WETLAND PROTECTION RESILIENCY DESIGN GUIDE

About This Guide

Coastal wetlands provide vital habitat for fisheries, shorebirds, and marine organisms, improve water quality, and can provide flood storage and prevent shoreline erosion. Wetland degradation in coastal Texas is primarily influenced by wave energy, low freshwater and sediment input, relative sea level rise (RSLR), extreme weather events and associated coastal flooding, and increased coastal development. The purpose of this guide is to provide concise guidance on how to plan for and manage resilient wetlands.

Conceptual

Protecting existing wetlands and creating new wetlands should be undertaken with a careful understanding of the site characteristics and design components. This overview applies to projects establishing new wetlands or projects enhancing existing wetlands.

Determine project goals	Evaluate site characteristics	Determine basic design components
• Habitat restoration and creation • Shoreline stabilization • Water quality enhancement • Beneficial Use of Dredge Material (BUDM) deposit location	• Hydrodynamics: water depth, wave energy exposure, tide, currents, and RSLR • Topography and erosion • Salinity • Vegetation options (based on native plant availability and timing of restoration planting) • Substrate and landscape characteristics • Migration area	• Budget including necessary easements or land purchases • Timeline • Availability of BUDM • Construction (including possible breakwaters)

Engineering/Design

Develop a detailed plan for configuration and construction of engineered wetlands based on the project goals and site constraints to provide a strong basis for a healthy wetland habitat.

Complete design and supporting calculations		Develop construction plan	Complete permit applications
• Geotechnical analysis • Survey • Hydrodynamic analysis • Water quality analysis	• Sunlight exposure analysis • BUDM availability • Planting types • Cost	• Schedule • Deployment logistics • BUDM coordination	• Permit-level plans • Address review comments

Permitting

Plan for and complete necessary permitting activities to ensure the project has a robust design and does not adversely impact the surrounding environment or socioeconomic activity. An engineer should also be identified during this step to complete permit-level (and subsequent) design/installation plans.

Identify project partners	Identify potential permits needed	Typical review agencies
• Federal • State • Local • Non-profit • University • *Tribal*	• **USACE Nationwide Permits** - 27 Aquatic Habitat Restoration, Enhancement, and Establishment Activities, 54 Living Shorelines, Section 404 Clean Water Act • **Texas Parks & Wildlife Department:** Species Introduction permit • **GLO:** Coastal Boundary Survey and Surface Lease if located on State-owned submerged lands • BUDM permits	• USACE • TPWD • EPA • USFWS • US Coast Guard • GLO

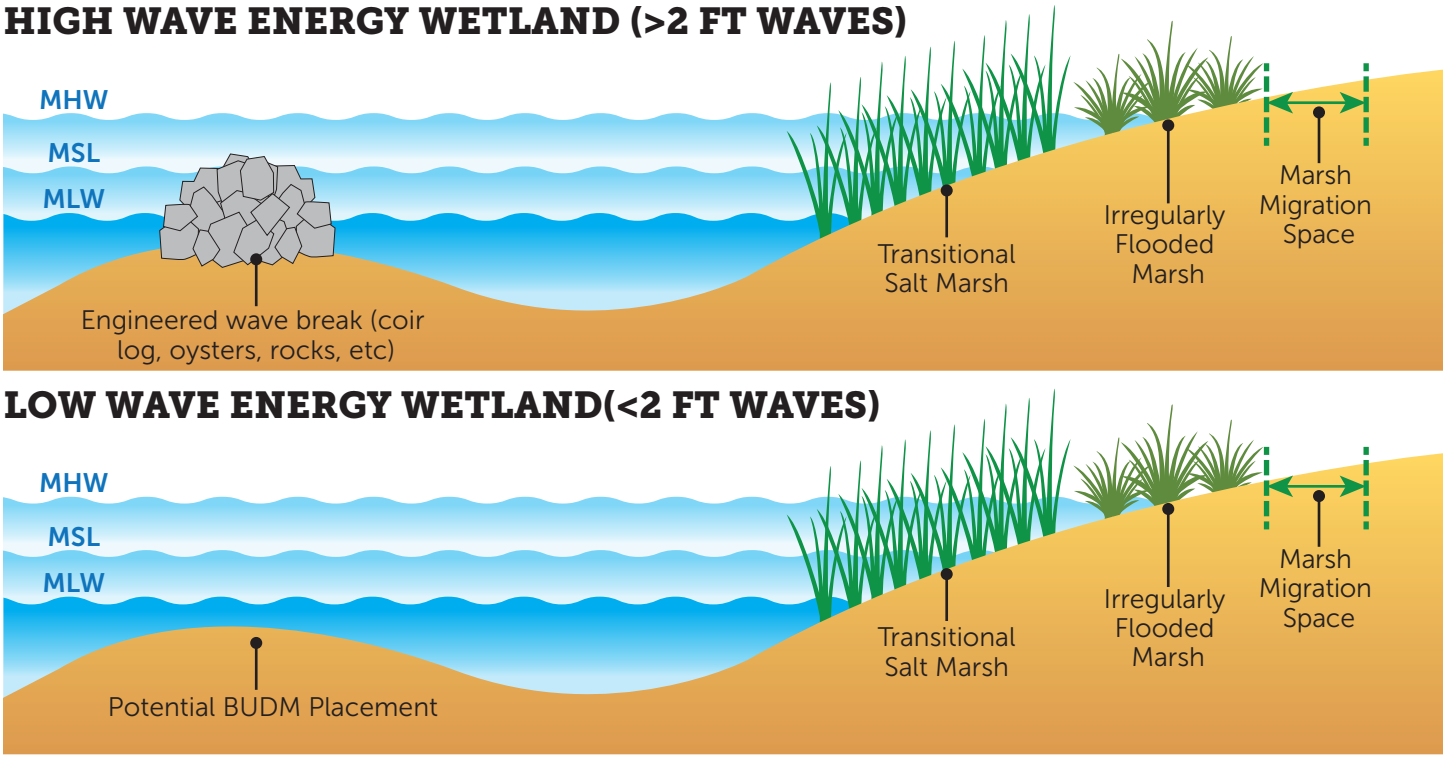
Monitoring

Continued monitoring of a wetland restoration or creation project using metrics aligned with project goals can aid in tracking the success of the wetland after construction.

- Wetlands constructed for water quality are monitored as part of the Texas Commission on Environmental Quality (TCEQ) Water Quality Management Program
- All wetlands should be monitored for elevation, vegetation stabilization/density (ideally 3 years)
- Continue to monitor wetland elevation compared to future *RSLR rates*

Profile-View

Profile view showing wetland components and typical elevations relative to tidal datums.

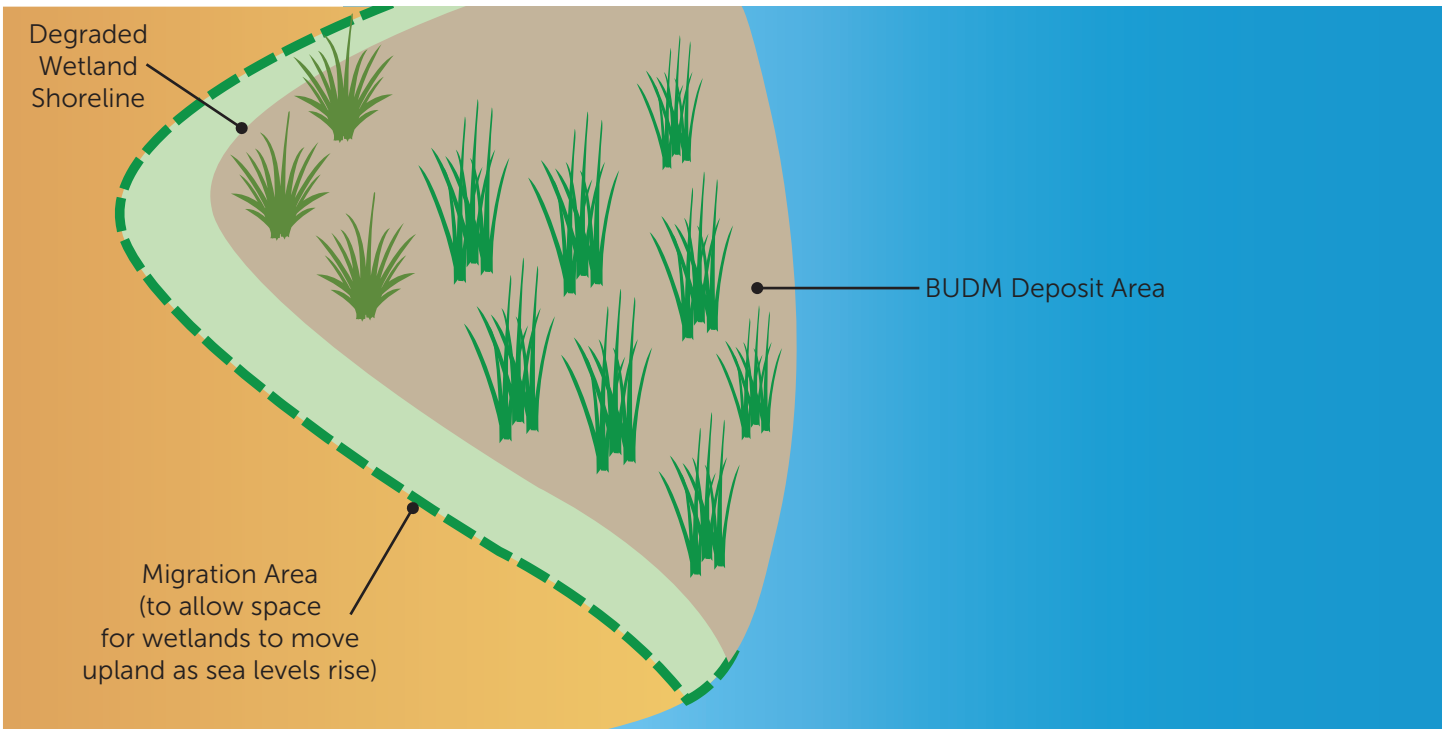


Wetland habitats are estimated to tolerate (by being able to migrate or withstand) a certain depth of RSLR. Estimated amounts of RSLR, in feet, that can be tolerated by Texas wetlands are shown in the table below. These values show the average change in water depth across the whole coast that generates a landcover change for the different wetland types, based on the Sea Level Affecting Marshes Model developed by the Harte Research Institute for the 2023 Texas Coastal Resiliency Master Plan. The model uses mean tide level as the tidal datum.

Wetland Type	Transitional Salt Marsh	Regularly Flooded Marsh	Mangrove	Tidal Flat	Irregularly Flooded Marsh
RSLR Depth (feet)	3.4	2.5	6.1	2.4	3

Plan-View

Plan view showing wetland components relative to shoreline.



Engineering Considerations for Wetland Protection

Wave Climate

The site characteristics including waves and hydrodynamic conditions as well as the project budget and timeline will be the primary considerations when planning a wetland protection project.

Low Wave (≤ 2ft)	High Wave (> 2ft)
Sheltered areas with low wave action may be able to be built without significant seaward protection. BUDM placement, plantings, and permitting should be considered.	Areas with higher wave action will require stabilization methods seaward of the wetlands to prevent erosion. Alternatives may include emergent or submerged oyster reefs, emergent or submerged stone breakwaters, etc.

PROJECT COST & ENGINEERING EFFORT

BUDM

To build up the base elevation of existing marshes or build new marshes, the BUDM can be employed by a technique to add the material to the wetland called Thin Layer Placement (TLP). The project manager will need to coordinate with USACE regarding the availability and quality of BUDM sources (~12+ months).

Design & Planing	Permitting	Soil Placement	Monitoring
Experienced coastal engineers design the placement areas. (~6-8 months)	Permitting and coordination with state and federal natural resource agencies. (~3-12 months)	Nearshore placement to supplement erodible pool and suspended solids near wetlands. Thin-layer placements directly on wetlands to increase elevation. (~1-2 months, once available BUDM sources are identified)	Post-construction monitoring to track the success of the restored or newly created marsh. (~1-2 years)

PROJECT TIMELINE

Vegetation

Vegetation can only be planted once the sediment has sufficiently accumulated to achieve a suitable water depth for the plants, considering tidal range. Leaving corridors for wetlands to expand and/or migrate will also be important. The timing of the project is important to consider the sourcing, availability, and seasonality of appropriate native plants.

Vegetation Type	Vegetation Density	Construction
As wetlands become submerged due to land subsidence, RSLR, or both, plants die off. The project designer needs to consider the salinity, water depth, erosion rates, habitat goals, etc. when planning the type of wetland vegetation to include.	After wetland elevations are increased (either from BUDM or from sedimentation that occurs naturally after constructing a breakwater), wetland vegetation can be planted. Vegetation should be planted with sufficient density based on the plant type for better survival rates.	Community volunteers can often be enlisted to help with plantings, but the process is labor intensive. Contractor-led plantings are another option, budget allowing.

Costs

These costs are estimates for planning purposes only, and may require significant refinement based upon specific site conditions. Economies of scale may reduce costs for large-scale projects. Land acquisition should also consider future migration areas as sea levels increase.

Land Purchase & Initial Construction	Monitoring and O&M
• Living shoreline with vegetation: » Low Wave Environment $75-$300/linear ft of shoreline » Hybrid/High Wave Environment $110-$600+/linear ft of shoreline • Land purchase: » Costs can range widely based on market condition	• Operations and Maintenance (O&M): » Per linear foot of shoreline $5-$100+/year

Resiliency for Wetland Protection

	Concerns	Effect on Wetland Project	Solutions
Salinity	• Droughts reduce freshwater input to bays and estuaries causing a spike in salinity • RSLR creates new hydraulic connections with higher-salinity Gulf of Mexico	• Vegetation have different levels of tolerance for salinity in the water	• Select sites with high circulation and high/reliable freshwater inflows to reduce susceptibility to salinity fluctuations • Conduct monitoring program and make adjustments, as necessary
Subsidence	• Increased inundation as land sinks due to subsidence	• If wetlands do not have space to migrate, they may become completely inundated and revert to open water	• Select sites with high circulation to reduce susceptibility to temperature fluctuations • Enable wetland migration • Use BUDM to offset subsidence • Conduct monitoring program and make adjustments, as necessary
RSLR	• Increased inundation as sea levels rise	• If wetlands do not have space to migrate, they may become completely inundated and revert to open water	• Select sites with high circulation to reduce susceptibility to temperature fluctuations • Enable wetland migration • Use BUDM to offset RSLR • Conduct monitoring program and make adjustments, as necessary
BUDM Availability	• Wetland development requiring the use of BUDM will require more permitting and the availability of this material	• Permitting can take a substantial amount of time • BUDM may not always be available	• Work with experienced practitioners to streamline the permitting process • Coordinate with USACE early to ensure availability of BUDM

Additional Information and Resources

- **Wetland Project Example**: Galveston Bay Marsh Mania organization has a 21 year history involving nearly 8,200 community volunteers to restore 212 acres of salt marsh habitat at 97 sites in Galveston Bay: *https://galvbay.org/event/marsh-mania/*
- **Wetland Program Example**: Texas State Wetland Program Summary Template from the Association of State Wetland Managers: *https://www.aswm.org/pdf_lib/state_summaries/texas_state_wetland_program_summary_083115.pdf*
- **Living Shoreline Permitting Assistance from GLO**: *https://glo.texas.gov/coast/coastal-management/permitting/index.html*
- **Native Plant Information**: Plant recommendations for Gulf of Mexico Protection & Restoration from the Natural Resources Conservation Service at the U.S. Department of Agriculture: *https://www.nrcs.usda.gov/wps/portal/nrcs/detail/plantmaterials/technical/publications/?cid=stelprdb1044274*
- **BUDM Design**
  - » USACE Engineering Manual 1110-2-5026: *https://budm.el.erdc.dren.mil/guidance/EM_1110-2-5026.pdf*
  - » USACE Engineering with Nature: *https://ewn.el.erdc.dren.mil/*
  - » USACE Natural Infrastructure Opportunities Tool: *https://www.arcgis.com/apps/MapSeries/index.html?appid=18079f5b628b4a7bb52acbe089d80886#*
  - » EPA Guidance on BUDM projects: *https://www.epa.gov/sites/production/files/2015-08/documents/identifying_planning_and_financing_beneficial_use_projects.pdf*
- **NOAA Nature Based Solutions:** Nature Based Solutions Installation and Maintenance Costs from NOAA: *https://coast.noaa.gov/data/digitalcoast/pdf/nature-based-solutions-installation-maintenance.pdf*

Volunteers plant wetland grasses as part of Marsh Mania
Source: Galveston Bay Foundation