Work Plan for Adaptive Management

Prepared by
Brazos River and Associated Bay and Estuary System Basin and Bay Area Stakeholders Committee (BBASC)

Revision 1
July 2025

Approved October 2025

Table of Contents

Work Plan for Adaptive Management 1

List of Abbreviations 3

1.0 Work Plan Purpose 4

2.0 Work Plan for Adaptive Management History 4

3.0 BBASC Assessment of 2013 WPAM Monitoring and Research Recommendations for Adaptive Management 6

4.0 BBASC Revised Monitoring and Research Recommendations for Adaptive Management for 2026 – 2036 6

5.0 Scopes of Work for New Monitoring and Research Recommendations 7

5.1.1 Long-term Community Level Monitoring 7

5.1.2 Oxbow Connectivity Modeling 9

5.1.3 Brazos River Estuary Sedimentation Rate Study 10

Appendix 1 – Indicator Species by Reach Identified by the Brazos BBEST 13

List of Abbreviations

ALM	Aquatic Life Monitoring (protocols)
BBASC	Brazos River and Associated Bay and Estuary System and Bay Area Stakeholders Committee
BBEST	Brazos River and Associated Bay and Estuary System Expert Science Team
BRA	Brazos River Authority
CRP	Clean Rivers Program
DFC	Desired Future Conditions
EFS	Environmental Flow Standards
EQIP	Environmental Quality Incentives Program
GLO	Texas General Land Office
GMA	Groundwater Management Area
HGAC	Houston-Galveston Area Council
NRCS	U.S. Department of Agriculture Natural Resource Conservation Service
SAC	Science Advisory Committee
SB3	Senate Bill 3 of the 80th Texas Legislature
SOW	Brazos River and Associated Bay and Estuary System Expert Science Team
SWQM	Texas Commission on Environmental Quality Surface Water Quality Monitoring Team
TCEQ	Texas Commission on Environmental Quality
TCRMP	Texas Coastal Resiliency Master Plan
TESCP	Temporary Erosion and Sediment Control Plan
TIFP	Texas Instream Flow Program
TPWD	Texas Parks and Wildlife Department
TSS	Total Suspended Solids
TWDB	Texas Water Development Board
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
WPAM	Work Plan for Adaptive Management

1.0 Work Plan Purpose

Senate Bill 3 (SB3) of the 80th Texas Legislature was written to create a basin-by-basin process for developing environmental flow standards. SB3 requires the creation of a "work plan" to facilitate the adaptive management of the environmental flow standards adopted. SB3 offers the following language for timing of and what components should be incorporated in the work plan.

Section 11.02362 (p) In recognition of the importance of adaptive management, after submitting its recommendation regarding environmental flow standards and strategies to meet the environmental flow standards to the commission, each basin and bay area stakeholders committee, with the assistance of the pertinent basin and bay expert science team, shall prepare and submit for approval by the advisory group a work plan. The work plan must:

1) *establish a periodic review of the basin and bay environmental flow analyses and environmental flow regime recommendation, environmental flow standards, and strategies, to occur at least once every 10 years;*

2) *prescribe specific monitoring, studies, and activities;*

3) *establish a schedule for continuing the validation of environmental flow analyses and environmental flow standards by the commission*.

2.0 Work Plan for Adaptive Management History

The Brazos River and Associated Bay and Estuary System and Bay Area Stakeholders Committee (BBASC), in coordination with the Brazos River and Associated Bay and Estuary System Expert Science Team (BBEST), developed the first *Work Plan for Adaptive Management* (WPAM) in 2013. The first *Work Plan for Adaptive Management* was officially approved by the BBASC in October 2013.

In the 2013 WPAM, the BBASC recommended maintaining a ten-year cycle for reviewing the TCEQ adopted environmental flow standards (EFS) and WPAM contents. The review cycle timeline was recommended to begin on the date TCEQ adopted the EFSs for the Brazos River Basin, which occurred on March 6, 2014. The 2013 WPAM recommended eleven studies to contribute data necessary to conduct future adaptive management reviews (Table 1).

Table 1 2013 WPAM Recommended Studies for Adaptive Management			
Report	Item	Priority	Recommended Study
BBEST[1] 8.1.1.1	3.1.1	1	Continue cooperative funding agreements for stream flow gauging stations into the future, especially for the 20 focal reaches evaluated in this report.
BBEST 8.1.3.1	3.1.2	1	Continue the on-going routine water quality monitoring at all locations that coincide with the focal reaches of the recommended flow regimes.
BBEST 8.1.2.1	3.1.3	1	Continue TSS data collection at routine water quality monitoring locations
BBEST 8.1.1.3	3.1.4	1	Continue support for reservoir surveys and evaluate the latest reservoir capacity information during the adaptive management review processes
BBASC[2] Pg. 52	3.1.5	1	Conduct studies to evaluate the benefits of over-bank flows to help maintain a healthy river system, including sediment and nutrient transfer, moving the river channel, maintaining the riparian ecology, and maintenance of oxbows
BBASC Pg. 52	3.1.6	2	Commission a long-term study to monitor salinity, nutrient transport, and sediment transport and deposition, and associated estuarine health in order to detect any negative effects as upstream projects are implemented over the next few decades.
BBASC Pg. 52	3.1.7	2	Analyze the BBASC environmental flow recommendation at the Richmond gage and compare to the results of the BBEST analysis
BBASC Pg. 52	3.1.8	2	Continue fish surveys (of all species) on the Middle Brazos Segments 1204 and 1206.
BBASC Pg. 52	3.1.9	2	Conduct additional studies for the area from Possum Kingdom to Whitney, including the golden algae issue.
BBEST 8.1.4.5	3.1.10	2	Conduct ALM assessments with expanded habitat data for the Salt, Double Mountain, and Clear Forks of the Brazos River and the river upstream of Possum Kingdom reservoir
BBEST 8.1.4.2	3.1.11	3	Historical and current community analyses should include other taxonomic groups as well as fish, especially mussels and aquatic insects

[1] BBEST. 2012 *Environmental Flow Regime Recommendations Report*. https://www.tceq.texas.gov/permitting/water_rights/wr_technical-resources/eflows/brazos-river-and-associated-bay-and-estuary-system-stakeholder-committee-and-expert-science-team

[2] BBASC. 2012. *Environmental Flow Standards and Strategies Recommendations Report*. https://www.tceq.texas.gov/permitting/water_rights/wr_technical-resources/eflows/brazos-river-and-associated-bay-and-estuary-system-stakeholder-committee-and-expert-science-team

The BBASC reconvened in 2023 and in 2025 officially requested that the BBEST review the adopted environmental flow standards for the Brazos Basin and 2013 WPAM and make recommendations for revision. The BBEST responded in July 2025 that there was not sufficient new data to warrant recommendations to the adopted environmental flow standards but did make recommendations for revision of the WPAM. The BBASC convened in July 2025 to consider the BBEST recommendations for WPAM revision and discussed revisions of the work plan. This document is the result of those interactions and discussion and is the first revision of the WPAM.

3.0 BBASC Assessment of 2013 WPAM Monitoring and Research Recommendations for Adaptive Management

Upon review of the recommendation in Table 1 above, the BBASC concluded that while many of their initial research priorities remain valid, several recommendations are being accomplished and funded through other programs, and others have been partially or completely accomplished during the previous ten-year period.

Items 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.8, and 3.1.11 are being accomplished in total or in part, via different programs and funding mechanisms through the combined efforts of the TWDB, TCEQ, TPWD, and BRA. Should any of these activities cease to be supported by these other agencies and programs, the BBASC strongly supports their continuation via SB3 research and funding efforts.

Items 3.1.5, 3.1.6, and 3.1.9 have been partially or completely accomplished through SB3 funding by academic research institutions, however, some of these topics could benefit from continued efforts to bolster the data and verify the reproducibility of their conclusions.

4.0 BBASC Revised Monitoring and Research Recommendations for Adaptive Management for 2026 – 2036

The BBASC recommends the addition of the following three topics to the work plan and be given special emphasis for future SB3 funding opportunities:

- Priority 1
    - Long-term investment into community level monitoring of aquatic biota response to flow recommendation and TCEQ EFS, including research to identify the magnitude, duration and frequency of flow tiers for maintenance of key indicator species by stream reach in the Middle (from Waco to Possum Kingdom Reservoir) and Upper (above Possum

Kingdom Reservoir) Brazos River basin. Appendix 1 lists potential indicator species by reach as identified by the BBEST.

- Priority 2
    - Repeat of the 2012 TWDB funded project to model flows necessary to connect the Brazos River with oxbow lakes in the lower Brazos River watershed (below Waco). Since the work was completed in 2012, there have been multiple high-flow and/or overbank flow events in the lower Brazos River that may have resulted in changes to the flows needed for oxbow connectivity. Repeating this work would be beneficial to assessing adopted high-flow pulse criteria in this reach of the river.
    - Monitoring and analysis of suspended sediment concentration in the lower Brazos River (below Waco) to understand sedimentation rates to the Brazos River estuary including effects on estuary geomorphology and aquatic community.

5.0 Scopes of Work for New Monitoring and Research Recommendations

The new Work Plan Items and associated SOWs have been developed from items recommended by the BBEST. Each SOW will include a discussion of the item and why monitoring and studies are needed, frequency and longevity of each study, existing project (available) funding and approximated associated costs.

5.1.1 Long-term Community Level Monitoring for Validation/Refinement of Upper and Middle Brazos River Basin Environmental Flow Standards.

The recommended environmental flow standards (EFS) for stream reaches within upper and middle Brazos River basin the 2012 BBEST report were based primarily on historical hydrologic data, as these reaches have limited historical aquatic and riparian community level data. Additionally, several of the reaches of the upper and middle Brazos basin which are known to support aquatic species that rely on the environmental flow regime of each reach, and some reaches are home to species currently on the Federal Endangered Species List and/or the State's list of threatened and endangered species.

To gain a better understanding of current ecological soundness and to determine legacy effects that might constrain environmental flow recommendations, long-term community level monitoring of aquatic and riparian species is necessary to establish trends, tendencies, cycles, and effects of rare events (e.g., floods, freezing events & extended drought) within aquatic communities of the upper and middle Brazos River watershed.

The studies proposed are designed to fill in knowledge gaps about ecological linkages between instream flows and components of the natural environment in order to help inform management decisions for aquatic systems in the upper and middle Brazos Rivers watershed. Fundamental information regarding instream abiotic and biotic

responses to reach-specific EFS flow tiers in addition to collecting needed aquatic community composition data including diversity and abundance, age class, evaluation of species health, physical characteristics of the river reaches, habitat utilization by species, and status of indicator species populations identified by the BBEST (Appendix 1) will be collected.

Specifically, these studies should be conducted in the following five reaches: the Salt Fork of the Brazos River, the Double Mountain Fork of the Brazos River, the Clear Fork of the Brazos River, the Brazos River above Possum Kingdom Reservoir, and the Brazos River between Lake Whitney and the City of Waco. Currently, the BRA is conducting similar studies in the middle Brazos River reaches between Possum Kingdom and Lake Granbury and Lake Granbury and Lake Whitney. These studies are self-funded by the BRA. This is an ongoing task for BRA and are anticipated to continue for foreseeable future in these reaches.

It is recommended that these studies be funded repeatedly over a minimum of 10-15 years with a minimum of 15 aquatic sampling events and 5 riparian assessments spread out through the study period to gather enough data for statistical significance and to cover the range of possible hydrologic conditions (dry, wet, average) and flow tiers (subsistence, base, high-flow pulse) identified in the EFS.

It should be noted that research teams proposing to perform this work will need to obtain a Texas Parks and Wildlife Department Scientific Permit that authorizes work in the geographic area and with the targeted species/groups. Additionally, research teams proposing to work in the Brazos River above Possum Kingdom Lake, the Double Mountain Fork of the Brazos River, and/or the Salt Fork of the Brazos River must have a U.S. Fish and Wildlife Service Section 10(a)(1)(A) permit authorizing the collection and handling of *Alburnops buccula* (Smalleye Shiner) and *Notropis oxyrhynchus* (Sharpnose Shiner). These permits can take anywhere from 9-12 months to obtain, so research teams working within the Texas Water Development Board's biennial funding cycle will need to have the permit prior to responding to requests for proposals.

Tasks should include, but are not limited to:

- Task 1 – Fieldwork
    - Daily monitoring of USGS gages in the five reaches identified above
    - Aquatics Community Monitoring
        - Collection methodologies utilized in each reach should be designed to maximize encounters with all anticipated aquatic species, including macroinvertebrates, fish and mussels (where applicable), and to gather data to evaluate community responses to a specific flow tier, as appropriate for each reach. For example, in some upper basin reaches the native riparian community has been all but eliminated due to the introduction of the invasive salt cedar (*Tamarix* spp.) in the United States in the 1800s, in some reaches freshwater mussels are not likely to occur due to naturally occurring high salinity levels.
        - Monitoring should attempt to collect 3 replicates of each flow tier and duration (e.g., short versus extended duration) in each reach during the funding period. If a flow tier is not anticipated to occur during the study period (e.g. high-flow pulses during a multi-seasonal drought), then the three replicates should be conducted

during base and/or subsistence flow tiers. Additionally, replicates could include sampling flowing unusual flow events, such as a flood pulse following subsistence flows, to assess community responses from flood pulses following base flows.
        - Data collection shall occur across the range of habitat types in the reach (e.g. riffle, run, pool, backwater), when available.
        - Research team should have the flexibility to incorporate additional sampling components should they be determined practical and valuable to the goal of validating EFS by reach (diet, age classing of minnows).
        - valuable to the goal of validating EFS by reach (e.g. tree coring).

- Task 2 - Data Reduction and Analysis - Upon data collection, the research team shall reduce and analyze all physical and biological data collected in Task 1 to inform two main objectives.
    - Establish baseline community data for the reaches, data analysis should include, at a minimum:
        - Enumeration of species identified and total number of taxa
        - Enumeration of each species by age class
        - Identification of habitat associations by species and age class
        - Initial population status assessment of reach-specific indicator species (Appendix 1)
    - Identify abiotic and biotic responses of reach-specific indicator species (Appendix 1) to the established reach-specific EFS flow tiers that can be used to inform on the validity of the reach-specific EFS.
- Task 3 – Draft/Final Project Report - Research team will prepare a Draft Project Report to include:
    - Description of methods, analysis and results of Task 1
    - Description of validation methodology development
    - Recommendations to the BBASC on potential ways to use the provided information.

The estimated cost for a two-year study of the five reaches is $100,000. The total cost for continuous monitoring of all reaches for ten years is estimated to be $560,000 (this estimate includes a cost inflator of 5.5% per each two-year funding biennium). The BBASC recognizes that funding a study with a 10-year study term may be infeasible for the TWDB. If that is the case, the BBASC recommends that the TWDB consistently fund this research over the next decade with the goal of building a statistically significant and valid data set for the reaches that can then be utilized by future BBASCs/BBEST to evaluate the validity of the adopted EFS for the upper and middle Brazos River watershed.

5.1.2 Oxbow Connectivity Modeling

Oxbow lakes provide nursery habitats for many species of fish and connectivity between the river and this nursery habitat is critical for maintaining sound ecological environments in the lower Brazos River. The 2012 study, funded by the TWDB, *Evolution of Oxbow Lakes along the Brazos River* (Giardino), provides valuable insights into the flows needed to connect oxbow lakes to the Brazos River. Giardino found that many oxbows

do not require overbank flows to connect to the river but connect with in channel high-flow pulses.

This study was not available to the BBEST in 2011 when it was developing its initial recommendations regarding high-flow pulses in the lower Brazos River. However, the Brazos River experienced multiple overbank flow events from 2015 through 2019, including the Tax Day Flood in 2016 and Hurricane Harvey in 2017. These events had the potential to cause widespread changes to the river channel through the processes of erosion and deposition, and thus altering the flows modeled by Giardino necessary for oxbow connectivity.

To ensure that the high-flow pulse EFS adopted for the lower Brazos River are adequate to maintain periodic oxbow lake connectivity, this project would conduct field investigations and modeling to identify the following:

1) Classification of individual oxbows from meandering bends to remnant oxbows
2) Identification of distance from river where an oxbow ceases to provide valuable nursery functions for the river
3) The flows and water elevations needed to connect individual oxbow lakes still providing valuable nursery functions for the river.

It is anticipated that this project may involve the following tasks:

- Desktop mapping
- Literature review
- Water level loggers on some oxbows
- Surveying the elevations of oxbows and data from the water level loggers
- Geographic Information System Data Analysis of survey data, USGS gage data, etc.

The study should be timed closer to the next 10-year evaluation of EFS, in FY 2032, to eliminate the possibility of flood events potentially invalidating the data again.

Currently, BBEST and BBASC are not aware of any entities doing this work.

Texas Water Development Board staff indicated that this study would cost $80,000 if issued currently.

5.1.3 Brazos River Estuary Sedimentation Rate Study

Sedimentation in riverine estuaries can significantly impact water quality, habitats, and the geomorphology of the estuary and adjacent coastal zone. Changes in sediment loading and sedimentation rates of an estuary can lead to filling in of coastal navigation channels, coastal erosion, altered nutrient cycling, decreased water clarity, smothering of benthic organisms, disruption of natural food chains and impacts on estuarine biota and fisheries.

Given the influence that sedimentation rates can have on the overall health of the Brazos River estuary (estuary), understanding how the sedimentation rates vary with environmental flow tiers will provide data relevant to understanding estuary responses to sedimentation and its impact on the geomorphology of the estuary.

The proposed study area would include the lower Brazos River from the Richmond/Rosenberg area south to the estuary's confluence with the Gulf of Mexico.

Anticipated tasks include:

- Task 1 – Literature Search, Data, and Geospatial Data Review
    - Review of work completed by the GLO's Texas Coastal Resiliency Master Plan studies into sediment dynamics in the Lower Brazos and San Bernard watersheds.
    - Water quality data review for study area
    - USGS gage data in study area
    - Any other relevant environmental flow data source
    - Literature review
        - Potential data collection methodologies
        - Estuary studies
        - Geomorphology studies in the lower Brazos River and estuary
        - Review of remote imagery of near coastal and estuarine changes in topography associated with major tropical storms and inland floods including historical gage readings and offshore current meters.
        - Any other topics deemed relevant by the research team
- Task 2 – Pilot Study for Field Methodology for *In Situ* Sediment Sample Collection and concurrent suspended solids concentrations (SSC).
    - High flows in the lower Brazos River and tidal dynamics makes using traditional methods of *in situ* sediment sampling used in smaller watersheds challenging. Testing and evaluation of various methods of *in situ* data collection to identify methodologies that will withstand high-flow events in the river and produce valid data are needed.
    - Draft recommendation for methodologies for Task 3 for Texas Water Development Board review and approval.
- Task 3 – *In Situ* Data Collection (assumes physical data collection is possible)
    - Physically collect data samples from sites in the study area as close to the locations of data collection in previous lower Brazos River and estuary studies previously funded by the Texas Water Development Board.
        - Deploy sediment traps.
        - Perform vertical profiles of water quality, including water temperature, conductivity, salinity, pH and dissolved oxygen at deployment and retrieval of traps.
        - Characterize water profile turbidity using a Secchi tube and nephelometers at deployment and retrieval of traps on selected sampling dates.
        - Collect flow weighted and surface grabs of water for analysis of suspended solids (SSC), total suspended solids (TSS), volatile suspended solids (VSS), dissolved organic carbon (DON), and total organic carbon (TOC) at deployment and retrieval of traps.
        - Survey channel shape at a transect at each sampling location at deployment and retrieval of traps.
    - Survey channel morphology at locations of data samples,
    - Collect bottom sediment samples at deployment and retrieval of traps.
    - Analyze sediment trap samples.
        - Volatile solids

        - Solids in sediment
        - Sediment particle size
        - Total organic carbon
        - Total carbon
        - Organic phosphorus
        - Total phosphorus
        - Organic nitrogen
        - Total nitrogen
    - Data Analysis, Modeling, and Reporting
        - Statistical analysis of data
        - Calculate flux rates of sediment, organic carbon and nutrient data
        - Modeling data results to assess impacts of river sediment loading to estuary geomorphology, habitat and overall health.
        - Generate a draft and final report summarizing data results and including recommendations to the BBASC on potential ways to use the provided information.

Currently, the Texas General Land Office has/is funding similar studies regarding sedimentation in the lower Brazos River and impacts of sedimentation on evolving coastal hazards. While this research has generated some valuable data it mainly relies on remote sensing techniques, and none of this research is directed specifically at evaluating the effects on the geomorphology and health of the Brazos River estuary.

Estimated costs for this work assume a project period of three years (one year per task item). The estimated cost for Task 1 (literature search, data, and geospatial data review) is $122,194. The estimated cost for Task 2 (pilot study for field methodology) is $164,801. The estimated cost for Task 3 (*in situ* data collection, if possible) is $215,253. The total estimate for all three tasks is $502,248.

Appendix 1 – Indicator Species by Reach Identified by the Brazos BBEST

1) **Double Mountain Fork of the Brazos River**
    a. Fish: *Alburnops buccula* (Smalleye Shiner) and *Notropis oxyrhynchus* (Sharpnose Shiner), *Macrhybopsis hyostoma* (Shoal Chub), *Hybognathus placitus* (Plains Minnow)
    b. Mussels: NA
    c. Riparian Trees: NA
2) **Salt Fork of the Brazos River**
    a. Fish: *Alburnops buccula* (Smalleye Shiner) and *Notropis oxyrhynchus* (Sharpnose Shiner), *Macrhybopsis hyostoma* (Shoal Chub), *Hybognathus placitus* (Plains Minnow)
    b. Mussels: NA
    c. Riparian Trees: NA
3) **Brazos River upstream from Possum Kingdom Reservoir**
    a. Fish: *Alburnops buccula* (Smalleye Shiner) and *Notropis oxyrhynchus* (Sharpnose Shiner), *Macrhybopsis hyostoma* (Shoal Chub), *Hybognathus* placitus (Plains Minnow)
    b. Mussels: NA
    c. Riparian Trees: NA
4) **Clear Fork of the Brazos River**
    a. Fish: *Macrhybopsis hyostoma* (Shoal Chub), *Paranotropis buchanani* (Ghost Shiner)
    b. Mussels: NA
    c. Riparian Trees: NA
5) **Brazos River between Possum Kingdom Lake and Lake Granbury**
    a. Fish: *Campostoma anomalum* (Central Stoneroller), *Aplodinotus grunniens* (Freshwater Drum), *Macrhybopsis hyostoma* (Shoal Chub)
    b. Mussels: *Truncilla macrodon* (Texas Fawnsfoot)
    c. Riparian Trees: *Fraxinus pennsylvanica* (Green Ash)
6) **Brazos River between Lake Granbury and Lake Whitney**
    a. Fish: *Campostoma anomalum* (Central stoneroller), *Aplodinotus grunniens* (Freshwater Drum), *Morone chrysops* (White Bass)
    b. Mussels: NA
    c. Riparian Trees: *Acer negundo* (Boxelder)

7) **Brazos River between Lake Whitney and Lake Brazos Dam**
    - Fish: *Aplodinotus grunniens* (Freshwater Drum), *Percina carbonaria* (Texas Logperch), *Morone chrysops* (White Bass)
    - Mussels: NA
    - Riparian Trees: *Acer negundo* (Boxelder)