BEACH AND DUNE MANAGEMENT ON THE TEXAS GULF COAST

Beach and dune management are important issues on the Texas Gulf Coast. These issues are particularly important in areas of shoreline erosion and urban development. The impacts of shoreline erosion and urban development have a major impact on beach and dune stabilization.

Shoreline erosion on the Texas coast is primarily an act of nature, which is difficult to control. The increase in erosion as a result of the actions of man; however, can be reduced by good management plans and practices. Successful management often requires a comprehensive effort from property owners, land users, and government.

Galveston Island, Padre Island, and the other barrier islands constituting the Texas Gulf shoreline constantly change due to natural wind and wave forces. Natural sand dunes provide a defense against these forces. Protection to the beach and inland areas is provided in several ways:

- Provide sand that nourishes eroded beaches.
- Prevent or delay the penetration of waves and storm surges.
- Absorb wave energy during storms.
- Act as buffers from wind blown sand and salt spray.

Residents near the Gulf use sand dunes for protection of their property from wind and wave energy. They maintain and improve the sand dunes on their property. In order to make effective improvements in a dune system, a thorough understanding of how dunes form is needed.

A coastal dune is formed by a buildup of sand held by vegetation. Grass traps and holds blowing sand. During a storm, wave actions flatten the beach and remove sand from the toe of the dune. Removal of this sand causes undermining and collapse of the dune's seaward face. In very heavy seas, the seaward face may recede several yards and leave a steep, high bank. The sand that is removed is carried off shore and deposited outside the surf zone. These deposits form large sand bars. The action of moving and redepositing sand dissipates wave energy during the storm, and the new sand bars dissipate future wave energy by "breaking" waves further offshore.

During calmer conditions, the waves transport sand from the offshore bar and surf zone to the beach. This builds up on the beach and forms a steep seaward profile. In time, sand blows back to the frontal dunes that lost the sand during storms. If the windblown sand from the beach is trapped by vegetation on the frontal dune, it is again available to storm waves. This natural cycle protects inland areas from storm waves. The cycle requires an adequate supply of sand on the beach and in the frontal dune system.

The loss of sand from the natural cycle results in erosion becoming more pronounced. The shoreline and dune area may recede a considerable distance. Disturbances in the frontal dune system by construction work or other activities can start the wind erosion process. This may remove the frontal dune and deplete the sand source. Construction of vertical sea walls disturbs the natural cycle of sand. Wave barriers can reduce the impact upon the sand cycle. Waves against these walls increase beach erosion and undermine the sea walls; however, sea walls are effective in some areas. Their costs are at an economical disadvantage to the naturally vegetated dune system.

Even before the effects of "Hurricane Allen", Galveston Island and the Upper Gulf Coast had a poorly organized dune system. Dunes varied in height from 2 - 12 feet and width from 20 - 160 feet. Vegetation was sparse with large bare

areas. Many small beaches or washovers were located between the dunes, and natural dunes disappeared. Other dunes were damaged by wave action, vehicles, and urban development.

The present dune formation is part of a slow natural regrowth process with the local conditions as the controlling factors. Natural rebuilding takes a long time. People can enhance and accelerate this process with positive actions.

Dune Improvement

Dunes are dynamic formations and change with natural events or human activity. Human activities normally increase the natural damage. Nature in time establishes a new structure or repairs damage to the existing dunes. New dunes may be smaller and at different locations than the original dunes. Some methods to improve, rebuild, or repair dunes include:

- acceleration of natural sand buildup,
- importing new sand, and
- revegetation.

The best technique depends on the type and extent of damage and the conditions of the site.

NATURAL DAMAGE

Winds continually reshape dunes and may cause some damage. The vegetation on dunes protects the sand from the effects of wind. If the vegetation is removed or destroyed by fire, wave action, animal trails, salt water spray, etc., the wind blows the sand inland where it is lost to the dune system.

Damage by water also plays an important role in the natural breakdown of dune systems. There are three main types of water related damage:

1. Erosion from storm tides.
2. Erosion from washovers ("topovers") when waves break over the tops of dunes moving from the Gulf to the bays.
3. Erosion from washouts, a result of storm runoff or surge retreating from the bay to the Gulf.

STORM TIDES: During severe storms, tide raise the water and completely cover the beach area. The base of the dune is exposed to prolonged direct wave action and erosion. A mild storm generates modest tides, and the wave action lasts a short time. The erosion undermines the toe of the dune and steepens the seaward face. If tides are high and prolonged, erosion proceeds rapidly and cuts further into the frontal dunes. In extreme cases, the retreating waves carry sand from the dunes into open water and the dunes are destroyed.

WASHOVER: When the height of approaching storm waves exceed the height of the lowest parts of the dune ridge, water moves over the low points. As the "topover" waters race down the landward side of the dunes, erosion occurs. These low points erode downward allowing increasing amount of water to flow further inland. The eroded sand moves inland and deposits behind the dunes or in the bay, where it is out of the dune system. During sever storms, channels may be cut into interior land areas.

On barrier islands, evidence of hurricane washovers are detected by site investigations on aerial photographs. On Galveston and Padre Islands, many bayous were probably shaped by washover activity. Areas with major washover regenerate dunes at a slow pace, because the sand deposits needed for reconstruction of the dunes are out of the system. Scouring from washover waters removes vegetation from broad expanses of land, and recolonization of erosion control plants is difficult.

WASHOUTS: Washouts are comparable to washovers. They differ in the degree of dune damage and the direction of water movement. Runoff waters from barrier islands and peninsulas move towards the bay behind the island. Excessive rain collects in the swales or valleys between dunes. Water stored in swales seeks the outlet at the lowest elevations and channels through breaches and other low points. The result is a washout or opening eroded and enlarged by escaping storm runoff. The sand settles on the beach or sandbars, and is available for movement back to the dunes by wind and wave action.

Washouts result from retreating bay waters. Slow moving hurricanes pile waters into the bay systems. If the natural channels are constricted, then the excessive build-up of watercuts new channels across low points in the barrier islands.

HUMAN DAMAGE

Erosion damage is more likely to occur at low points in the dune lines. People accessing the beaches cut roads through dunes or create trails. In both cases, breaches in the dunes are created.

Road construction radically alters the dune area. Sand is removed for road passages, and the side of dunes in road cuts are exposed to wind erosion. Sand accumulates in the dune opening of a road and is continually removed to maintain access. Passing vehicles prevent effective sand accumulations. Winds channel through road cuts allowing the movement of sand from beaches to interior areas. Low elevation road cuts act as conduits for storm tides and become locations of washovers and washouts.

Pedestrian traffic impacts the stability of dunes by trampling vegetation, and repeated usage establishes trails. Winds lift and remove sand from trail exposures. Continual removal of sand by wind and hikers deepen the trail cuts. These low points increase the vulnerability of the dune system to storm damage.

Motorcycles, horses, grazing cattle, and clearing sites for construction are other examples of human induced dune damage. Sometimes the entire dune structure is removed for a structure or pipeline. This destroys the dune at the site and accelerates dune erosion in adjacent areas.

IMPROVING DUNES

In the natural system, sand constantly blows landward from the beach and is trapped by grasses in the existing dunes. If a dune does not exist or additional sand build-up is desired closer to the beach, several techniques are available to capture the blowing sand in the desired location.

Trapping blown sand on beaches with a large supply of small sand particles is the easiest method. The presence of fresh sand deposits around clumps of grass or other obstructions is evidence of the type and quantity of sand available. Wind blown sand can be trapped by mechanical means like sand fencing or brush placement. Sand can be imported if the location does not have an adequate quantity available. Vegetation can be used to trap sand, or to stabilize dunes build-up by other means.

SAND FENCING: Standard wooden sand fencing, or polyethylene construction fencing have been used for collecting wind blown sand for dune build-up. This fencing is readily available, handled easily, and erected quickly. When improving a pre-existing dune, place the sand fence 5 - 15 feet in front of the existing vegetation line. After sand has formed, place another fence in the swale between the dunes. Continue this process behind the original dune until the desired height is reached.

Two construction designs are suggested for new dunes. One option uses two lines of fencing spaced 20 feet apart, with a crossover fence every 50 feet. This option effectively creates a new dune in the presence of crosswinds. A second option uses a single line of fence. In both options the fence is placed 10 - 20 feet from the existing vegetation line. On long stretches of beach with predominant head winds, a single line of fence has proven successful and economical.

Use standard 2 - 4 foot height fencing material. The fence should be in good condition. Wood fence supports can be made from black locust, red cedar, white cedar, treated pine or other wood of equal life and strength. Do not use untreated pine. The supports can range from 4 to 8 feet in length depending on the height of the fencing material. A minimum post diameter of 3 inches is recommended. Weave the fence between posts with every other post on the ocean side. Use 12 gauge or larger galvanized wire to attach the fence to the posts. The fence should be attached to each post in 4 locations, evenly spaced along the length of the post.

BRUSH PLACEMENT: Brush will trap sand and build dunes. Pile or spread brush at desirable dune locations. A porous pile is more effective and takes less material than a solid pile. Brush piles hold sand well and little is lost to shifting winds. Two foot high piles make a good start for dune construction. Some effective material include: palm leaves, Christmas trees, hedge and/or tree clippings. In breaches, Christmas trees can be placed straight up with their bottom branches buried in the sand, or laid down and staked to the ground to prevent being blown away by wind. Do not use inorganic materials like washing machines, stone, wire, or tires.

LOCATION: Regardless of technique, location is very important. When repairing a breach, start the initial fence or pile at the point of the breach farthest from the Gulf. After the initial sand is

built-up, place another fence or pile about 20 feet closer to the Gulf and build-up a second pile. Place a third fence or pile between the first two and on top of the built-up sand. Continue this process always working towards the Gulf. When the toe of the existing dunes on either side of the breach is reached, the dune repair is complete.

If the dunes were completely destroyed by human activity, location of the front toe of the dune is the first step. Look at the dunes on either side of the destroyed area and estimate where the toe may have been located or try to find an old aerial photo that shows the location of the old dune. The toe of the old dune on the Gulf side is the desired location for the new dune. Begin the build-up process about 20 feet in front of the existing vegetation line and work toward the Gulf until the location of the old dune toe is reached.

If the dunes were destroyed by natural causes like wave action or overwash, re-establishment may be more difficult. The new dunes may not reestablish at the old location, because too much sand has been lost form the old toe and equilibrium can not be reestablished. In cases like this, the new dune will have to be built-up further inland than the old dunes.

There is no single rule of thumb for new dune location, but there are general guidelines for distances from the Gulf:

1. No closer than 100 feet from mean high tide line in order to avoid destruction by minor storms.
2. No further than 100 feet from the existing vegetation line. Preferably 10 - 20 feet from the existing vegetation line.
3. No closer to the Gulf than the original dune.
4. No closer to the Gulf than the remaining natural dunes in the area.
5. Allow for seaward expansion of dune growth. Place fence or brush 10 feet landward of the closest point the dune can be located toward the Gulf.

IMPORTED SAND

Most of the beaches on the Upper Texas Gulf Coast are sand starved. The natural process of dune construction is slow and it may take 20 years or more for a growth of six feet in height. Sand fencing takes several years. Rebuilt dunes of imported sand require much less time. Two major rules fro building dunes with imported sand are:

1. NEVER remove sand from the beach.
2. Imported sand should be as similar as possible to the sand that exists on the beach.

Obtaining sand from the beach robs donor areas of sand needed for maintenance of both beaches and dunes. Erosion increases if large quantities of sand are removed.

Important characteristics of imported sand are grain size and salinity. Grain size should be comparable to native sand which is fine-grained. If coarser sand is introduced, the dunes will not shape in the same manner by the wind. High salinity will inhibit plant growth. Freshly dredged material is not suitable as a sand source. Leaching the salt from the dredged material requires 2 - 3 years of rainfall. The salinity of dune material should not exceed 3.5 - 4 parts per thousand (ppt).

SHAPING DUNES: Shaping clues should be taken from the adjacent dunes. Shape new dunes to the same height as the adjacent dunes (not less than 4 feet high). Earthmoving equipment can fill breaches or shape new dunes.

Construct new dunes with the same slope as the adjacent dunes. Never exceed a 1:1 slope or a 45 degree angle. A slope of 3:1 or 33 degree angle if preferable. The width of manmade dunes should be comparable to the adjacent dune areas and not less than 20 feet. A dune with a small base will not grow sufficiently to provide storm protection.

VEGETATIVE SAND TRAPS

Vegetation traps wind blown sand in the natural dune building process. Re-establishment of vegetation on the dunes is important regardless of the method of repair or creation. Vegetation can be transplanted from other dune sites or the plants can be collected and propagated vegetatively in a nursery or greenhouse.

SHAPING DUNES: Two grass species have been proven to work for stabilization of dunes. They are **Bitter Panicum, *Panicum amarum*** and **Sea Oats, *Uniola paniculata.***

As with many native plants there are few commercial sources of either species. For relatively small stabilization projects, transplants can be removed from existing stands near the project site. For large projects it may be possible to contract with a nursery to vegetatively propagate larger quantities of both species.

Bitter panicum is a native plant with moderately high salt tolerance. It is a hardy grower with bluish smooth leaves 0.25 - 0.50 inches wide and 4 - 12 inches long. New plants grow from tillers (shoots) that grow from the nodes of the roots. The seed of bitter panicum is sterile, so the only way this plant can be propagated is vegetatively.

If transplanting from a nearby site is the selected method of plant material collection, obtain permission from local landowners or authorities before making a collection. Be sure some roots are attached to the plants collected. Select collection locations with dense healthy stands, and leave more than you take. Do not create areas of bare sand at the collection site.

The plants may be placed in the ground, either upright or horizontally, since they root at the nodes. In areas with rapidly shifting sand, upright planting is recommended. Stabilization of a dune with bitter panicum will take about a year.

WHEN: Plant in early winter to early summer. Survival is dependent on adequate moisture.

DEPTH: Six inches.

SPACING: Generally two feet on center, closer on crowns and steeper areas of the dunes.

STOCK: Stems 2 - 3 feet tall are preferable to small tillers. Stems may be trimmed to a length of 1 foot above the roots to reduce moisture stress. Plants can be stored for up to 4 weeks if the roots are kept moist.

Sea Oats are native to Texas, grow rapidly, and have pale green leaves that die back in the winter. The stiff seed topped stems grow to 2 feet or more in length. Sea oats are less tolerant of salinity and salt spray than bitter panicum. For this reason, sea oats are usually used in combination with bitter panicum. The majority of the stand should consist of bitter panicum.

Sea oats produce some (about 10%) viable seed, and can be propagated by seed with limited success. Collect entire seed spikelets when they are ripe (golden brown in color), usually in late September. Store them in a cold dry place over the winter. Plant the whole spikelet in the desired location or germinate them in peat pots and plant them on the dune site after several months of growth in the pots. Do not attempt to seed barren dunes, because the seed will not establish fast enough to be successful.

The best source of sea oat plants is collection from existing stands. Choose only healthy vigorous plants, and do not over harvest the collection site. Young sea oats found in small hammocks in front of sand dunes have a greater chance of transplant success than older longer rooted plants. Avoid transplanting plants with seedheads. Plant collected material as soon as possible. The plants will remain viable for about 4 days if the roots are kept moist and covered. Stabilization of a dune with a mixture of sea oats and bitter panicum will take about 2 years.

WHEN: Plant from June through November with adequate moisture.

DEPTH: Plant 6 to 10 inches deep. Keep roots moist during collection and prior to replanting.

SPACING: 12 - 36 inches on center.

Planting of both species is usually accomplished with a shovel or dibble bar. On large relatively flat or uniform slopes, small modified tobacco, vegetable, or tree planters may be used. Expect a survival rate of 50 - 80 percent. Bare areas can be filled with plants from established sites. If survival is less than 10 percent, complete replanting is needed.