South Padre Island Beach and Dune Assessment Project

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Summary Overview

Develop recommended adaptation pathway for the beach and dune system for the City of South Padre Island.

- Task 3: Adaptation Strategies

Progress Narrative: Adaptation for Resilience

Sea level rise adaptation planning requires considering the causative hazards for each identified vulnerability and taking effective and timely action to alleviate the range of consequences. Good adaptation planning considers secondary impacts and examines how different adaptation measures could be used to alleviate vulnerability in one area, and interact with the other measures for other areas. An interwoven tapestry of adaptation measures is needed to develop a sustainable beach resiliency plan. Good adaptation planning is "collaborative" and considers the interconnected environmental, ecological, social, political, and economic systems, including adjacent jurisdictions.

Sea level rise risks can be addressed by reducing vulnerability or exposure through the development of forward-thinking policies combined with the implementation of specific projects. Failure to take forward-thinking approaches to adaptation will result in increasing maintenance costs. As not all issues can be addressed at once, it is important that responses to risks be prioritized and phased to maximize the use of the community's resources while avoiding costly emergency response where possible.

Strategies for addressing sea level rise hazards require proactive planning to balance the protection of coastal resources with physical development and recreational use. **No one category or specific adaptation strategy is considered the "best" option forever.** The effectiveness of different adaptation strategies varies across space and time with changing strategies able to accommodate various coastal hazards and elevations of sea level rise. The

strategies considered as part of this project are focused on beach and dune maintenance, and enhancements and policy changes arising from the scope of the study.

Policy approaches such as altering ordinances on beach and dune management, and requiring sea level rise considerations in development permits can help educate community members and improve resilience. Specific early investments, particularly in policy changes, can avoid costly maintenance, and potentially avoid legal claims in the future. Reviewing current City programs and policies associated with risk reduction is the first step to identifying potential short-term adjustments to alleviate or eliminate risks. Where adjustments to current practices will not sufficiently address the risks, more substantial actions should be identified and implemented.

Of utmost importance to the successful implementation of an adaptation strategy is communicating the issues and proposed response strategies to the community. Studies repeatedly show that knowledgeable and prepared communities with educated decision-makers who understand how to respond to extreme events will be far more resilient. An informed community is also more likely to support decisions and new programs reflecting its knowledge. All these factors enable community members to contribute to developing a vision to face sea level rise and other climate change hazards.

Adaptation Pathways Approach

Adaptation to coastal erosion and sea level rise along the SPI coast will require multiple approaches over time. Uncertainties in the timing of large storm waves occurring at high tides, the elevation of sea level rise in the future, and projected extents of future coastal erosion, require consideration of feasible adaptation strategies over both short- and long-term time scales with an adaptation pathways approach.

An adaptation pathway (Figure 1) helps visualize the sequences of possible adaptation responses through time in a stepwise manner. Each modification is designed to meet a certain performance level over a period of time, and once it reaches a threshold where the results are no longer acceptable, a transition to another strategy is required. Before this point is reached, planning should be undertaken to identify possible triggers and anticipate the lag times associated with outreach, permitting, design, and construction. Due to the uncertainty over future physical conditions, natural variability, and changing societal values, adaptation pathways should remain flexible.

Triggers

The moment of an adaptation tipping point or trigger helps identify when a change in path is necessary, however, not all actions can be implemented at once. As a result, trigger points are used that are hind-cast from a potential tipping point, providing lead-time for permitting and other considerations. The following tipping points may be considered when laying out an adaptation pathway:

- **By sea level rise elevation (or rate of sea level rise)**—SPI is already vulnerable to hazards that may occur from tropical storms or winter cold fronts; however, sea level rise could increase the severity and impacts of these storms. By monitoring sea level from the nearest NOAA tide gauge at Brazos-Santiago Pass, triggers could be tied to an elevation change from present conditions over a 6-month period (to avoid seasonal signals) or a rate of sea level rise increase that would allow SPI to implement further actions in advance of projected sea level rise impacts.

- **By physical distance**— through a monitoring program, routinely measure distances, especially following storm or erosion events, such as when the width of the beach or elevation of the primary dune decreases below a specified distance or height.

- **By storm exposure and frequency**—monitor the frequency of exposure to wave action (e.g., how frequently are the foredunes in the northern portion of SPI eroded, or how often does a high scarp form on the lower beach? To monitor the frequency of erosion, SPI could track and record erosion events and include the date, location, type, amount, and severity. This could be partially accomplished by implementing a citizen science program.

Adaptation plans that utilize triggers selected in a robust manner are important for facilitating planning, which incorporates the inherent uncertainty and risk surrounding the effects of sea level rise and climate change hazards on coastal areas.

Policy Adaptation

Policy-based adaptation strategies can be effective in the initial period of implementation in order to put the necessary regulations in place to make the coastal system more resilient. For instance, SPI's beaches and dunes are less resilient than ideal due to human activities that include:

- trimming the primary dune height to 10 ft when it exceeds that value through natural accretion
- removing dunes completely to allow space for recreational use
- having beach access pathways through the dunes, rather than over them

Both the historical analysis (Phase 1 Report: Characterization of the Beach and Dune State) and the future modeling (Phase 2 Report: Modeling Future Conditions of the Beach and Dunes) indicate that dunes greater than 12 ft in elevation provide the most protection, especially if a wide beach is maintained. When storms or high water-level events occur, the up-rushing water can flow through the existing dune access walkthroughs, causing lateral erosion of the dunes, further compromising them. If the water flows to the base of the coastal infrastructure, it can begin to scour the dunes from the back and potentially cause damage to the structure it encounters.

For the policy adaption pathway (Figure 1) the first step is to codify the required elevation of the dune and width of the beach that will define the triggers for a nourishment project. In the adaptation pathway for SPI, this is a first step, to be undertaken in the very near term. The next stage is to modify the existing ordinance to require dunes be maintained at an elevation of ≥12.5 ft, with a protective (and recreational) beach maintained at widths of ≥ 200 ft. These steps should be included in an updated shoreline management plan. It is also suggested that modified ordinances include replacing dune access walk-throughs with walkovers, and consolidating the number of areas where dunes can be completely removed for recreation or access. This may require a campaign of educating the local community and property owners about the necessity of adapting and making changes to habitual ways of doing things in light of climate change induced sea level rise and increased storm intensities. There will need also to be planning to determine how to fund or subsidize the conversion of walk-throughs to walk-overs.

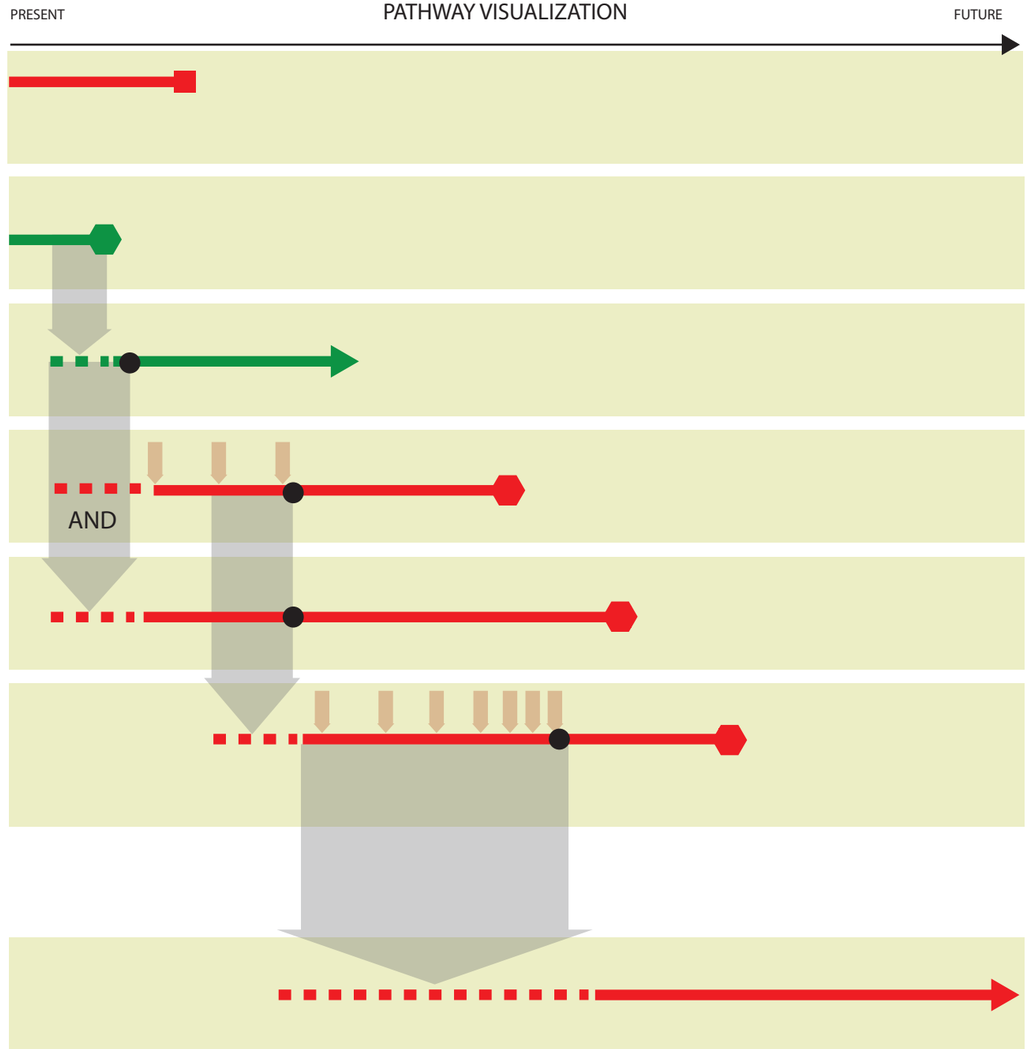
Physical Adaptation

Physical adaptation at SPI will continue to be in the form of soft protection – beach nourishment and dune maintenance for the foreseeable future, dependent on any drastic changes to sea level rise rate or other hazards in which case other alternatives may have to be considered, such as hybrid strategies. Sand nourishment programs refer to efforts to maintain or increase the local sediment supply to widen beaches, repair dunes, increase coastal recreational opportunities, and mitigate coastal erosion. Sand nourishment programs tend to be cyclic and are often in the form of nourishment projects that place large volumes of sand to widen and elevate beaches. Longer-term sand management programs can be in the form offshore placement of sand to allow natural nearshore processes to redistribute the material, or localized placement to add sand at a specific location on a periodic basis. Such programs aim to create higher sand volumes, and improve coastal recreation and access, and resilience.

In addition to beach nourishment, dune restoration and maintenance, accompanied by a vegetation planting program is a nature-based strategy that includes the process of both restoring and assisting in the development of new coastal dunes, and may include beneficial placement of sand to form back-beach dunes where they are narrow or nonexistent. This can serve as a natural way to mitigate backshore erosion and maintain a wider beach. This process is suited for wider beaches and can be effective in slowing erosion.

SPI has had a long-term beach nourishment and dune maintenance program in place for over a decade. The location benefits from its proximity to the Santiago-Brazos Pass, which is a navigational channel that requires regular dredging to maintain appropriate channel depth. The material is placed on the beaches and dunes at SPI as part of a Beneficial-Use Dredge Material (BUDM) program. Occasional dredging of the Mansfield Channel also makes available sand for use on SPI beaches.

	STRATEGY	TRIGGER(S) TO INITIATE STRATEGY	OTHER CONSIDERATIONS	UPFRONT COST / MAINTAIN
Current	Continue with Current Beach Nourishment Allow dunes to be trimmed to 10 ft Dune walk-throughs remain	BUDM is available Significant storm erosion	Frequent beach and dune erosion Lateral dune erosion in walk-throughs	$$ Medium
Near-term Policy	Codify Triggers 12.5 ft dune height 200 ft beach width	N/A	N/A	N/A
	Modify Ordinance Dunes maintained >/= 12.5 ft Restrict/replace dune walk-throughs Require continuous dune field	12.5 ft most resilient based on historical analysis and modeling Breaks in dunes increase vulnerability	Community resistance Costs of building walk-overs	$ N/A
SLR Near-term 0 to 1.5 ft	Beach Nourishment Maintain primary dune >/= 12.5 ft Maintain beach width >/= 200 ft Offshore placement if excess BUDM Establish yearly monitoring program	Dune erodes to < 12.5 ft or Beach erodes to < 200 ft Dune vegeation is sparse or loses diversity	Views may be impacted Require increased frequency with time Based on BUDM - occurs in dredging years Dune habitats improved Dunes less vulnerable to lateral erosion	$$ Medium
	Dune Maintenance Convert dune walk-throughs to walkovers Reconstruct and plant dunes Monitor dune vegetation			$$ Medium
Mid-term 1.5 to 3.5 ft	Increase nourishment Maintain beach width >/= 300 ft - may require narrowing dune field Increase primary dune crest and toe height Consider adopting hybrid approaches	Beach erodes < 200 ft yearly Dunes regularly eroded < 12.5 ft	More frequent nourishment Difficult to maintain 300 ft beach	$$$ High
Long-term > 3.5 ft	Managed Relocation Restrict rebuilding after damage Consider elevating land and/or Galveston-style seawall	Existing protection strategy can no longer be maintained	Little accommodation space for relocation Loss of beach recreation	$$$$ Low



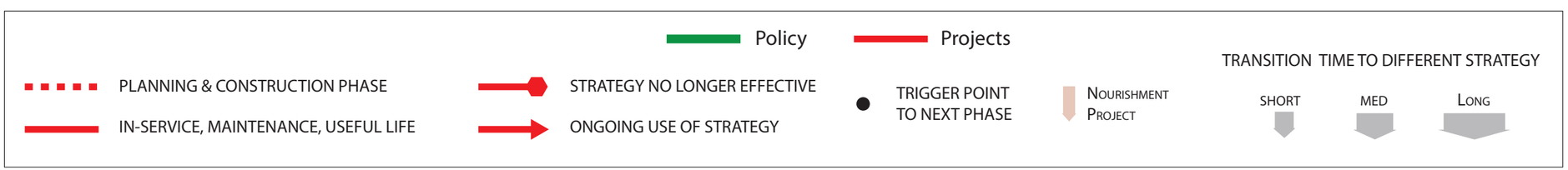


Figure 1. Adaptation pathway for resilient beaches and dunes at SPI.

Maintaining the status quo – 'do nothing' strategy

One adaptation strategy is to do nothing, that is continue with the current beach nourishment program, nourishing when sand is available from dredging of the Pass (top of adaptation pathway in Figure 1). In the do-nothing case, the policy changes would not be implemented and the dunes would continue to have vulnerable elevations and walk-through access points. **Over the course of the next several decades, rising sea level elevations and increased storm activity will likely result in a severely eroded beach and dune system, with occasional damage to oceanfront infrastructure and the likelihood of flooding.**

Next steps

Figure 1 shows the implementation of the shoreline management plan as part of the adaption pathway, which should also include a dune maintenance plan. Enforcing the new policy will require a beach and dune-monitoring program to identify when the triggers have been exceeded, that is the primary dune elevation below 12.5 ft and beach width narrower than 200 ft. It is unlikely that the exceedance of a trigger in a single location would trigger an action, rather it should be viewed as a systemic state for the majority of the system.

There may be periods of relatively calm weather, when BUDM is available but the triggers have not been exceeded. In this case, an option would be to undertake an offshore sand placement as has been done in the past, allowing natural processes redistribute the material along the island.

In the same period that the beach and dune system is being constructed and monitored as part of the shoreline management plan, dune walk-throughs are converted to dune walk-overs, dunes that have been completely removed are reconstructed and planted, and the vegetation is monitored for coverage and diversity.

As seas continue to rise through time and sea level rise exceeds 1.5 ft and trends towards 3.5 ft, the rate of nourishment required to maintain a resilient beach and dunes will substantially increase. At some point in the future, with continued sea level rise and storms, it may become challenging or unrealistic to continue to rely on nourishment projects to mitigate flooding and storm damages at SPI, as the need for sand may exceed the availability of BUDM or other sediment sources. Knowing this as a future likely condition, planning for the next stage should begin relatively early in the process.

The community will ultimately need to decide if they will attempt to fund and build a Galveston-style seawall as well as raising the elevation of the land with fill, and beginning the process of managed relocation – moving oceanfront properties or not allowing those significantly damaged in storms to rebuild. An early and accurate assessment of individual property seawall elevations and coastal defenses currently in place, including an assessment of their efficacy, will be invaluable in determining present-day gaps in the existing hard

infrastructure that may be the only line of defense in the event of dune failure before other solutions have been implemented.

This study and adaptation plan are focused on examining the resilience of the beaches and dunes and making recommendations for managing them into the future. A full adaptation plan might include options for gray infrastructure that could be considered and could also include cost-benefit analyses of different options, as well as secondary impacts and trade-offs. However, this is beyond the scope of the present study.