide adequate capacity to capture up to 6 inches of rain, and Dow would implement emergency drawdown of the proposed reservoir in advance of a tropical storm (hurricane) landfall near the proposed Project site.

Host fishes may become entrapped or entrained in intake structures and be killed or injured (NMFS and FHWA 2018). Killing or wounding host fish may indirectly affect the larval stage of Texas fawnsfoot that parasitize fishes. The Applicant would implement avoidance and minimization measures including screened intakes to avoid and minimize entrapment and entrainment of host fish (see Appendix A). Effects to the habitats that support host fish in Oyster Creek may indirectly affect the Texas fawnsfoot.

Although Texas fawnsfoot has not been documented in Oyster Creek, populations are dependent on host fish such as the freshwater drum for persistence (USFWS 2019b). Operation of the proposed Project would affect the water quality of Oyster Creek downstream of the proposed Project as described above, that could affect the fishes, resources, and habitats of fishes during drought conditions.

Based on the available data on the distribution and occupancy of the Texas fawnsfoot, its status in the Action Area, the expected extent of effects to potentially suitable habitat in the Action Area, and the Applicant's proposed conservation measures to reduce and minimize effects to flows and water quality of the Brazos River and Oyster Creek, the proposed Project's actions would not jeopardize the continued existence of the Texas fawnsfoot.

The USACE determines that the effects of the proposed Project's actions "may affect, not likely to adversely affect" the Texas fawnsfoot due to degradation of water quality in the Action Area. The Applicant has voluntarily proposed to implement avoidance and minimization measures to address these adverse effects.

4.2 Whooping Crane

4.2.1 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 2020d). 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 (2020d), 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).

4.2.2 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.

4.2.3 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 and Appendix A). 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, 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.

4.3 Monarch Butterfly

The monarch butterfly is a candidate for listing as threatened or endangered (USFWS 2020c). Although federal agencies are not required to consult on candidate species, it is possible that the USFWS may decide to list the monarch butterfly as threatened or endangered under the ESA within the timeline of the proposed Project. Should the monarch butterfly become listed in the future, initiation of ESA Section 7 consultation could be applicable. Therefore, the effects of the proposed Project are discussed herein.

4.3.1 Biology, Life History, and Habitat

Monarch butterflies occur in Texas during the spring both for breeding (March through early July) and as pass-through migrants (late April through late July), and occur in the state again as south-bound migrants during the fall, generally from September through early November (Monarch Joint Venture [MJV] 2021; USFWS 2019c). Monarchs in Texas are part of an eastern population that overwinters in the mountains of central Mexico, primarily in the state of Michoacán (USFWS 2020c). Monarchs migrating through Texas are found in a variety of habitats with abundant nectar plants including native prairies, pastures, open woodlands and savannas, desert scrub, roadsides, and other habitats, including urbanized areas. Milkweed (primarily *Asclepias* sp.) is an obligate host plant for egg deposition and is an essential component of habitat required for reproduction and survival of the species (USFWS 2020c). The USFWS (Tuggle 2014) noted three milkweed species common in Texas that are important to monarch butterflies: antelope horn (*Asclepias asperula*) that blooms between March and July, Zizotes (*A. oenotheroides*) that blooms between March and October, and green milkweed (*A. viridis*) that blooms between April and September. Green milkweed is the most common species for Brazoria County, Texas.

The annual life cycle of the eastern population of the monarch occurs in three to four generations and begins as butterflies from the previous year head north in March from their overwintering site in Mexico. These butterflies lay eggs in the southeastern United States that will become the year's "generation 1" butterflies (MJV 2021). The eggs that produce generation 1 butterflies are laid from late March to early May, becoming mature adult butterflies from late April to June; only a matter of days later, generation 1 lays the eggs of generation 2 butterflies farther north within the southeastern United States (MJV 2021). Generation 2 butterflies emerge as adults in June and July, moving farther north and breeding days later in the northern United States during the summer breeding period, laying the eggs of generation 3 (MJV 2021). Early generation 3 butterflies may breed again in the northern United States to produce a generation 4, with this the generation that then migrates south to Mexico; however, any generation 3 butterflies that emerge later in the season will undergo diapause (suspended reproduction) and migrate south to Mexico with generation 4 butterflies (MJV 2021; USFWS 2020c). Generally, an individual monarch spends 2 to 5 days within its egg, 9 to 18 days as a larvae (molting four times, categorized as five instars), 6 to 14 days inside a chrysalis before emerging, 2 to 5 weeks as an adult butterfly during generations 1, 2, and possibly 3, and 6 to 9 months during final generations (generations 3 or 4) (MJV 2021; USFWS 2020c). Thus, based on information produced by the USFWS (2020c), it appears monarch butterflies could be present in Texas from March through late July as eggs, larvae, and breeding and migrating adults, and from September through early November as migrating adults. However, monarchs have been recorded in Texas from all months of the year (iNaturalist 2021; Journey North 2019). It is unclear whether the "out of season" records represent a combination of late fall migrants and early spring migrants, or may include some overwintering individuals.

4.3.2 Status in the Action Area

The Action Area is within the species' fall and spring migration corridors, as well as their spring breeding area (USFWS 2018). The migration of monarch butterfly is diffused across its migratory corridor and the entire state of Texas is included in the monarch butterfly spring migration (MJV 2021; USFWS 2020c). Based on the NLCD land cover data (see Section 2.6), within the Action Area there are approximately 3,184.1 acres of grasslands, herbaceous uplands, and pasture lands that may be used by the monarch butterfly during migration, where suitable nectar and host plants are available. The monarch butterfly and potentially suitable breeding habitat for the species have been documented in the vicinity of the Action Area, approximately 1.5 miles west, in the Nash Prairie Preserve (see Figure 16) (iNaturalist 2021). Several tagged adult monarchs were observed in Katy and Houston, Texas, north of the Action Area during the 2017–2020 Monarch Watch field seasons (Monarch Watch 2021).

Although the Applicant has not performed species-specific surveys for the monarch butterfly, there has been considerable effort surveying the vegetation communities during wetland delineations within the proposed Project site (Cardno and Jacobs in 2012, 2018, and 2019 [Cardno 2019]; SWCA in 2019 [SWCA 2019a]). Vegetation sampling as part of wetland delineations occurred along east-west transects that traversed the entire proposed Project site. Wetland delineations in March 2012, December 2018, and February 2019 occurred along 11 transects, collecting data on soils, vegetation, and hydrology at 73 sample points located in uplands and wetlands. The wetland delineations in June and July 2019 occurred along nine transects, collecting similar types of data at 168 sample points located in uplands and wetlands (Figure 17). Per the USACE (1987) manual and regional supplements (USACE 2010) the sample plot radii for the wetland delineations ranged between 5 feet and 30 feet depending on type of vegetation community in the sample plot (Cardno 2019; SWCA 2019a).

No monarch butterflies nor milkweed plants identified as important to this species (antelope horn, zizotes, or green milkweed) were documented amongst that data collected from 241 upland and wetland sample points in the proposed Project site (Cardno 2019; SWCA 2019a). Most of the vegetation sampling occurred in March, June, and July during the blooming period of all three milkweed species. Based on the survey effort and the timing of surveys, it is probable that antelope horn, zizotes, or green milkweed would have been detected if these species were dominant plants (or occurred in clusters) on the proposed Project site.

The data from the 241 sample points indicate the upland herbaceous communities are dominated by grasses associated with pasturelands. The dominant vegetation identified in the upland herbaceous areas were nonnative, invasive, or noxious grasses and weeds including Bermuda grass (*Cynodon dactylon*), perennial ryegrass (*Lolium perenne*), Santa Maria feverfew (*Parthenium hysterophorus*), and giant ragweed (*Ambrosia trifida*) (SWCA 2019). These species grow in disturbed and overgrazed areas, reducing and outcompeting native prairie plant species. Representative photographs of the upland herbaceous communities are included in Appendix B. SWCA (2019a) occasionally detected a few (i.e., <10% cover) nectar-producing plants that may provide forage for monarch butterflies, including Turk's cap (*Malvaviscus arboreus*), Indian blanket (*Gaillardia pulchella*), and spotted bee-balm (*Monarda punctata*), as well as a few (i.e., <10% cover) aquatic milkweed (*A. perennis*) in uplands adjacent to wetlands.

The available data on the vegetation communities in the proposed Project site indicates that some potentially suitable foraging habitat for monarch butterflies (i.e., nectar-producing plants) is present in the upland herbaceous grasslands in the proposed Project site, but breeding habitat (milkweed host plants) is likely not present or may be marginally present. Based on a desktop assessment using a combination of the vegetation data from sampling points and NLCD land cover data (Section 2.6), an estimated 755.5 acres of potentially suitable herbaceous grassland habitat for the monarch butterfly occurs within the proposed Project site (see Figure 17). This potentially suitable habitat is of marginal quality for several reasons. The available data indicates that the three milkweed species (i.e., antelope horn, zizotes, and green milkweed) that are important to breeding monarch butterflies are not present or uncommon within the proposed Project site. Nectar-producing plants are also uncommon (<10% cover). The upland herbaceous communities are grazed and dominated by grasses and invasive weedy plants adjacent to cultivated crops treated with herbicides.

Since monarch butterfly is a widely occurring, highly mobile, species that migrates and breeds across central Texas, it probable that individual monarch butterflies fly or flit across the proposed Project site and occasionally forage on nectar flowers in the potentially suitable habitat in the proposed Project site between spring and fall. The number of individual monarch butterflies that fly or flit across the proposed Project site would be low due to the marginal quality of the potentially suitable habitat.

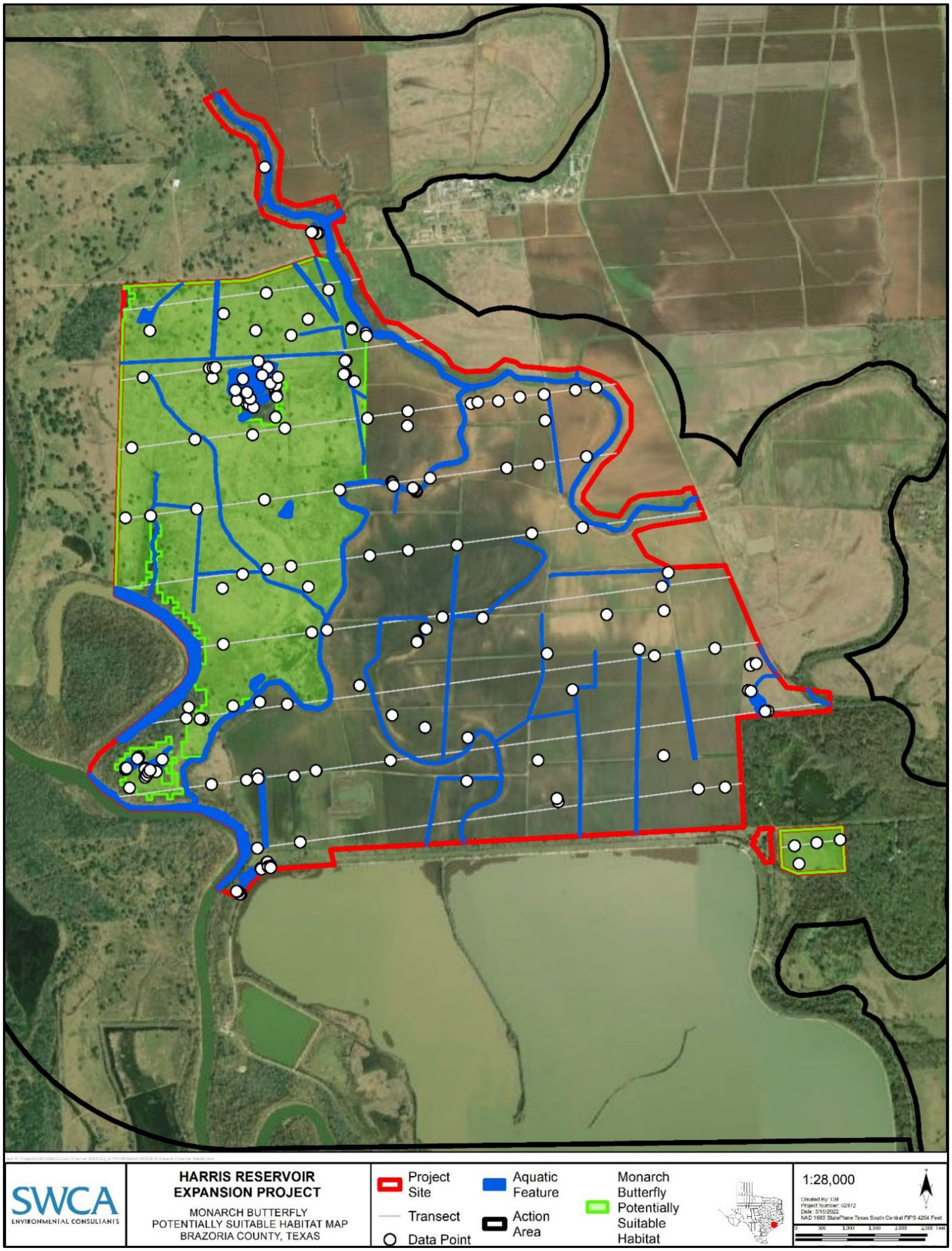

Figure 17. Desktop mapping of potentially suitable habitat for the monarch butterfly in the proposed Project site. Transects and data points sampled during SWCA's (2019a) wetland delineation are also shown.

4.3.3 Effects of the Action

The proposed Project is expected to result in the loss of flowering plants within the mapped potentially suitable habitat (see Figure 17) reducing food resources of adult monarch butterflies. Potential loss of a small number of milkweed plants that monarch butterflies could use for reproduction may occur. In addition, depending on the time of year that vegetation-clearing activities are performed, development activities could result in the destruction of monarch butterfly eggs or death of monarch butterfly caterpillars. The proposed Project site contains approximately 755.5 acres of potentially suitable habitat determined to be of marginal quality, as described in the previous section. Any impacts to the monarch butterfly caused by the proposed Project are likely to be minor given the monarch is a highly mobile species that migrates along wide corridor that spans entire state of Texas (USFWS 2020c).

The USFWS (2020c) and Jepsen et al. (2015) state that restoration of migratory habitat is important for conservation of the monarch butterfly. The Applicant proposes to use an upland seed mix that includes milkweeds (*Ascelpias* spp.) in off-site mitigation areas to reduce impacts from the proposed Project and improve the availability of breeding habitat in the Action Area (see Section 5 and Appendix A). The Applicant would further minimize impacts through the incorporation of voluntary conservation measures including monitoring, management, and remediation of invasive plant species; and evaluation and targeted application of herbicides, pesticides, and fertilizer to minimize impacts to non-target plant and insect species (see Section 5 and Appendix A).

The proposed Project would result in the loss of 755.5 acres (23%) of marginal quality potential monarch habitat of the 3,184.1 acres of potentially suitable habitat in the Action Area and a very small (i.e., <0.01%) of the mapped migration corridor for the monarch butterfly in the state of Texas (USFWS 2020c). The loss of this marginal herbaceous grassland may result in a small reduction in the total available migratory habitat for monarch butterflies. Given the marginal quality of the potential habitat in the proposed Project site, few monarchs are expected to occur and habitat loss would not substantially affect the species. Better quality suitable native prairie is available in the Nash Prairie Reserve 1.5 miles from the proposed Project site. The Applicant's proposed conservation measures would minimize or avoid effects to monarch butterflies and their breeding and foraging habitats 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 monarch butterfly.

The USACE has determined that the effects of the proposed Project's actions "may affect, not likely to adversely affect" the monarch butterfly due to loss of forging and breeding habitats and potential loss of individuals inhabiting vegetation cleared during construction activities. 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 That May Be Affected By the Proposed Project

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 (see Section 4.1.2), they have 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 to the quality of habitat 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.
Monarch Butterfly (*Danaus plexippus*)	
Best Management Practices for Construction and Operation Activities: During construction Dow proposes to implement measures to avoid or reduce impacts to mapped potentially suitable habitat in the proposed Project site. These include 1) monitoring, management and remediation of invasive plant species and 2) evaluation and targeted application of herbicides, pesticides and fertilizer to minimize impacts to non-target plant and insect species, and 3) reclamation and restoration at off-site mitigation areas with seed mixes that include milkweeds.	Monitoring and managing invasive species would reduce potential impacts to native prairie habitats in the vicinity that may serve as potential habitat for the monarch butterfly. Hand application of herbicides and pesticides is expected to minimize the likelihood of unanticipated or unintended exposure of plants or animals to chemicals that may result in death or injury. This measure is expected to specifically avoid negative effects to the monarch butterfly habitats. Restoring and reclaiming areas using seed mixes including milkweed and/or nectar-producing plants would reduce potential impacts of habitat loss from vegetation clearing activities.
General Conservation Measures	
Environmental Awareness Training: The Applicant would ensure that all field personnel performing work related to the proposed Project receive the appropriate environmental awareness training, all construction personnel to brief them on the status of the special-status species and the required avoidance measures.	Training would help to 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. Of these 13 species, the proposed Project may affect the endangered whooping crane, the proposed threatened Texas fawnsfoot, and the candidate monarch butterfly. Based on the analysis in this BA, the proposed Project may affect, but is not likely to adversely affect these three species. The proposed Project would have no effect on the other 10 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, Texas fawnsfoot, or monarch butterfly.

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APPENDIX A

Applicant-Proposed General Construction Conservation Measures

GENERAL CONSERVATION MEASURES TO REDUCE AND MINIMIZE IMPACTS TO POTENTIAL TEXAS FAWNSFOOT HABITAT

- Erosion and stormwater pollution control measures would be consistent with the National Pollutant Discharge Elimination System (NPDES) and Texas Pollutant Discharge Elimination System (TPDES) general permit and would be included in a stormwater pollution prevention plan (SWPPP). Proposed best management practices (BMPs) would be implemented as approved by TCEQ and inspected at installation and throughout the construction period in compliance with the general permit.
- Temporary erosion and runoff best management control measures would be implemented during construction to minimize stormwater pollution resulting from erosion and sediment migration from the construction, borrow, and staging areas. Temporary control measures including sediment control fences, vertical tracking, rock or timber construction exits, diversion dikes, and erosion control logs would be installed.
- All sediment barriers would be installed along the contour, perpendicular to runoff flow, with each end curving gently upslope enough to capture and pool the design volume of runoff during a storm event.
- Sediment control fences would be inspected and maintained after each rainstorm.
- All stockpiles will be covered or seeded.
- Dikes may be used to intercept runoff and divert it to stabilized areas or erosion control devices. Soil used for dike construction would be machine compacted. Dikes in place for more than 14 calendar days would be stabilized to prevent sediment runoff. Sediment and debris would be removed from dikes after rain and whenever accumulation affects device performance.
- Gravel or riprap areas or pads would be installed at points where vehicles enter and leave the construction site. This BMP provides a buffer area where vehicles can drop their mud and sediment to avoid transporting it onto public roads, to control erosion from surface runoff, and to help control dust.
- The outer face of the proposed reservoir embankment and the slopes to either side of the embankment maintenance road would be mulched and/or hydroseeded and maintained by mowing.
- Because the discharge from the proposed reservoir would only occur during drought conditions, the potential for and extent for erosion on Oyster Creek to occur is unclear and requires an adaptive management approach. Erosion that may result downstream of the proposed reservoir on Oyster Creek shall be addressed in the mitigation, monitoring and adaptive management plan. When Dow operates the proposed reservoir in response to drought conditions, monitoring will be conducted on the portion of Oyster Creek downstream of the proposed reservoir discharge to its confluence with the existing Harris Reservoir outfall. Monitoring shall be conducted by a qualified aquatic ecologist and include identification of any areas where erosion is occurring per standard practices. If erosion is identified, Dow will take immediate action to remediate the erosion. These steps may include curtailing of operations to prevent further erosion, installation of bioengineered bank stabilization, revegetation of riparian areas, among others.
- Staging areas and temporary workspaces have been sited to avoid impacts to surface waters and wetlands to the extent possible.

- The Applicant would comply with the requirements of the Section 401 Water Quality Certification issued by TCEQ.
- Blankets and matting (i.e., sheets or rolls of porous erosion control material) would be installed and anchored at the soil surface in channels and swales and on diversion dikes, steep slopes, and stream and tidal banks.
- A protected, lined area for concrete truck washouts would be clearly identified and located away from streams, storm drains, or ditches.
- A spill prevention, control, and countermeasures plan would be prepared that would minimize potential impacts to water quality during construction.
- Spill kits will be kept on-site to clean up any spills or leaks immediately, including spills on pavement or earthen surfaces.
- Aquatic nonnative invasive species would be monitored and managed in accordance with the monitoring plan described above.
- The BMPs to minimize impacts to surface water would also minimize impacts to the aquatic fauna.
- Impacts to the water quality, including the temperature, dissolved oxygen, and total suspended solids, will be monitored and mitigated during drawdown and addressed through adaptive management in Dow's mitigation and monitoring plan and operation and maintenance plan.
- Screens with 2-mm wedge wire using a configuration that creates turbulence to reduce entrainment shall be installed.
- Intakes will be designed, adjusted, or adaptively managed with minimal flows to prevent entrainment.

GENERAL CONSERVATION MEASURES TO REDUCE AND MINIMIZE IMPACTS TO POTENTIAL WHOOPING CRANE HABITAT

- A stop-work order shall be employed when a whooping crane is observed within 1,000 feet of construction activities and work shall resume only after the bird has left the area.
- Lower all vehicles and equipment taller than 15 feet at night to minimize risk of collision during migration.
- 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).

GENERAL CONSERVATION MEASURES TO REDUCE AND MINIMIZE IMPACTS TO POTENTIAL MONARCH BUTTERFLY HABITAT

- Revegetation at off-site mitigation areas would include use of milkweeds and/or other nectar-producing plants to reduce, avoid and mitigate for potential impacts to foraging habitat for the monarch butterfly.
- A monitoring plan would be developed and implemented to prevent and manage nonnative invasive plant species.
- A remediation plan would be developed to address revegetation for any temporarily disturbed areas. Revegetation would include only native species and would be monitored for meeting success criteria.
- Invasive plant species would be selectively removed and controlled using herbicides selected based on the type of application procedure and would be in accordance with federal regulations. The evaluation of herbicide, pesticide, and fertilizer use shall include the accuracy of applications, effects on target and non-target species, and the potential impacts to aquatic and terrestrial ecosystems. The invasive plant removal and follow-up herbicide application would be conducted by experienced contracted personnel.
- Only native shrubs, trees, and seed mixes from local ecotypes will be included in the reclamation and restoration of disturbed sites.

GENERAL CONSERVATION MEASURES FOR ALL THREATENED AND ENDANGERED SPECIES

- 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.

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APPENDIX B

Representative Photographs of Herbaceous Upland Communities in the Proposed Project Site

PHOTOGRAPHIC LOG		
Property Name: Dow Harris Expansion Project	**Location:** 29.25619687° N, 95.55867502° W	**Permit No.**

Photo No. 4	**Date:** 12/19/18

Direction Photo Taken: East

Description:

View of Pit 44-Upland Area

PHOTOGRAPHIC LOG		
Property Name: Dow Harris Expansion Project	**Location:** 29.260750° N, 95.528588° W	**Permit No.**

Photo No. 16	**Date:** 2-5-19

Direction Photo Taken: WSW

Description:

View of Wetland N-Ephemeral Drainage

Upland herbaceous vegetation communites documented during Cardno's wetland delineations (Cardno 2019).

Upland herbaceous vegetation communites documented during SWCA's 2019 wetland delineation.

Figure C-1. An herbaceous upland as seen from DPB002_U; view facing south.

Figure C-2. An herbaceous upland as seen from T2DPB014_U; view facing west.

Figure C-3. An herbaceous upland as seen from DPB051_U; view facing east.

Figure C-4. An herbaceous upland as seen from T7DPC004_U; view facing south.

Figure C-5. An herbaceous upland as seen from T2DPD017_U; view facing north.

Figure C-6. An herbaceous upland as seen from DPD001_U; view facing west.

Figure C-7. An herbaceous upland as seen from T4DPD011_U; view facing north.

Figure C-8. An herbaceous upland as seen from T4DPA005_U; view facing south.

Figure C-9. An herbaceous upland as seen from T6DPA009_U; view facing south.

Figure C-10. An herbaceous upland as seen fromT8DPA013_U; view facing west

Figure C-11. An herbaceous upland as seen from DPA027_U; view facing west.

Figure C-12. An herbaceous upland as seen from DPA035_U; view facing west.