



**Rollover Pass  
Erosion and Hazard-related Issues**

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# **Rollover Pass Erosion and Hazard-related Issues**

## **Executive Summary**

### **Introduction**

Rollover Pass on Bolivar Peninsula in Galveston County, Texas has been a very popular fishing attraction to fishermen in southeast Texas since it was constructed in 1955. However, construction of the Pass resulted in significant unexpected consequences due to the hydraulic connection established between Rollover Bay and the Gulf of Mexico. Beaches located east and downdrift of the Pass experienced accelerated shoreline erosion, and the Gulf Intracoastal Waterway (GIWW) experienced high shoaling rates due to beach sediment being transported through the Pass and deposited into the navigation channel.

During the 2009 legislative session, the Texas State Legislature passed Senate Bill 2043 (SB 2043), which Governor Rick Perry signed on May 19, 2009. SB 2043 amended the Natural Resources Code to authorize the Texas General Land Office (GLO) to close or modify manmade channels or passes found to be contributing to erosion of adjacent shorelines. Legislative appropriations were allocated to fund the closure of Rollover Pass.

### **Summary of Issues**

The existence of the man-made Pass at Rollover Bay built in 1955 has contributed to increased erosion of adjacent shorelines and to numerous hazards and risks to the environment and public safety. Specifically:

- **The Pass has contributed to significant beach erosion.** Before construction of the Pass, the shoreline of Bolivar Peninsula at Rollover eroded at approximately 5 feet per year. Since construction of the Pass, the shoreline west of the Pass has eroded at an average of 7 to 8 feet per year. Approximately 240,000 to 290,000 cubic yards of beach material are transported through the Pass each year. This means that almost 10 million cubic yards of sand have been lost from the Gulf beaches since the Pass was built.

The Taylor Engineering Inc. 2010 report “*Analysis of Rollover Pass Impacts to Adjacent Beaches and the Littoral System*” cited numerous studies from 1958 to the present that indicate Rollover Pass contributes to increased erosion of the adjacent beaches and increases the frequency and costs to dredge the GIWW.<sup>1</sup> Such adverse impacts arise primarily from the flood dominant characteristics of the Pass that transport material from the natural littoral zone into the Pass interior. The report concludes that closure of Rollover Pass is justified to reduce erosion of the adjacent beaches, reduce the required frequency and costs of GIWW

maintenance dredging, and help improve the effectiveness of future beach restoration projects.

- **The Pass poses a significant risk to the GIWW.** To reduce shoaling from sediment transported through the Pass and to maintain safe navigation, the United States Army Corps of Engineers (USACE) is required to conduct annual maintenance dredging of the GIWW in the vicinity of the Pass at a cost of approximately \$600,000 per year. Closing the Pass would reduce the required frequency and costs of GIWW maintenance dredging. Interruption or loss of navigation of the GIWW due to shoaling or breaching of Bolivar Peninsula in the area of the Pass could have significant state and national economic impacts.
- **The Pass increases the vulnerability of the peninsula to storm impacts.** Bolivar Peninsula is impacted by storms on average every 2.62 years. The location of the Pass within a natural coastal washover feature makes the area more vulnerable to storm surge and potential breaching by high water levels and wave action during a storm.
- **The Pass increases the risk of oil and/or pollutant spills entering Rollover Bay and East Bay.** If a significant Gulf oil spill event such as the Deepwater Horizon oil spill were to occur near Rollover Pass, the Galveston Bay ecosystem could suffer substantial, if not catastrophic, damage due to the potential migration of oil through the Pass.
- **The Pass contributes to high salinity levels in the Galveston Bay estuarine system.** Before the Pass, salinity levels in Rollover Bay and East Bay were about 10 - 20 parts per thousand (ppt), which is in the ideal range of 10 – 28 ppt for oyster growth. After the Pass was opened, salinity levels increased to over 25 ppt, resulting in decreased oyster communities.
- **The Highway 87 bridge spanning Rollover Pass is more vulnerable to storm damage due to increased flow velocities within the confined space of the Pass.** Highway 87 is the only land access to Bolivar Peninsula and the hurricane evacuation route along the peninsula. The Pass could cause severe damage to the bridge in subsequent storms, preventing people from reaching safety in time before approaching storms. Post-storm recovery would also be significantly impacted by the lack of access to areas of the peninsula west of the Pass.
- **The condition of the Pass poses a significant public health and safety risk.** The bulkheads, sidewalks, and handrails sustained significant and currently unrepaired damage from Hurricane Ike. Corrosion to the steel sheet piles has left a jagged top, putting the general public at great danger. Weaknesses to the sheet piles, which is partially caused by corrosion, also increase the likelihood of structural failure and collapse of the sidewalls. In addition, Rollover Pass does not

meet Americans with Disabilities Act (ADA) guidelines or Texas Accessibility Standards.

- **The Pass creates a negative fiscal impact to state and federal agencies.**
  - The USACE spends approximately \$600,000 per year dredging the GIWW.
  - TxDOT spent \$675,152.33 in emergency repairs after Hurricane Ike.
  - GLO has spent \$827,531 in matching funds toward federal disaster assistance for beach nourishment after three hurricanes from 2001 to 2008.
  - Since 1999, GLO and Galveston County have spent approximately \$166,000 per year in incremental costs to return sediment from the USACE maintenance dredging of the GIWW near Rollover to the Gulf beach.
  
- **Modifications to the Pass will not solve hazard and risk issues.** Several of the previous reports pertaining to Rollover Pass have studied potential modifications to mitigate the negative effects caused by the Pass. The most comprehensive study reviewed prior studies, collected physical data, and investigated potential modifications to the Pass while attempting to keep it open. A 2001 report by Pacific Engineering, Inc. (PIE) “*Physical Processes, Engineering Analysis and Environmental Impacts — Shoreline Erosion Control, Rollover Pass, Texas*” identified the major causes of erosion at Rollover Pass as: large-scale/long-term regional shoreline erosion; sand loss to the Pass by flood tide currents; sand loss to deep water by ebb tide currents; and ebb delta deterioration.<sup>2</sup>

Advocates for keeping Rollover Pass open maintain that longer jetties constructed at the Gulf end of the Pass would adequately address the loss of beach sediment to Rollover Bay and the GIWW. Although longer jetties would effectively halt the littoral transport of sediment from the east into the Pass, longer jetties would still allow ebb tidal currents from the Pass to transport littoral sand to deeper water offshore and would continue to prevent sand from reaching the beaches west of the Pass. Additionally, any modifications to the Pass would essentially require the entire reconstruction of the existing infrastructure of the Pass since the steel sheet pilings used for channel bank bulkheads are heavily corroded and at risk of failure.

Closing Rollover Pass and restoring the man-made channel to its natural state will:

- reduce beach erosion to the Bolivar beaches and lower the cost of beach nourishment
- reduce the costs associated with the shoaling and dredging of the GIWW to maintain navigability
- act as a natural oil spill and leak barrier to the Galveston Bay system to prevent major environmental destruction and loss to critical habitat and endangered species

- provide a means for reducing future damages to the State Highway 87 bridge over Rollover Pass, which is a major evacuation route from Galveston
- remove a public hazard that, as a result of Hurricane Ike, presents numerous health and safety issues

## **Rollover Pass Erosion and Hazard-related Issues**

### Detailed Report

### **Background**

Rollover Pass is an artificial channel on Bolivar Peninsula constructed by The Texas Game and Fish Commission (now Texas Parks & Wildlife) under an agreement with the property owner, the Gulf Coast Rod, Reel, and Gun Club. The construction that occurred from October 1954 to February 1955 connected the Gulf of Mexico and Rollover Bay. The purpose of the Pass was to improve bay water quality and salinity, enhance fish migration into Rollover Bay and East Bay, perpetuate state fish and wildlife resources and improve local fishing conditions.

The Pass is located in the narrowest part of Bolivar Peninsula (Figure 1) within a natural washover area, which is periodically breached by sheet flow during tropical storms and hurricanes. Prior to the construction of the Pass, the natural process in the area during high tide and storm events allowed sediment to be transported offshore and deposited in offshore sand bars. The sand reservoir provided sediment for rebuilding the beach and dunes after a storm event and provided sediment to shorelines to the southwest along the littoral drift.



Figure 1 Rollover Pass Area Pre-Construction 1954

During the 2009 legislative session, the Texas State Legislature passed Senate Bill 2043 (SB 2043), which Governor Rick Perry signed on May 19, 2009. SB 2043 amended the Natural Resources Code to authorize the Commissioner of the Texas General Land Office (GLO) to undertake the modification or closure of a man-made pass between the Gulf of Mexico and an inland bay if he determined that the pass causes or contributes to significant erosion of the shoreline of the adjacent beach. One requirement of the bill was the development of a plan for recreational alternatives if Rollover Pass was closed.

## **Identified Hazards and Risk**

### **Erosion**

Numerous studies from 1958 to the present indicate Rollover Pass contributes to significant erosion of the adjacent beaches, primarily to the west, and increases the frequency and cost for dredging of the Gulf Intracoastal Waterway (GIWW). Such adverse impacts arise primarily from the flood dominant characteristics of the Pass that transport material from the natural littoral zone into the Pass.

Natural coastal processes transport sediment along the littoral current of the Gulf shoreline through breaking waves suspending sand from the bottom into the water. The sand is then carried a short distance along the shoreline until it settles out, only to be re-suspended and carried along by the next breaking wave. Rollover Pass interrupts this natural process due to high tidal exchange velocities through the Pass. These tidal velocities are a result of the lag time in tide levels between the Gulf of Mexico and Rollover Bay. As the water surface in the Gulf of Mexico rises daily, a differential in water elevation is established between the higher water surface on the Gulf side and that in Rollover Bay. As a result, current velocities increase through the Pass in a flood flow to Rollover Bay. Sediment already in suspension as a result of wave action and littoral transport occurring at the Gulf entrance is readily swept through the inlet into Rollover Bay where it is eventually deposited because of the decrease in water velocity. Eventually the water surface in the Gulf drops to a level below that in the bays and the cycle reverses itself in an ebb flow with water flowing out of the bays toward the Gulf. However, the ebb flow contains a significantly lower amount of suspended sediments.

GLO, in cooperation with Galveston County and USACE, has conducted numerous beach nourishment projects in the vicinity of Rollover Pass to try to mitigate the effects of shoreline erosion. Sand from beach nourishment projects conducted on the east and up-drift side of Rollover Pass was quickly lost to Rollover Bay and the GIWW. Annual beneficial use of dredged material projects associated with maintenance dredging of the GIWW by USACE attempt to return sand lost from the littoral system back to the eroding beaches west of the Pass. However, projects to place sand west of the Pass have been unsuccessful in keeping pace with the accelerated shoreline erosion on the down-drift beaches caused by the lack of littoral transport from up-drift beaches. Future attempts to nourish the beaches adjacent to Rollover Pass will most likely be futile with the continued existence of the Pass.

### **Gulf Coast Intracoastal Waterway (GIWW)**

The large amount of sediment transported from the beach through Rollover Pass and into the GIWW requires USACE to conduct annual maintenance dredging along the Rollover Bay section of the channel. Even with the more frequent dredging schedule, barges that travel along the GIWW through Rollover Bay are often light-loaded to avoid grounding on the unpredictable shoals along that section of the channel. The increased presence of dredges in the Rollover Bay section of the GIWW and the high potential for grounding negatively affects the navigation safety of this vital petrochemical commerce route, which in turn has a national economic impact.

Dredging operations within this portion of the GIWW may result in the reduction of barge traffic allowed through the area during such activities. Approximately 74 million tons of cargo with a commercial value estimated at \$25 billion travels the Texas GIWW each year on approximately 109,558 one-way barge trips.<sup>3</sup> The Texas GIWW is a vital commercial link to the nation's economy. Thirteen percent of the nation's freight is carried on the GIWW at only a fraction of the cost of moving the same cargo by truck.<sup>4</sup> More than half of the nation's chemical products and gasoline comes from plants along the Texas portion of the GIWW.<sup>5</sup>

Dredging data from the USACE indicates that 240,000-290,000 cubic yards of beach materials are transported through Rollover Pass and deposited in the GIWW annually.<sup>6</sup> This means that almost 10 million cubic yards of sand have been lost from the beaches through Rollover Pass since it was built in 1955.

The Pass also increases the vulnerability of Bolivar Peninsula to being breached by storm surge and wave action. With the Pass causing accelerated erosion rates and a reduction in the sand volume required to maintain the natural beach conditions along the adjacent Gulf shoreline, there is a concern that a large high energy storm or subsequent storms could result in the washover area of the Pass being opened to the Gulf of Mexico. An additional concern is the poor conditions of the steel bulkheads lining the Pass. The bulkheads are susceptible to failure even in high tide and smaller storm events. Failure of the bulkheads will result in rapid expansion of the channel from tidal scour as was seen in 1955 when the Pass was constructed. If the portion of the GIWW near Rollover Pass becomes open to the Gulf of Mexico, the GIWW will no longer be navigable. Bolivar came dangerously close to being breached by Hurricane Ike within the Rollover Pass area as shown in Figure 2.



Figure 2. Rollover Pass Post-Ike 2008

### Storm Impacts

Based on historical records dating back to 1871, on average, this area is affected by a tropical storm or hurricane every 2.62 years.<sup>7</sup> Direct impacts from hurricanes with average wind speeds of 107 mph affect this area, on average, every 8.69 years.<sup>8</sup> In addition, the NOAA National Climatic Data Center Report on Floods from 1994 to 2011 has identified 68 flood events in this area over the past 17 years.

Scientific studies indicate global sea levels could rise as much as 1 to 2 feet in 100 years. However, with the effects of local subsidence, the area surrounding Rollover Pass has one of the highest relative sea level rise rates in the state. The tide gauge at the Pleasure Pier in Galveston indicates local sea levels are rising at approximately 6 mm/year (.02 feet/year).<sup>9</sup> At this current rate, sea levels in the area could be approximately 1.75 feet higher by the year 2100. As sea levels rise, the width of this area of Bolivar Peninsula will become narrower, increasing the risk of the area being inundated more frequently. Currently, washovers in the Rollover Pass area have been associated with hurricane events, which as mentioned above occur on average every 8.69 years. If Rollover Pass remains open, rising sea levels could result in washovers occurring even with tropical storm events, placing the frequency averaging closer to every 2.62 years. Each washover event can further increase the risk of this area of Bolivar Peninsula being breached. It is critical that steps are taken now to allow for the area to fully recover back to its natural state before subsidence and sea level rise contribute to an increase in washovers near the Pass.

### **Oil Spills**

Without the closure of Rollover Pass, Rollover Bay and East Bay are vulnerable to oil and pollutants being pulled into the bays, causing major environmental destruction and loss to critical habitat and endangered species in addition to major economic impacts due to an interruption of freight transport along the GIWW and affects on recreational and commercial fishing. Closure of Rollover Pass will reduce the risk of oil and pollutants from entering Rollover Bay and East Galveston Bay, thereby mitigating the impacts of a major spill. If an event such as the Deepwater Horizon oil spill were to occur near Rollover Pass in its current state, Rollover Bay and the Galveston Bay system could realize substantial, if not catastrophic, damage.

### **High Salinity**

Oyster reefs comprise a key ecological component of the Galveston Bay estuarine system. Natural oyster reefs generally fall within a salinity range from 10 – 30 parts per thousand (ppt).<sup>10</sup> Wilson et al. (2005) identified an optimal salinity range of 10 – 28 ppt for eastern oyster growth and reproduction.

Salinity measurements in 1954 showed salinity levels varied from about 10 ppt in the eastern-most reaches of East Bay to approximately 20 ppt in Galveston Bay.<sup>11</sup> After the Pass opened in 1955, salinity levels almost doubled in the eastern-most area of East Bay, averaging almost 18 ppt to approximately 15 ppt in the Galveston Bay region.<sup>12</sup> Reid measured salinities of 12 – 13 ppt in Rollover Bay before construction of the Pass, which increased to above 25 ppt in 1955 after the Pass opened.<sup>13</sup>

Results of Taylor Engineering's salinity modeling study indicate that closing Rollover Pass would moderately reduce salinity levels within Rollover Bay and would have a lesser effect on the eastern portion of East Bay. In the closed Pass condition, the model predicts salinity concentrations would fall within the natural salinity tolerance range of the dominant, tidally-influenced vegetation communities currently occurring in the Rollover Pass vicinity. These results suggest that closing Rollover Pass would not have a

significant adverse impact on the vegetation community structure in the vicinity. Taylor Engineering's study further indicates that closing Rollover Pass may result in the creation of additional essential fish habitats, particularly within Rollover Bay. Reduced salinities within the Bay may promote development of additional oyster communities. In addition, closing Rollover Pass would reduce current velocities within Rollover Bay, which may promote the development of additional intertidal sand and mud flat essential for fish habitat.

## **Highway 87**

Closure of Rollover Pass provides a means for protecting the bridge spanning Rollover Pass at State Highway 87, the only land route and hurricane evacuation route from Bolivar Peninsula west of the Pass. State Highway 87 serves as a major artery for residents and tourists travelling to and from Galveston. The bridge over Rollover Pass sustained significant damage during Hurricane Ike, reducing the bridge to one lane for several months after the storm. The damage required the Texas Department of Transportation (TxDOT) to execute a \$650,000 emergency contract to repair the bridge. These repairs opened the bridge for two way traffic, but did not restore the bridge to the pre-storm width of three lanes. Closure of Rollover Pass would contribute to reducing future negative impact to the bridge and minimize the adverse evacuation impacts before and after a major storm.

## **Public Health and Safety**

Numerous health and safety concerns pose significant issues for the public frequenting Rollover Pass. The bulkheads of the Pass are constructed of steel sheet piles with a concrete cap that serves as a walking surface for the public. The bulkheads sustained significant, and currently unrepaired, damage as a result of Hurricane Ike. Concrete slabs provided a wide sidewalk adjacent to the bulkheads. In many places, these concrete slabs are dislodged or have subsided. The current sidewalks are significantly damaged with many tripping and falling hazards.



Figure 3. Rollover Pass north of Highway 87

Due to wave attack associated with Hurricane Ike, the handrail system on top of the bulkheads sustained significant damage. In many places it provides no protection to prevent pedestrians from falling 10 feet into the waters below. The areas north of Highway 87 were not constructed with a concrete cap, and corrosion to the steel sheet piles has left a jagged top with potential safety hazards (Figure 3). Additionally, Rollover Pass does not meet Americans with Disabilities Act (ADA) guidelines or Texas Accessibility Standards (TAS). Rollover Pass has experienced significant erosion near the sheet piles lining the Pass. Weaknesses to the sheet piles, caused by corrosion, also

increase the likelihood of structural failure and collapse of the sidewalls. This damage, coupled with the fact that Rollover Pass is not ADA or TAS compliant, could lead to localized failures and major safety issues, putting the general public in danger.

### **Fiscal Impacts**

**United States Army Corps of Engineers (USACE)** – As a direct result of Rollover Pass, the USACE spends approximately \$600,000 per year to dredge the portion of the GIWW adjacent to the Pass.

**TxDOT Rollover Bridge FHWA Repair** – Emergency repairs to the Highway 87 bridge over Rollover Pass as a result of Hurricane Ike amounted to \$675,152.33. The repairs did not restore the bridge to its pre-Ike condition.

**General Land Office (GLO)** – The GLO spent a over \$800,000 to nourish the Gulf beach in the area of Rollover Pass after Hurricane Claudette in 2001, Hurricane Rita in 2005, and Hurricane Ike in 2008. These costs could have been reduced or avoided if the increased erosion due to Rollover Pass had not occurred.

**GLO Coastal Erosion Planning and Response Act (CEPRA) funds** – Since 1999, the GLO has spent \$166,000 per year in incremental costs to the USACE for returning the sediment dredged from the GIWW back to the Gulf beach.

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<sup>2</sup> *Physical Processes, Engineering Analysis and Environmental Impacts*, Pacific International Engineering, 2002.

<sup>3</sup> Texas Department of Transportation Gulf Intracoastal Waterway: Legislative Report – 81<sup>st</sup> Legislature. <http://ftp.dot.state.tx.us/pub/txdot-info/library/reports/gov/tpp/giww08.pdf> p. 5.

<sup>4</sup> Texas Department of Transportation Gulf Intracoastal Waterway: Legislative Report – 81<sup>st</sup> Legislature. <http://ftp.dot.state.tx.us/pub/txdot-info/library/reports/gov/tpp/giww08.pdf> p. 5.

<sup>5</sup> *The Economic Value of the Texas Gulf Coast*, Redwine, A. [http://gbic.tamug.edu/gbepubs/T1/gbnepT1\\_01-06.pdf](http://gbic.tamug.edu/gbepubs/T1/gbnepT1_01-06.pdf).

<sup>6</sup> *Severe Beach Erosion Caused by Permanent Beach Sand Loss Through Rollover Fish Pass Bolivar Peninsula, Texas*, Richard L. Watson, Ph.D., 1999, P.15.

<sup>7</sup> *Galveston, Texas history with tropical storms*, Hurricane City.Com: <http://www.hurricanecity.com/city/galveston.htm>

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