BLIND PASS INLET MANAGEMENT STUDY
2018 UPDATE

Prepared For:

Board of County Commissioners of Lee County

Prepared By:

Aptim Environmental & Infrastructure, Inc.

August 2018

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EXECUTIVE SUMMARY

Blind Pass is a natural tidal inlet located in Lee County on the Gulf Coast of Florida and is bounded by Captiva Island to the north and Sanibel Island to the south. This area of the coast is characterized by a series of barrier islands and tidal passes that are separated from the mainland of Florida by various water bodies. Blind Pass has migrated and closed at various times throughout history, and is presently managed by Lee County with an ongoing dredging program to maintain the inlet in an open condition.

The study described in this document provides an update to the 1993 Blind Pass Inlet Management Plan and recommends refinements for future management of Blind Pass. The study was developed as a collaborative effort with Lee County, the City of Sanibel, and the Captiva Erosion Prevention District (CEPD) to develop a mutually agreeable inlet management strategy for the future in a science-based approach. The study also aligns with the objective of balancing the sediment budget between the inlet and adjacent beaches, and assisting the FDEP in adopting an Inlet Management Plan pursuant to the requirements of Section 161.142, Florida Statutes.

The scope of this study included literature review, data collection, preparing a sediment budget update, performing an alternatives analysis with advanced numerical modeling, and developing inlet management recommendations. The alternatives analysis utilized the numerical model Delft3D to evaluate the conceptual designs in an individual and combined fashion. A Technical Advisory Committee (TAC) was involved in the study development and execution, which included representatives from Lee County, the CEPD, The City of Sanibel, and the FDEP. The study also included a series of stakeholder meetings at key points in the progression of the work where the study findings, modeling approach, and project alternatives were presented and discussed.

Beginning in 2008-2009, Lee County implemented the Blind Pass Restoration Project with the objective of maintaining Blind Pass in an open condition. The project resulted in several maintenance dredging events with 100% of the material placed south of the inlet along northern Sanibel Island. The rapid adjustment of the system after the dredging project suggests that the dredge template exceeds the equilibrium channel cross-sectional area and tidal currents alone are not sufficient to maintain the desired dredged depths. Within about a year following a dredge maintenance event, the outer part of the dredged channel begins to trap sand, which causes a temporary deficit to adjacent areas until the channel fills and bypassing is restored. This suggests a dominance of the wave-induced alongshore drift over the tidal forces, which effects the sediment balance between the channel and adjacent beaches and overall stability of the inlet. These factors represent the primary challenges in maintaining Blind Pass in an open condition.

According to the updated 2009-2015 sediment budget, approximately 51,000 cy/yr is transported toward Blind Pass from the north (Captiva Island) and 89,000 cy/yr is transported south of Bowman's Beach (Sanibel Island). This indicates a sediment deficit of 38,000 cy/yr within the study area on Sanibel Island. The material being captured by Blind Pass is already being dredged and placed entirely along northern Sanibel Island, which supports the objective of bypassing 100% of the 21,000 cy/yr of inlet material to the south.

Based on a review of the previous inlet management plan, along with the overall history, aerial photographs, monitoring data, sediment budget analysis and input from the TAC and local stakeholders, a comprehensive alternatives analysis was performed with the Delft3D numerical model. Eighteen (18) preliminary alternatives were evaluated to identify the most-effective management options and screen out the less effective measures. The preliminary alternatives included options such as: no action, dredging, changes to the Blind Pass jetty, beach fill, deposition basins, structures on the north end of Sanibel Island, and a spur at Blind Pass jetty.

Based on the results of the preliminary alternatives, the most effective components were combined into three final alternatives for comparison of inlet management strategies. The scenarios include combinations of a truncated dredge template, connections to Pine Island Sound, beach fill on Sanibel Island and a structural spur at the end of the Blind Pass jetty. Each final alternative was simulated for a period of 5 years and for two storm conditions. The results were analyzed through evaluation of morphology, volume changes, channel stability and storm response. In general, the final alternatives show similar morphological trends and comparable benefits to each other, with the main difference being the magnitude of changes. Based on the results of the study and the findings presented herein, Final (combined) Alternative 3 is the selected recommended management plan update. The recommended plan includes:

- Truncated dredge template based on Preliminary Alternative 3c with the variable dredging depth along the inner channel.
- Sanibel Island beach fill based on Preliminary Alternative 6a with the fill template between R-110.5 and R-112.5.
- Modified connections to Pine Island Sound with a re-established connection to Sunset Bay and Wulfert Channel extension.
- Spur at Blind Pass Jetty as a 100 ft long extension in a north-south orientation.

The features of the plan may be implemented in a phased approach based on existing permits, performance monitoring and regulatory considerations. Other ongoing actions with regard to the inlet maintenance should continue and be updated as appropriate, such as a monitoring program and navigational notices. Ongoing discussions between the County, CEPD, the City of Sanibel, FDEP and other commenting agencies may result in modifications to the recommended plan. Further refinement and engineering for the design phase is recommended prior to implementation.

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1. INTRODUCTION

Blind Pass is located in Lee County on the Gulf Coast of Florida and is bounded by Captiva Island to the north and Sanibel Island to the south (Figure 1-1). This area of the coast is characterized by a series of barrier islands and tidal passes that are separated from the mainland of Florida by various water bodies. The adjacent inlet about 5 miles to the north is Redfish Pass, which separates Captiva Island from North Captiva Island. To the south, Clam Bayou and Old Blind Pass are currently closed making the next connection to Pine Island Sound about 13 miles away at the south end of Sanibel Island. The islands are connected by the Blind Pass Bridge, and the Blind Pass jetty is located on the northern side of the pass on Captiva Island.

Figure 1-1. Location Map (Background Image Date: March, 2017, Source: Lee County).

1.1 History

Blind Pass is a natural tidal inlet and has migrated and closed at various times throughout history. A detailed account of early history can be found in the Blind Pass Inlet Management Plan (CPE, 1993). Prior to the opening of Redfish Pass in 1921, Blind Pass was a more substantial inlet with a larger tidal prism. The Blind Pass ebb shoal associated with the larger tidal prism (pre-Redfish Pass) most likely helped maintain the seaward position of the south end of Captiva Island and the north end of Sanibel Island.

When Redfish Pass opened, it captured a significant portion of the tidal prism of Blind Pass, making Blind Pass a smaller, more unstable inlet. The ebb shoal of Blind Pass migrated to shore and no longer provided protection for southern Captiva and northern Sanibel. The inlet cross section decreased due to shoaling to a point of complete closure of the channel. A cycle ensued in which Blind Pass was opened by storms and closed by shoaling. By 1964, the spit once again migrated to the south and closed the pass. The pass was not reopened again until 1972 following Hurricane Agnes.

In 1972, Lee County installed a terminal groin on the north side of the pass to protect the road and bridge by stabilizing the beach to the north at Turner Beach Park. The pass was closed again between 1975 and 1980. The pass was reopened in its present position by a subtropical storm in June 1982. In 1988, the Captiva Erosion Prevention District (CEPD) extended the terminal groin on the north side of Blind Pass by 100 feet to stabilize the beach nourishment project on Captiva Island.

Between August 1998 and October 1999, Blind Pass closed due to natural processes. In a limited effort to open the inlet, 20,400 cubic yards (cy) were removed from the channel in early 2001 seaward of the Blind Pass bridge. The project had a short expected life span, since the controlling cross-section landward of the bridge was not dredged. During construction, sand infilled and was removed two additional times. In the years after the project, the inlet closed, reopened, and closed several times.

In December 2008, Lee County began dredging to re-open Blind Pass, which was completed on July 31, 2009. The project was accomplished pursuant to the original inlet management plan (CPE, 1993) and interlocal agreement joined by the CEPD, Lee County and City of Sanibel with the state contributing financial support. With ongoing maintenance dredging, the pass has remained open and the dredge material has been placed downdrift on Sanibel Island. Lee County has undertaken the study described herein with an advanced 3D numerical modeling effort to evaluate options to refine the management of the pass on a scientific basis.

1.2 Overall Objective

Based on historic records and dredging events, Blind Pass is an unstable inlet that has a tendency to close without ongoing maintenance. When open, the pass is narrow, shallow and lacks the typical ebb and flood shoal features of a well-established tidal inlet. Since 2009, Blind Pass has been maintained in an open configuration by dredging the channel and bypassing material to the downdrift beach of Sanibel Island. The pass has required frequent dredging due to rapid infilling of the channel, and the downdrift beach has been periodically affected depending on the condition of the inlet and location of the channel.

Several management strategies that have been developed and/or implemented are described in the existing management documents for Blind Pass: the Blind Pass Inlet Management Plan (CPE, 1993) and the Florida Department of Environmental Protection Strategic Beach Management Plan, Southwest Gulf Coast Region (SMP; FDEP, 2015). The current management strategy is to maintain Blind Pass in an open condition by dredging and mechanically bypassing material to Sanibel Island.

The study described in this document provides an update to the original inlet management plan (CPE, 1993) and refines the maintenance of Blind Pass. The study has been developed as a collaborative effort with Lee County, the City of Sanibel, and the Captiva Erosion Prevention District (CEPD) to develop a mutually agreeable inlet management strategy for the future and assist the FDEP in adopting an Inlet Management Plan for Blind Pass. The intent of this study also aligns with the strategy of the SMP to bypass sand to Sanibel Island, update the sediment budget and support State adoption of an inlet management plan.

1.3 Purpose and Scope

The primary purpose of this inlet management study is to develop an updated sediment budget for the inlet and to evaluate strategies of inlet sediment management with the objective of balancing the sediment budget between the inlet and adjacent beaches pursuant to the requirements of Section 161.142, Florida Statutes. The study assesses the coastal processes at Blind Pass and evaluates strategies of inlet management with the objective of maintaining Blind Pass in an open condition. The study seeks to improve the function of the inlet thereby extending the life of dredging projects so that periodic dredging is more effective. The study also considers protection of the existing infrastructure, maintaining the existing level of recreation access and use, and avoiding potential impacts to navigation. Overall, the study provides recommendations for the ongoing management of the inlet and adjacent beaches within its area of influence and considers the collective input of the appropriate governmental agencies and local stakeholders whom have been engaged through a series of public meetings.

The scope of this study included literature review, data collection, preparing a sediment budget update, performing an alternatives analysis with advanced numerical modeling, and developing inlet management recommendations in a science-based approach. The alternatives analysis utilized the numerical model Delft3D to evaluate the conceptual designs in an individual and combined fashion. A Technical Advisory Committee (TAC) was involved in the study development and execution, which included representatives from Lee County, the CEPD, The City of Sanibel, and the FDEP. The study also included a series of stakeholder meetings at key points in the progression of the work where the study findings, modeling approach, and project alternatives were presented and discussed.

The TAC met frequently throughout the process and their input, combined with the valuable insights of the local residents from the public meetings, was taken in account along with engineering judgement and technical findings. The results of the Delft3D modeling effort were discussed with the TAC and presented to local stakeholders for their input. By combining model results, outcomes of discussions with the TAC and stakeholders, and engineering analyses (e.g. sediment budget update, historical findings, aerial and literature reviews, flow and transport analyses, etc.), recommendations for the Blind Pass Inlet Management Study were developed.

The information presented in this study has been developed to assist in the adoption of an Inlet Management Plan by the State of Florida and to support future permitting efforts for implementation. The Delft3D Modeling Study - Inlet Management Study of Blind Pass and Adjacent Beaches, and documentation with the presentations from each of the stakeholder meetings are included with this report as Appendix A and Appendix B, respectively.

2. PHYSICAL INLET CHARACTERISTICS

2.1 General

Blind Pass is a natural inlet that joins the Gulf of Mexico with Pine Island Sound and is approximately 90 miles south of the Tampa Bay entrance. Redfish Pass, which separates Captiva Island from North Captiva Island, is the nearest adjacent inlet and is located 5 miles to the north. To the south, intermittent connections to Clam Bayou and Old Blind Pass have historically occurred, although they are currently closed. At the south end of Sanibel Island, Pine Island Sound connects directly to the Gulf through the San Carlos Bay entrance. The pass is bridged by Sanibel Captiva Road, which connects Sanibel and Captiva Islands. Blind Pass has a jetty located on the north side of the inlet on the south end of Captiva Island. On both Sanibel and Captiva Islands, the shorelines adjacent to Blind Pass are classified by the FDEP as critically eroded (FDEP, 2016) and both islands have been periodically nourished with both offshore and inlet sands.

Blind Pass is an unstable inlet evidenced by its tendency to close, which is primarily due to wave-induced alongshore drift dominating the tidal forces that flow through the inlet. Prior to 2009, Blind Pass has been periodically opened and closed. When open, the pass is narrow and shallow, and lacks the typical ebb and flood shoal features of a well-established tidal inlet. The tidal currents alone are not sufficient to keep the pass open, and the sediment mobilized by wave action and transported typically from north to south in the littoral drift fills in the inlet, resulting in periodic closure.

Since 2009, Blind Pass has been maintained open by periodically dredging the channel and bypassing material to the downdrift beach of Sanibel Island. The frequent dredging is needed to address the rapid infilling of the channel, and the southerly beaches have benefitted from the sand bypassing; however, the inlet's erosive effects have proven to exceed the downdrift sediment need.

2.2 History of Blind Pass

Although the objective of this study focuses on the timeframe since the development of the 1993 Blind Pass Inlet Management Plan (CPE, 1993), the main events, manmade or natural, that affected the dynamics of the inlet and its area of influence are described below for context. Aerial photographs of Blind Pass for 1995, 1999, 2001, 2009, 2010, 2011, 2013, 2014, 2016, 2018 are provided in Figure 2-1 through Figure 2-12 for reference.

The major historic events affecting Blind Pass generally include the opening of Redfish Pass in 1921, various storms and hurricanes, the opening and closing of Clam Bayou and Old Blind Pass, nourishment projects, dredging of Blind Pass, and the jetty construction/extension. The history of Blind Pass through 1992 is provided in the previous inlet management study (CPE, 1993).

The opening of Redfish Pass in 1921 captured a significant portion of the tidal prism of Blind Pass, making it a smaller and more unstable inlet. The inlet cross section decreased in area (due to shoaling), which eventually resulted in the complete closure of the channel. Storm activity is credited for periodic opening, but shoaling resulted in repeated subsequent closure. Clam Pass and Old Blind Pass, which are smaller unstable inlets south of Blind Pass on Sanibel Island, have also intermittently opened and closed (CPE et al, 1993). Sunset Bay was connected to the main Blind Pass channel for decades; for example, from at least 1970 as shown in the 1993 Blind Pass Inlet Management Plan (CPE, 1993) through 1995 (Figure 2-1). By 1999, the connection began to experience significant shoaling (Figure 2-2) and eventually closed as shown in the 2008 aerial (Figure 2-4).

In 1972, a terminal groin was installed on the north side of Blind Pass to protect the bridge by stabilizing the beach to the north at Turner Beach Park. The terminal groin was extended in 1988 as part of the beach restoration project that was constructed along the entire length of Captiva

Island (CPE et al, 1993). The jetty is a rubble mound structure approximately 200 feet in length (Figure 2-1).

The dredging history of Blind Pass is presented in Table 2-1. The first dredging of Blind Pass occurred in 2001. The pass was completely closed prior to dredging (Figure 2-2). Approximately 20,400 cy sand was removed from the Gulf side of the Blind Pass Bridge to re-open Blind Pass and place a small quantity of sand on Sanibel Island beaches from R-115 and R-115.5. Blind Pass closed shortly after the 2001 project was completed (Figure 2-3). The immediate closure of Blind Pass was a result of insufficient sand removal to establish tidal flow necessary to maintain an open inlet.

Table 2-1. Blind Pass Dredging History.

Completion Date	Project	Quantity (cy)	Dredge Type	Dredge Location	Placement Location
March 2001	Interim	20,400	Mechanical	Gulf	Sanibel Island
May 2009	Restoration	148,000	Hydraulic	Gulf and Sound	Sanibel Island
September 2012	First Maintenance (Phase I)	63,300	Hydraulic	Gulf	Sanibel Island
June 2013	First Maintenance (Phase II)	37,600	Hydraulic	Sound	Sanibel Island
June 2017	Second Maintenance	89,700	Hydraulic	Gulf and Sound	Sanibel Island

Beginning in 2008-2009, Lee County implemented the Blind Pass Restoration Project with the objective of maintaining Blind Pass in an open condition. The project intended to include maintenance dredging every 5 years and several maintenance dredging events have occurred since then (Table 2-1). The dredging events and the inlet response based on monitoring reports is summarized below in order to frame the context of the past performance of the current management approach for Blind Pass, and the objectives of this study.

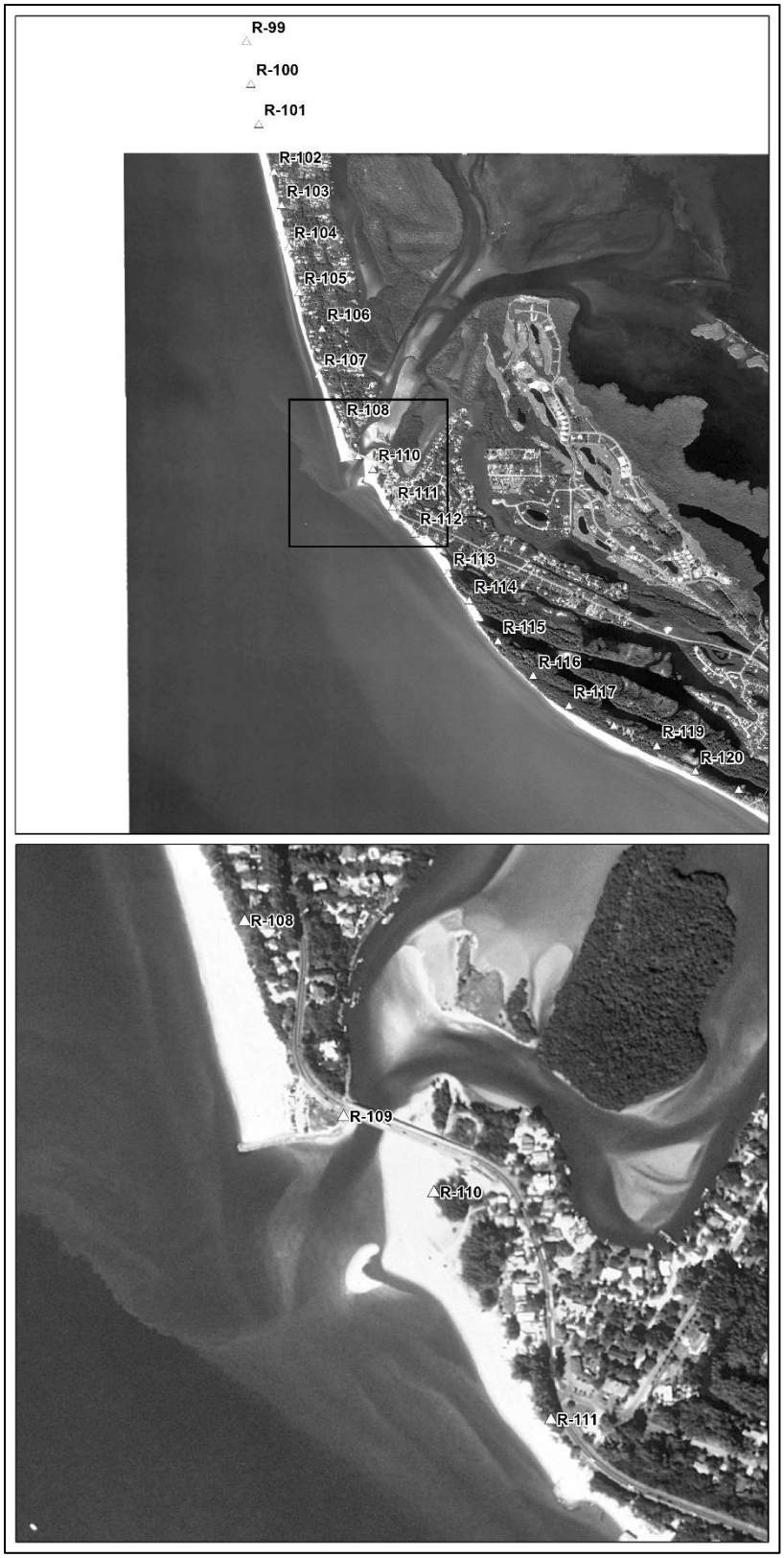

Figure 2-1: Aerial view of Blind Pass, January 1995. Source: U.S.G.S. through Google Earth.

Figure 2-2: Aerial view of Blind Pass, January 1999. Source: LABINS.

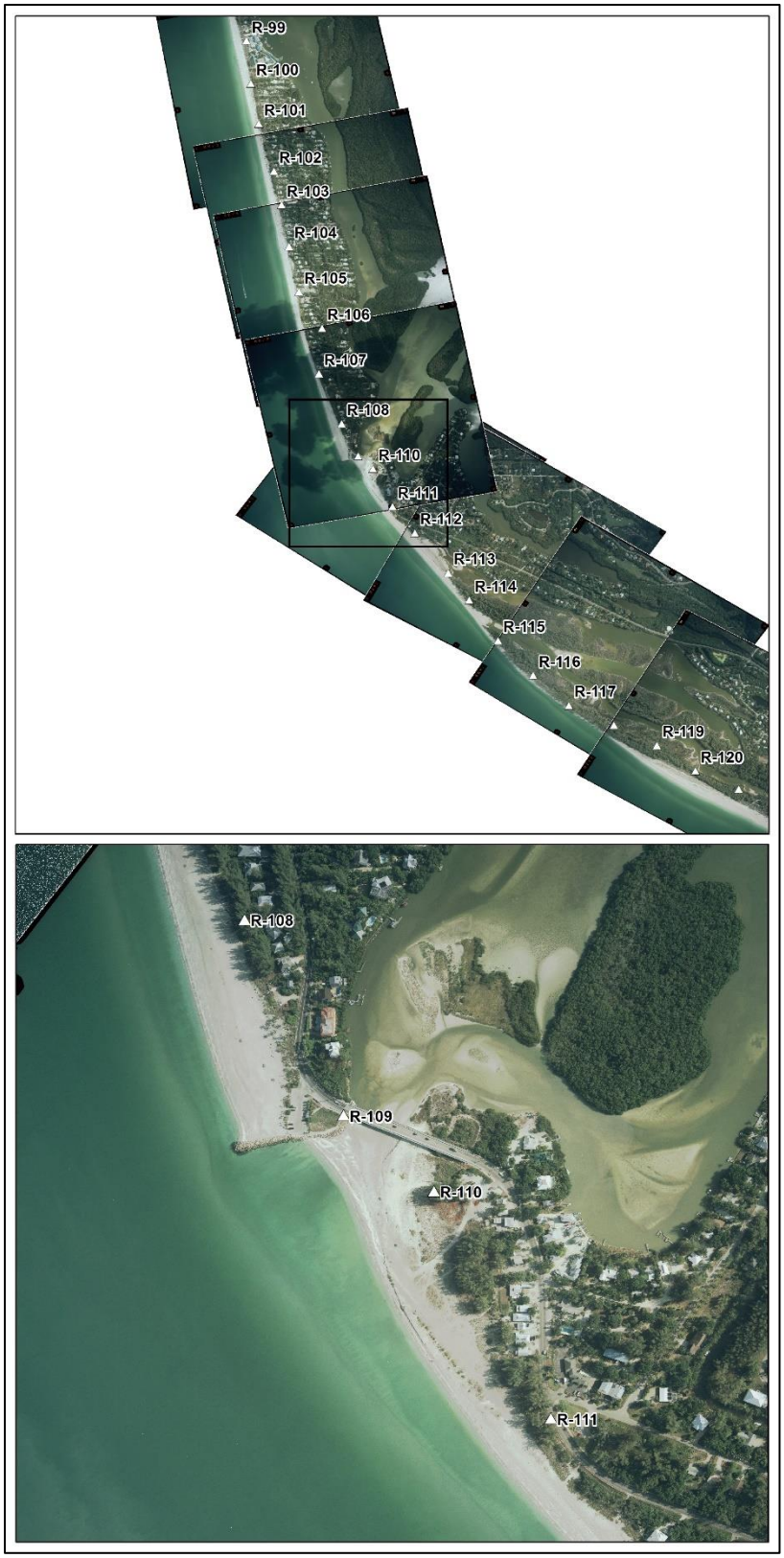

Figure 2-3: Aerial view of Blind Pass, 2001. Source: Lee County.

Figure 2-4: Aerial view of Blind Pass, January 2008. Source: Lee County.

Figure 2-5: Aerial view of Blind Pass, October 2009. Source: Lee County.

Figure 2-6: Aerial view of Blind Pass, February 2010. Source: Lee County.

Figure 2-7: Aerial view of Blind Pass, February 2011. Source: Lee County.

Figure 2-8: Aerial view of Blind Pass, February 2013. Source: Lee County.

Figure 2-9: Aerial view of Blind Pass, February 2014. Source: Lee County.

Figure 2-10: Aerial view of Blind Pass, January 2016. Source: Lee County.

Figure 2-11: Aerial view of Blind Pass, February 2017. Source: Lee County.

Figure 2-12: Aerial view of Blind Pass, January 2018. Source: Lee County.

2.2.1 Blind Pass Restoration Project

Blind Pass was successfully dredged in 2008-2009 on both sides of the bridge, including channels leading to Pine Island Sound and Roosevelt Channel during the Blind Pass Restoration Project. The project excavated 148,000 cy and placed approximately 136,900 cy between R-112 and R-114 (105,100 cy on the beach and 31,800 cy in the nearshore). Approximately 11,100 cy was hauled away and disposed of (CEC, 2010). Figure 2-4 shows an aerial view of Blind Pass closed in 2008. The channel had been closed for a period of time as evidenced by the vegetation established north of the bridge. Figure 2-5 shows the pass open in October 2009, approximately 5 months after the dredging was complete.

Significant shoaling of Blind Pass occurred between August 2009 and January 2010. The amount of sand shoaled into the dredge template was approximately 40,100 cy (CEC, 2010). Most of the shoaling occurred in the outer channel section as a shallow sandbar between Captiva and Sanibel Islands. This shoaling is highlighted by the waves breaking on the outer ebb shoal area during a wave event captured in the aerial view of February 2010 (Figure 2-6). In the following year, the development of a spit of sand became emergent downdrift of the groin as seen in the February 2011 aerial (Figure 2-7). This dynamic feature is frequent in the Blind Pass coastal system, forming within months and then spreading in the outer channel.

In response to the continued channel shoaling in the following years, the first maintenance dredging of Blind Pass was conducted in 2012 (Phase I, Gulf side) and 2013 (Phase II, Sound side). The 2012 effort placed 63,300 cy between R-116 and R-118 (dredged from seaward of bridge), and the 2013 effort placed 37,600 cy between R-112 and R-113.5 (dredged from landward of bridge) (CEC, 2013). The amount of sand excavated from the permitted borrow area totaled approximately 101,000 cy (CEC, 2013). It is noted that approximately 40% of the infilled volume was measured only 5 months after construction, especially in the outer section of the channel (seaward of bridge). Figure 2-8 shows the aerial view of Blind Pass in January 2013.

Based on the June 2013 survey, the total volume within the Blind Pass dredge template was approximately 53,160 cy (CEC, 2013), predominately in the sections seaward of bridge. This corresponds to approximately 53% of the total dredged volume completed in May 2013. The majority of this volume (84%) was dredged from the outer section of the channel, which was completed in September 2012, nine months before the survey was collected.

Between June 2013 and July 2014, an additional 30,670 cy of accretion was calculated within the dredging template, 33% seaward of bridge, 53% immediately landward of bridge and 13% further north (CEC, 2014). Based on the 2014 survey, the total volume within the Blind Pass dredge template was approximately 83,680 cy. The 2014 aerial view of Blind Pass is presented in Figure 2-9 and depicts the shoaling in the dredging template and a sand spit downdrift of the terminal groin.

In June 2017, the second maintenance dredging excavated approximately 89,700 cy from Blind Pass, mostly from the outer section. Approximately 67,060 cy were placed between R-112 and R-114+200 and approximately 22,640 cy were placed between R-116 and R-118 (CEC, 2017). Figure 2-10 presents the aerial view in January 2016 (before dredging), and Figure 2-12 shows the aerial view in January 2018 (after dredging).

The rapid adjustment of the system after the dredging project suggests that the dredge template substantially exceeds the equilibrium channel cross-sectional area. This is especially the case in the outer section of the channel, seaward of the bridge. Consequently, tidal currents alone are not sufficient to maintain the dredged depths and the system returns to pre-dredging conditions.

The bathymetry maps from annual monitoring reports show that the northern sections of the channel are getting wider over time (CEC, 2010, 2011, 2013, 2014). This is due to the adjustment of the dredged slopes of the channel, resulting in deepening outside the template limits and accretion inside the channel limits, which is cleared in subsequent maintenance dredging projects. Theoretically, this process benefits the stability of the Pass, since it results in less restriction to water flow through the area and potentially increases the tidal flow.

The outer section of the channel serves as a sand source for beach nourishment projects on Sanibel Island as part of the maintenance dredging events. However, the outer part of the dredged channel that crosses the bypassing bar begins to trap sand rapidly within about a year following dredging projects. This trapping process causes a temporary deficit to adjacent areas until the channel fills and bypassing is restored. The sediment balance between the channel and adjacent beaches and the instability of the Blind Pass channel, given by the dominance of the wave-induced alongshore drift over the tidal forces, are the primary challenges of maintaining Blind Pass in an open condition.

2.2.2 Nourishment on Adjacent Beaches

Several beach nourishment projects have been constructed on Captiva and Sanibel Islands, adjacent to Blind Pass. The first sand placement project on Captiva Island was built in 1961 placing 107,000 cy of material from the bay side of the island in conjunction with 134 groins. Most of the groins that were constructed have either since been removed, buried, or destroyed. The second project, known as the South Seas Plantation fill project, placed 655,000 cy of beach fill along 1.2 miles of beach at the north end of the island from R-87 to R-93.4 and was completed in 1981. The third project was the first island wide beach nourishment and was built in 1988/89 and was constructed as a federally reimbursable project. The nourishment project placed approximately 1,596,000 cy of fill along the entire 4.7 miles of Captiva Island.

A nourishment program to maintain the Captiva Island's beaches was implemented with the initial island-wide project in 1988/89 and typically occurs on the 8-10 year nourishment cycle, barring major storm impacts and/or subsequent repairs. The first, second and third renourishment projects occurred in 1996, 2005/06 and 2013, respectively, and also included fill placement on Sanibel Island. One interim project was constructed in 2008 to repair storm damages. Placement volumes and locations are summarized in the following paragraphs. Figure 2-13 shows the locations of projects constructed since 1981.

The 1988/89 Captiva Island project utilized sand dredged from the ebb shoal of Redfish Pass and marked the initial project for the island's nourishment program between R-85 and R-109. The subsequent projects after 1988/89 utilized offshore borrow areas. The first renourishment following the 1988/1989 project was constructed in 1996, and placed approximately 821,000 cy on Captiva Island from R-84 to R-109 and 239,000 cy on Sanibel Island from R-110 to R-114. In 2005-2006, the second renourishment project placed approximately 1,017,000 cy between R-84 to R-109 on Captiva Island, and on Sanibel Island 245,000 cy between R-110.5 and R-116 and 91,000 cy between R-116 and R-118. No fill was directly placed between R-114 and R-115 on northern Sanibel Island at Clam Bayou due to permit constraints. In 2008, 54,836 cy were placed between R-85 and R-86, and 44,554 cy were placed between R-94 and R-96 to repair damages from the 2005 hurricanes. In 2013, the third renourishment project placed 783,400 cy between R-84 and R-109 on Captiva Island and 80,800 cy from R-110.5 to R-116 on Sanibel Island. As in the 2005-2006 project, fill was not placed between R-114 to R-115 at the Clam Bayou gap. Following construction of the 2013-14 renourishment project, a new 15-year permit was obtained from FDEP for future renourishments of the islands, which removed this constraint. The permit was issued in 2014 and expires December 11, 2029. Captiva Island nourishments are anticipated to continue in accordance with the CEPD's ongoing beach management program and permit authorizations.

The nourishment projects on Captiva Island supply sand to the beach updrift of Blind Pass. The Blind Pass jetty serves to stabilize the south end of Captiva Island and the north side of the Blind Pass inlet. Because of the updrift supply, sediment is transported beyond the jetty to the areas south of Captiva Island, i.e. Blind Pass and Sanibel Island. Additional structural interventions have the potential to alter the existing transport of fill and impart various downdrift effects. For example, extending the existing Blind Pass jetty further offshore would likely hold a wider beach to the north, but require additional sand to maintain the transport benefit. Whereas, a new structure on the south side of Blind Pass may provide local stabilization, but could also interfere with the natural bypassing and create a shadowing effect on the downdrift beaches. Thus far, the placement of material on Sanibel Island in conjunction with Captiva Island nourishments has aided in offsetting the erosion on the north end of Sanibel Island in addition to the natural and mechanical (dredging) bypassing of material across Blind Pass. Alternative concepts are explored further in the modeling analysis as summarized in the sections below.

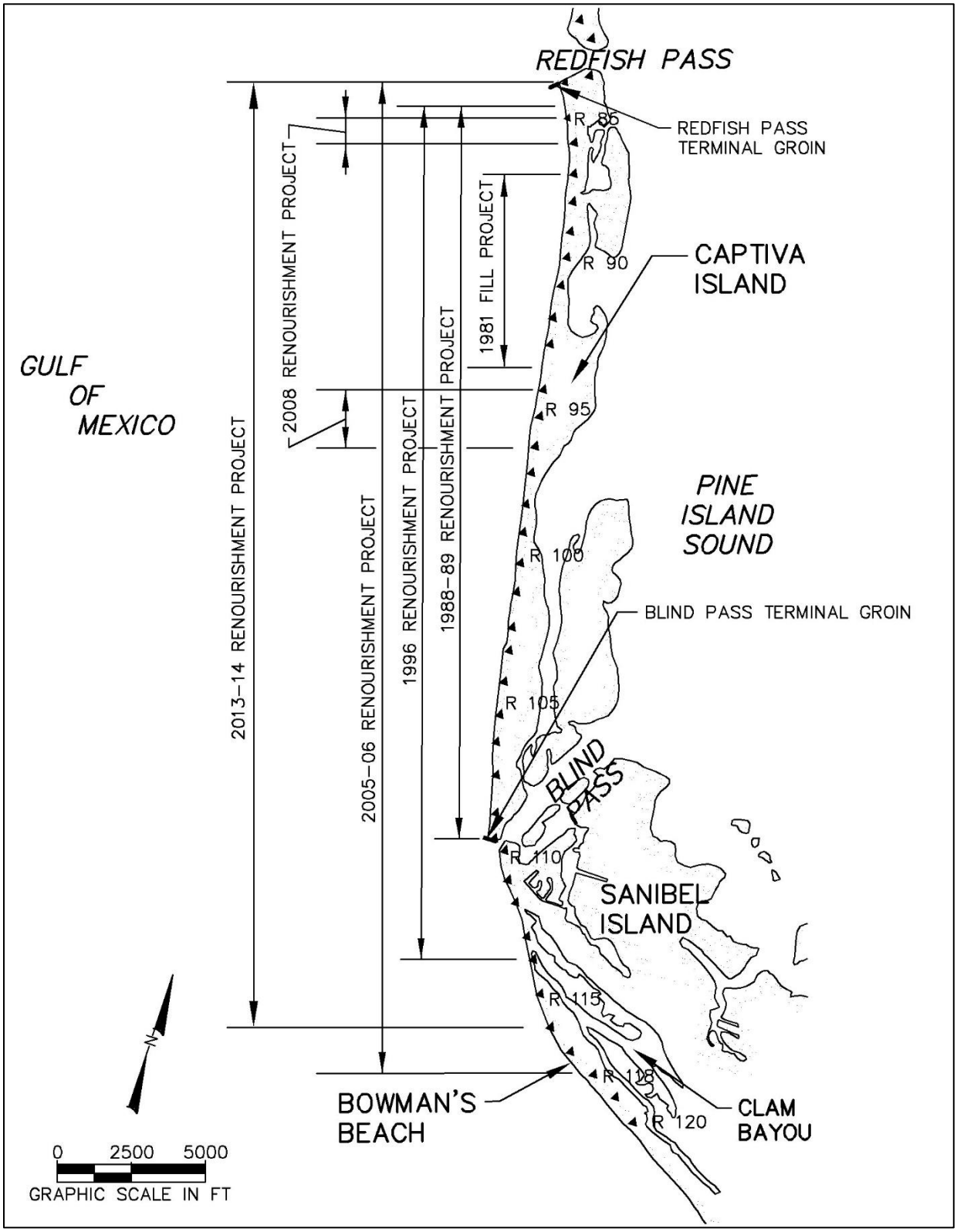

Figure 2-13. Historical Beach Nourishment Projects since 1981.

2.3 Sediment Budget Update (2009-2015)

The sediment budget for Blind Pass and adjacent beaches was analyzed using the period from 2009 to 2015 between monuments R-78 on North Captiva Island and R-121 on Sanibel Island. The sediment budget was performed to analyze and update the coastal processes and trends of sediment transport in the inlet complex and study area. The sediment budget was also used to calibrate the Delft3D model (Appendix A).

The start of the time period coincides with the initial dredging of the Blind Pass Restoration Project in 2009 as the baseline for analysis. The project has the intent of maintaining Blind Pass in an open condition through periodic dredging, and its implementation represents a fundamental change in the historic management of Blind Pass. The end of the study period coincides with the most recent surveys available at the time of the analysis (2015).

The sediment budget time period also accounts for the 2013 Captiva and Sanibel Islands Renourishment Project and the Blind Pass Restoration Project maintenance event in 2012-2013. The 2013 renourishment project placed approximately 783,400 cy of sand from offshore sources between monuments R-84 and R-109 and 80,800 cy on Sanibel Island from R-110.5 to R-116 (CB&I, 2014). No fill was placed in the gap between R-114 to R-115 due to regulatory restrictions. The 2012 Blind Pass Restoration Project dredged Blind Pass and placed 63,300 cy between R-116 and R-118, and the 2013 effort placed 37,600 cy between R-112 and R-113.5 (CEC, 2013).

Previous sediment budgets are presented in the 1993 Blind Pass Inlet Management Plan (CPE, 1993) spanning 1941 to 1991 and are summarized below for comparison in this analysis.

2.3.1 Longshore Transport

Longshore transport is defined as the movement of sand within the surf zone in a direction parallel to the beach, depending primarily on the incident wave height and wave angle. The longshore transport curve is used to illustrate the direction of transport, north or south, along the study area. The shape of the curve is most informative in identifying erosion trends. The net annual longshore transport for the 2009 - 2015 period is presented in Figure 2-14.

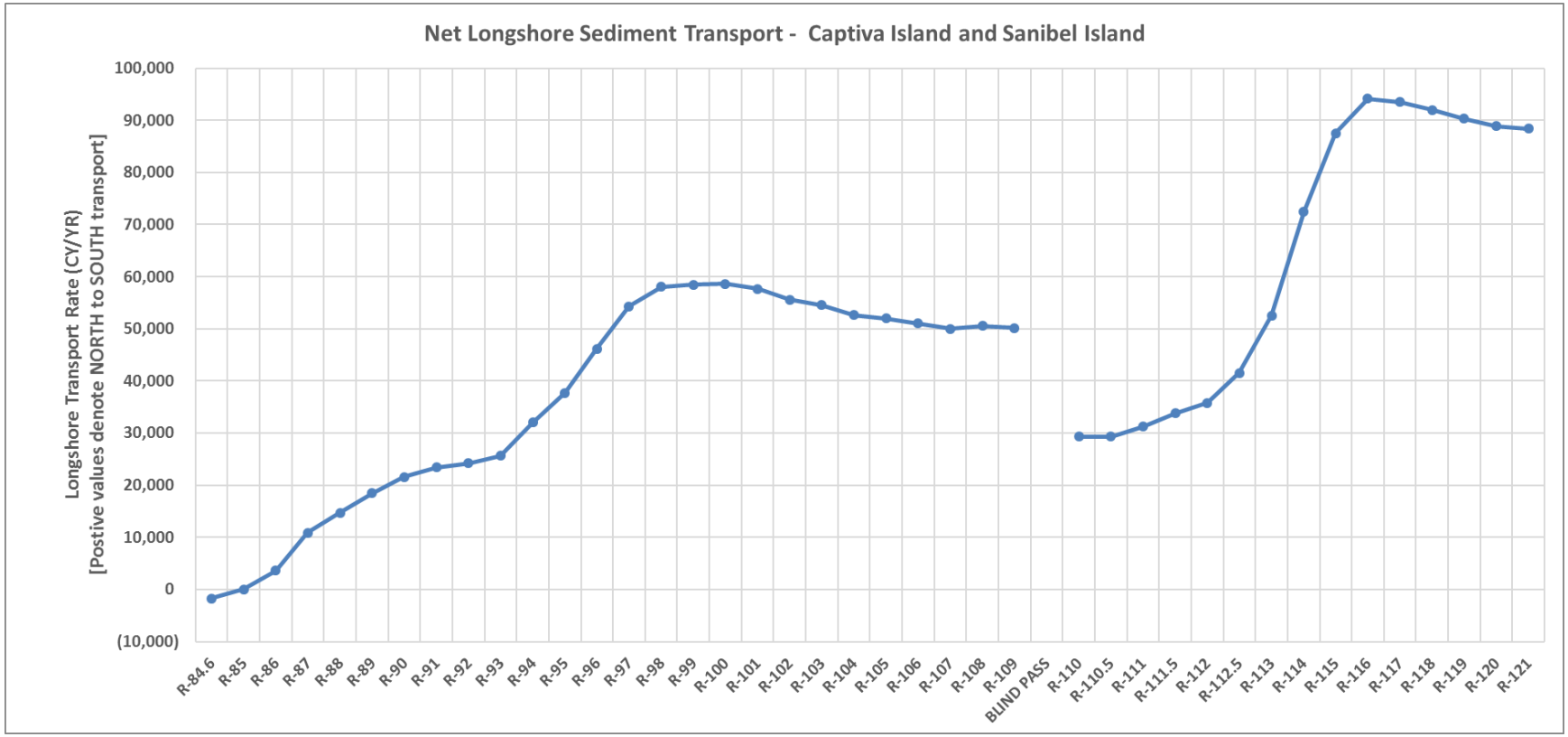

Figure 2-14: Net Longshore Transport Rates along Captiva Island and Sanibel Island.

A negative slope on the longshore transport line indicates accretion, which removes sand from the longshore transport. Conversely, a positive slope indicates erosion, which adds sand to the longshore transport. Transport is to the north when the curve is below 0 cy/yr. Transport is to the south when the curve is above 0 cy/yr.

The longshore transport is based on measured volume changes at R-monuments above the depth of closure (-13 feet, NAVD) and accounts for the volume placed on Captiva and Sanibel Islands during the 2013 Captiva and Sanibel Islands Renourishment Project (R-84 to R-109) and on Sanibel Island during the 2012-2013 maintenance event of the Blind Pass Restoration Project. The depth of closure is derived from long term monitoring of beach profiles (CPE, 2007). The longshore transport curve starts at R-84.6 at the north end of Captiva Island and accounts for 1,000 cy/yr being transported from the bypassing feature at Redfish Pass towards Captiva Island south of R-85 and ends at R-121 at Bowman's Beach south of Blind Pass.

Along the study area, the net sediment transport is from north to south, primarily attributed to the prevailing wave direction coming from the northwest. A nodal point exists at the north end of Captiva Island, where the transport reverses to the north towards Redfish Pass, and the net sediment transport is 0 cy/yr. The location of the nodal point is not a fixed position in time, but was approximated to be monument R-85 based on review of historic reports (CPE, 1995; CPE, 2010), recent data trends, and inspection of dominant current patterns from the numerical model.

South of the nodal point, the longshore drift resumes toward the south. The net sediment transport increases (erosion) until it stabilizes around monuments R-98 to R-100. Transport decreases (accretion) from about R-100 to R-105, where is reaches an equilibrium rate of approximately 50,000 cy per year towards south, between R-105 and R-109. The historic hotspots on Captiva Island are located in the northern and central littoral cells, which correspond to the highest erosion rates on the littoral transport curve (steepest slopes). The area between R-98 to R-109 is shown to be relatively stable/accretional.

It is estimated that approximately 51,000 cy of beach sand is transported to Blind Pass annually. A pronounced nodal point is not apparent on the downdrift side of the inlet due to the absence of a developed ebb shoal, which is supported by inspection of dominant current patterns from the numerical model. The transport curve also suggests that approximately 30,000 cy/yr are transported through Blind Pass to Sanibel Island, indicating a reduction of 21,000 cy/yr due to the inlet. South of the pass, longshore drift continues south and increases (erosion) until R-116, where it decreases (accretion) through R-121. The highest erosion rates in the study area on Sanibel Island demonstrated by the littoral transport curve (steepest slopes) are between R-112 and R-116.

The data from the longshore transport curve was used in the sediment budget analysis, which is discussed further in the section below.

2.3.2 Sediment Budget Analysis

The 2009-2015 sediment budget update is presented in Figure 2-15, and includes Captiva Island, Blind Pass and Sanibel Island. The alongshore calculation limits for the sediment budget cells are associated with R-monuments as shown in Figure 2-15. The volume changes on Captiva and Sanibel Islands are calculated above the depth of closure (-13 feet, NAVD), and account for the volume placed on Captiva and Sanibel Islands during the 2013 Captiva and Sanibel Islands Renourishment Project and the 2012-2013 maintenance of the Blind Pass Restoration Project.

The Blind Pass inlet complex was designated into three (3) cells based on regional and bathymetric features: the inlet landward of the bridge, the inlet seaward of the bridge, and a bypassing feature. The boundary of the sediment budget cell shown in Figure 2-15 for the inlet landward of the bridge designates the physical limits of the calculation. All other cells are depicted with exaggerated seaward boundaries for graphical purposes.

The inlet changes seaward of the bridge were calculated to the extent of the available data between R-109 and R-110.5. The bypassing feature extends south of the inlet and overlaps adjacent R-monuments on Sanibel Island. In order to separate the volumetric changes occurring on the beach and those occurring in the inlet/shoal in this area, the cell between monuments R-110.5 to R-112 were divided. This is shown in the sediment budget (Figure 2-15), where the "beach" cell represents volumetric changes above -5 feet, NAVD88 and the "shoal" cell extends to the depth of closure like all other cells.

Along the study area, the sediment transport is from north to south. Approximately 51,000 cy/yr was transported from Captiva Island to Blind Pass inlet from 2009-2015. During this time, the inlet seaward of the bridge gained 20,000 cy/yr. Approximately 20,000 cy/yr was also transported from the inlet to the north end of Sanibel Island (R-110.5 to R-112) and 10,000 cy/yr was transported from the inlet to the bypassing feature. A volume gain of 1,000 cy/yr was measured in the flood shoal, which may be limited by the available data and the flattening/sloughing of the dredged channel slopes. The sediment budget aligns with the transport curve and demonstrates that the inlet complex (seaward and landward of the bridge) captures approximately 21,000 cy/yr.

Sanibel Island south of the inlet from R-110.5 to R-112 was erosional during the assessment period, losing 14,000 cy/yr and contributing to the sediment transport to the south of 34,000 cy/yr. The bypassing feature gained 7,000 cy/yr, and 3,000 cy/yr and was transported south of R-112. The area from R-112 to R-116 was also erosional, losing 58,000 cy/yr. Approximately 95,000 cy/yr crosses the southern boundary of that cell at R-116, where the trend on Sanibel Island changed to accretional with the section between R-116 and R-121 having gained 6,000 cy/yr. Beyond that location, approximately 89,000 cy/yr was transported south of R-121.

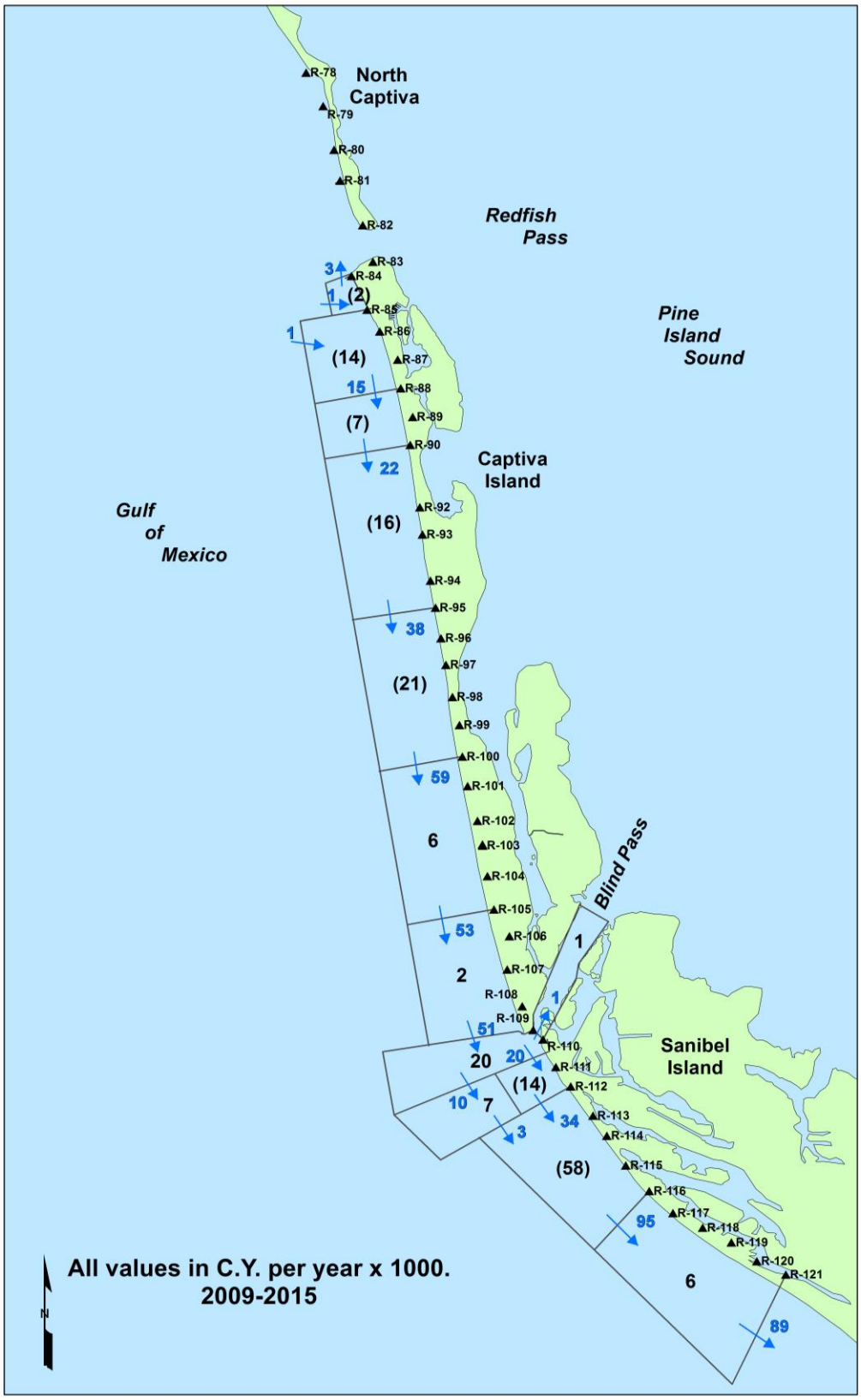

Figure 2-15. Sediment Budget Update for Blind Pass (2009-2015).

The sediment budgets presented in the previous inlet management study span from 1941 to 1991 (CPE, 1993). The discussions in the previous inlet management study (CPE, 1993) and the observations to date indicate that the historic condition of the study area is very dynamic, considering the various states of opening, infilling and closure at Blind Pass, the presence or lack of an ebb shoal or bypassing, the formation and/or development of adjacent inlets (Redfish Pass, Clam Bayou, Old Blind Pass), structural influences, beach nourishments and vulnerability to storm impacts. These natural and anthropogenic actions influence the coastal processes and can change the magnitude and trends of inlet and beach behavior from erosional to accretional between time periods. The condition from 2009 to 2015 is fundamentally different than the time periods analyzed in the past since Blind Pass has been maintained in an open condition since 2009, although it is noted that it infilled rapidly and approached closure during this time period (see Section 2.2.1). The more recent updated sediment budget provides a basis for the alternatives analysis presented herein as it reflects the current condition of the relevant coastal processes.

3. INLET MANAGEMENT ALTERNATIVES EVALUATION

The inlet management alternatives analysis presented herein represents the evaluation of the different strategies that may be available to achieve the stated study objectives. The different strategies are referred to as "alternatives" throughout the study for an objective comparison of different factors focused on balancing the sediment budget and evaluating the effect of various options for managing the inlet and adjacent beaches. Based on previous studies and the sediment budget developed in this study, the management of Blind Pass should primarily address the rapid infilling of the pass and the high erosion rates on the north end of Sanibel Island without causing negative effects to the coastal system.

The alternatives were developed to test options to address the challenges in the behavior of the pass and adjacent beaches. The primary challenges include (1) the instability of Blind Pass channel position and cross-sectional area caused by high sedimentation rates around the bridge and seaward with a tendency of inlet closure over time and requiring frequent maintenance dredging, and (2) the unstable downdrift beach behavior and erosion at the north end of Sanibel Island associated with the pass.

The alternatives analysis included a preliminary screening and final analysis phase. This allowed for an initial individual evaluation of many different inlet management strategies, such as dredging, sand placement, sediment basins, and structural stabilization. The alternatives were evaluated for their overall effect on the coastal system including the erosion/sedimentation patterns, inlet stability, and volumetric changes along the inlet's adjacent beaches.

Based on the findings from the preliminary alternatives analysis, several alternatives identified as positive measures were adapted and combined into three 'Combined Scenarios' for comparison of

inlet management strategies and carried forward to the final analysis phase. The Combined Scenarios were simulated in order to evaluate the collective effects of the most effective design features on the system according to the study objectives. The findings were used to formulate recommendations for inlet management.

A numerical model, Delft3D, was setup, and calibrated for the Blind Pass study area. This state of the art hydrodynamic and sediment transport model allows the simulation of various alternatives to simulate the effects of each alternative on the inlet and adjacent beaches. The details of the model setup and calibration are provided in Appendix A. Each of the individual and combined alternatives was simulated in the Delft3D numerical model.

The preliminary alternatives were evaluated under average conditions for 5 years. Each alternative was designed to a preliminary level sufficient for description in the numerical model and for comparison of the effects on the beach with No Action or the current management approach (i.e. Blind Pass Restoration Project). The final alternatives were evaluated under average conditions (5-year simulation) and two storm conditions. The two conditions were selected to represent winter conditions (January 2016 Cold Front) and summer conditions (Hurricane Charley, 2004).

Detailed results and technical discussions are presented in Appendix A and summarized below. It is recognized that any of these conceptual alternatives will require additional refinement in engineering and design for permitting and implementation, which is outside the scope of this study.

3.1 Preliminary Alternatives Analysis

Preliminary alternatives were developed and discussed with the Technical Advisory Committee (TAC) and presented to stakeholders. A list of preliminary alternatives to be evaluated was finalized following the initial meetings and resulted in eighteen (18) alternatives described below and shown in Table 3-1.

3.1.1 Preliminary Alternatives Development and Evaluation

The preliminary alternatives included options such as: no action, dredging, changes to the Blind Pass jetty, beach fill, deposition basins, structures on the north end of Sanibel Island, and a spur at Blind Pass jetty. See Appendix A for additional information including volumes and discussion of the preliminary alternatives results.

The layout for each alternative is shown in the initial bathymetry for each alternative in Sub-Appendix A-1. Alternative 0 (No Action) and Alternative 3a (Blind Pass dredge template, -10 ft

NAVD) represent the two baseline conditions for comparison in the alternatives analysis. Results for Alternative 3a are evaluated relative to No Action.

Results for all other alternatives are analyzed relative to Alternative 3a. Therefore, these relative results represent the net effects associated with each tested component. For the initial alternative screening, the Blind Pass dredge template (Alternative 3a) was implemented in the model as an idealized version of the permitted dredge template considering a uniform dredging depth of -10 ft NAVD. The alternative does not include beach fill placement, which allows the effects of the inlet dredging to be isolated and evaluated independent of other effects.

Table 3-1: Summary of the Preliminary Alternatives.

• Alt 0: No Action (2016 bathymetry as initial condition).	NO ACTION
• Alt1b: Blind Pass dredge template + Wulfert Channel extension to Pine Island Sound	
• Alt3a: Blind Pass dredge template (-10 ft NAVD)	DREDGING
• Alt3c: Truncated Blind Pass dredge template (-10 ft NAVD)	ALTERNATIVES
• Alt4: Alt3a + Restore connection to Sunset Bay (1995 condition)	
• Alt5a: Alt3a + Blind Pass jetty: Remove	BLIND PASS
• Alt5b: Alt3a + Blind Pass jetty: Shorten by 50 ft	JETTY
• Alt5c: Alt3a + Blind Pass jetty: Lengthen by 100 ft	ALTERNATIVES
• Alt6a: Alt3a + Beach fill*: north end of Sanibel Island	
• Alt6b: Alt3a + Beach fill*: south end of Captiva Island	BEACH FILL
• Alt6c: Alt3a + Beach fill*: Ebb shoal enhancement	ALTERNATIVES
• Alt6d: Alt3a + Beach fill*: Nearshore placement at Sanibel Island	
• Alt7: Alt3a + Deposition Basin (interior and exterior)	DEPOSITION BASINS
• Alt8b: Alt3a + Angled (Z) structure on Sanibel Island	
• Alt8South: Alt3a + Straight structure (tip at similar location as 8b)	SANIBEL
• Alt8Center: Alt3a + Straight structure north of previous	STRUCTURE
• Alt8North: Alt3a + Straight structure north of previous	
• Alt9: Alt3a + 200 ft Spur at Blind Pass jetty	SPUR

*Beach fill volume = 102,000 cy for all Alt6 variations.

The permitted dredge template for the Blind Pass Restoration Project (Alternative 3a) terminates just north of Roosevelt Channel. Alternative 1b represents the Blind Pass dredge template with a Wulfert Channel extension to Pine Island Sound. Alternative 4 represents the Blind Pass dredge

template with restoring the connection to Sunset Bay. These alternatives are intended to test improvements to the tidal flow between Pine Island Sound and the Gulf of Mexico in an effort to increase the stability of the inlet. Alternative 1b serves to extend the template further, towards Pine Island Sound, and connect it through existing shallow channels. Alternative 4 restores the historic connection to Sunset Bay, demonstrated by conditions that have existed in the past. An example of this condition can be seen in the 1995 aerial photograph in Figure 2-1. This provides an additional pathway for tidal exchange between Pine Island Sound and the Gulf. The dredge volume for Alternative 1b and Alternative 4 is 264,000 cy and 184,000 cy, respectively.

Alternative 3c represents a truncated Blind Pass dredge template (-10 ft NAVD). The truncated template was inspired by the performance of the past dredging efforts (discussed in Section 2.2) and rapid infilling of the outer section of the existing dredge template. The truncated template leaves the outer section of the existing dredge template in place, maintaining a portion of the bypassing bar, which is the primary sediment transport pathway from north to south across the pass. The basis of this alternative is to reduce the initial disruption in alongshore sediment transport following dredging and alleviate the temporary downdrift effect on the adjacent beaches. The dredge volume for Alternative 3a is 66,000 cy.

Structural modifications to the existing Blind Pass north jetty were evaluated in Alternative 5. The Blind Pass jetty alternatives were included to examine effects on the system by modifications to the jetty, which serves to stabilize the north side of Blind Pass and south end of Captiva Island. Each of these alternatives also includes the dredge template. Alternative 5a removes the jetty completely, Alternative 5b shortens the jetty by 50 feet, and Alternative 5c lengthens the jetty by 100 feet.

Several sand placement options were considered in Alternatives 6a, 6b, 6c, and 6d. These include sand placement on the north end of Sanibel Island, south end of Captiva Island, ebb shoal enhancement, and nearshore placement at Sanibel Island. Each of the alternatives also includes the dredge template. The fill volume is 102,000 cy for all Alternative 6 variations.

Alternative 7 considers the use of two sediment basins in an effort to trap sand from the littoral budget in designated locations for mechanical bypassing. Each of the alternatives likewise includes the dredge template. The deposition basins are located immediately adjacent (south) of the Blind Pass jetty and landward of the bridge. The dredge volume for Alternative 7 is 181,000 cy.

Several structural alternatives for the north end of Sanibel Island were considered in Alternative 8, referred to as: 8b, 8S (south), 8C (center), and 8N (north). Alternative 8a was initially set up as a long groin on the south side of Blind Pass, but did not include the dredged channel and had negligible effects on the flows without dredging. Therefore, each of the tested versions of Alternative 8 includes the dredge template. Alternative 8b includes an angled structure on Sanibel Island shaped similar to the letter ‘Z’. Alternative 8S is a straight structure, but maintains the

seaward tip location at the same position as Alternative 8b. Alternatives 8S, 8C and 8N are all straight structures at various proximities to Blind Pass inlet. The objective of the Sanibel structure alternatives is to compare the effect on the inlet stability, channel migration to the south (inlet shoreline erosion) and downdrift effects.

Alternative 9 is a 200-foot spur extended south from the end of the Blind Pass jetty, perpendicular to the existing structure, and includes the dredge template. The objective of this alternative is to evaluate the ability to redirect flow and sediment transport in a more southerly direction past the inlet channel. The basis is that by reducing the transport and subsequent infilling of the inlet channel, natural bypassing can be improved and channel migration reduced.

3.1.2 Preliminary Alternatives Results

Each preliminary alternative was simulated for a period of 5 years as described in Appendix A. Model results were analyzed qualitatively and quantitatively using several model outputs to evaluate the multiple objectives of the study. The two baseline scenarios were Alternative 0 (No Action) and Alternative 3a (Blind Pass dredge template, -10 ft NAVD). Results for all the preliminary alternatives are analyzed relative to Alternative 3a, which is a baseline condition that includes the presently permitted action (dredge template). Therefore, results relative to Alternative 3a represent the net effects associated with each tested component compared to the existing program.

Considering the large number of alternatives and model results, a subset of model plots is provided in the main text of the model report (Appendix A) to facilitate review of the performance of each alternative. The results primarily focus on relative bathymetric changes over 5 years, volumetric changes alongshore, and evaluation of minimum inlet cross-sectional area for stability purposes. Additional model set-up data, sensitivity analysis, and relative change plots are provided in the Sub-Appendices to the model report.

Following the preliminary alternatives analysis, a combination of the most effective management strategies were identified for further consideration based on the initial study findings, including:

1. The current inlet maintenance approach is functional and beneficial.
2. Dredging though nearshore bar temporarily disrupts bypassing.
3. Connections from the Gulf of Mexico to Pine Island Sound support channel stability.
4. The system is in balance with existing Blind Pass Jetty (Captiva Island terminal groin).
5. Fill placement benefits the adjacent beaches without a considerable effect on inlet stability.
6. Erosion on Sanibel is related to inlet channel variability and sediment transport deficit.
7. Structural installations on Sanibel may offer protection from channel variability.
8. A combination of alternatives would provide a greater benefit to the maintenance plan.

9. Channel instability and sediment transport variability may be addressed with:
    a. Modifications to dredging template
    b. Connections to Pine Island Sound
    c. Fill placement on Sanibel Island
    d. Structural stabilization

3.2 Final Combined Scenarios Alternatives

Several preliminary alternatives identified as positive measures were adapted and combined into three final alternatives as "Combined Scenarios" for comparison of inlet management strategies. The Combined Scenarios are simulated in order to evaluate the collective effects of the multiple design features on the system. Similar to the screening of the preliminary alternatives, the final alternatives phase was approached in a step-wise fashion. The scenarios include combinations of the truncated Blind Pass dredge template, connections to Pine Island Sound, beach fill on Sanibel Island and the spur at the Blind Pass jetty. Table 3-2 below shows the features that are included in each final alternative, herein referred to as Final Alternative 1 (F-Alt 1), Final Alternative 2 (F-Alt 2), and Final Alternative 3 (F-Alt 3).

Table 3-2. Final Alternatives - Combined Scenarios Matrix.

Alternative Feature	F-Alt 1	F-Alt 2	F-Alt 3
Truncated template	✓	✓	✓
Connection to Pine Island Sound (Wulfert Channel)	✓	✓	✓ *
Sanibel beach fill	✓	✓	✓
Connection to Pine Island Sound (Sunset Bay)		✓	✓ *
Spur at Blind Pass jetty			✓

*Smaller connection than Final Alternative 2.

See Appendix A for additional details on the combined scenarios selected for the development of the final alternatives, which are summarized below.

3.2.1 Final Alternative 1

The preliminary alternatives analysis suggest that the permitted dredge template creates a sediment sink and temporarily interrupts the longshore transport, therefore reducing the bypassing of

material to Sanibel Island. This is most apparent immediately after dredging, and slows as the dredge template fills in. The infilling effects channel stability, which may also be related to flow restrictions in the channel itself. Likewise, the current plan has the beach fill template between approximately R-112 and R-114, which is south of the apparent area of need. The beach fill in this alternative is shifted to the north (R-110.5 to R-112) to absorb the effect of the inlet dredging. In addition, by placing the material further to the north, the material that is mechanically bypassed in the dredging event may provide a buffer for the interruption in natural bypassing and function as a feeder beach for the area to the south.

To further assess these hypotheses, Final Alternative 1 includes the following features:

- Truncated dredge template based on Preliminary Alternative 3c with the variable dredging depth along the inner channel. The primary objective of including this feature in the combined scenario is to maintain the bypassing bar in order to reduce the disruption of the alongshore sediment transport and the negative effects in downdrift beaches.

- Connection to Pine Island Sound (Wulfert Channel extension) based on Preliminary Alternative 1b with a channel approximately 100 ft wide (-8 ft NAVD). The primary objective of including this feature in the combined scenario is to enhance connection between Blind Pass and Pine Island Sound in order to increase the tidal flux and inlet stability.

- Sanibel Island beach fill based on Preliminary Alternative 6a with the fill template between R-110.5 and R-112.5 (60,000 cy, average density of approximately 38 cy/ft). The primary objective of including this feature in the combined scenario is to bypass the dredged material that has accumulated in the channel to the north end of the island creating a buffer to absorb the inlet-induced dynamics.

3.2.2 Final Alternative 2

This alternative was developed on the same basis as Final Alternative 1, but adds a connection to Pine Island Sound through Sunset Bay. It includes the truncated dredge template, extended connection to Pine Island Sound through Wulfert Channel, and the same beach fill template. The addition of the Sunset Bay connection is expected to further improve water flow through the main inlet channel, increasing stability. This was also one of the features that local stakeholders identified as having existed in the past with positive benefits.

To further assess these hypotheses, Final Alternative 2 includes the following features:

- All the features of Final Alternative 1.

- Connection to Pine Island Sound (Sunset Bay) based on Preliminary Alternative 4 ,which includes a 75 ft wide channel with transitioning depths from Blind Pass to inland sections (-10 ft, -9 ft and -8 ft, NAVD). The primary objective of including this feature in the combined scenario is to reduce the restriction in the main inner channel (south of the Roosevelt channel intersection) and reduce hydraulic losses in order to increase tidal flux and inlet stability.

3.2.3 Final Alternative 3

Final Alternative 3 is a scaled-back, or moderated, version of Final Alternative 2, plus a structural modification to the Blind Pass Jetty. It includes the truncated dredge template, modified connections to Pine Island Sound through Wulfert Channel and Sunset Bay, the same beach fill template, and adds a spur at the Blind Pass Jetty.

The dredge footprint was moderated in an attempt to reduce the impact to the natural resources in the area, and was considered to be more realistic for implementation and permitting. For example, the Wulfert Channel extension and the connection to Pine Island Sound through Sunset Bay were reduced to a uniform -7.3 ft NAVD (-5 ft MLLW) and the bottom of the cut was defined to be 20 feet wide with 1V:5H side slopes.

Considering much of the connection back to Pine Island Sound is at 2.5 ft MLLW (or below) in the 2015 bathymetry, the top of the cut may be close to 45 feet wide in order to achieve the bottom depth and dimension. Cutting through the existing land mass in areas that are higher than 2.5 ft MLLW to recreate to connection to the Blind Pass channel will require a wider surface cut in order to achieve a uniform bottom cut. Therefore, the width of the top of the cut for the connection varies based on the existing bathymetry and topography, but the bottom channel width was assumed to be constant at 20 feet.

The spur is proposed in a north-south orientation, extending perpendicular from the seaward end of the existing jetty to redirect some of the mean total sediment transport past the inlet. The effect of this modification is expected to reduce the tendency for sediment to settle in the inlet channel, and likewise reduce the channel migration. In order to evaluate the sensitivity of the coastal system to spur length and location, a comparative analysis was performed as described in Sub-Appendix A-3 of the modeling report. The results suggest that the effectiveness of the spur increases with length and 100-ft was selected to balance effectiveness with feasibility of implementation.

To further assess these hypotheses, Final Alternative 3 includes the following features:

- Same truncated dredge template and beach fill location as Final Alternative 1.

- Modified connections to Pine Island Sound (Sunset Bay and Wulfert Channel extension) based on Preliminary Alternatives 1b and 4, with a narrower (20 ft wide) and shallower (-7.3 ft NAVD) channel. The primary objective of including this feature in the combined scenario is to enhance the connection between Blind Pass and Pine Island Sound to improve the tidal flux and inlet stability.

- Spur at Blind Pass Jetty based on Preliminary Alternative 9 with a shorter structure extension (100 ft long) in the same north-south orientation. The primary objective of including this feature in the combined scenario is to redirect flow and sediment transport in a more southerly direction past the inlet, reducing the transport into the inlet and slow the channel migration to the south (erosion at Sanibel), and enhance inlet stability.

3.2.4 Morphology Simulations

The morphology (sedimentation/erosion) of the alternatives at the end of the 5 year simulation relative to the permitted template is shown in Figure 3-1, Figure 3-2, and Figure 3-3 below. Warm (red) and cool (blue) colors represent areas in these delta plots that are shallower and deeper, respectively, at the end of the 5 year simulation compared to the base scenario where only the permitted template was dredged.

In general, the final alternatives show similar morphological trends and comparable benefits to each other, with the main difference being the magnitude of the morphological changes. This can be observed by visually comparing the intensity of colors in the delta plot of Final Alternative 3 being between that of Final Alternative 1 (less intensity) and Final Alternative 2 (greater intensity).

The similarities between the three final alternatives after the 5 year simulations include deeper/wider back channel connections, less channel migration, ebb shoal growth and less erosion on the northern beaches of Sanibel. The deeper/wider channels are demonstrated by the deeper areas (cool colors) through the channel areas leading toward Pine Island Sound; whereas, the shallower areas (warm colors) observed along the inlet shoreline adjacent to R-110 indicate that the alternatives are performing better in this location compared to implementation of the permitted template. The shallower areas (warm colors) along the inlet shoreline on Sanibel are also accompanied by adjacent deeper areas (cool colors) towards the middle of the channel, indicating that the channel in the final alternatives remains closer to the dredged location compared to implementing the permitted template alone.

Each of the alternatives also shows an increase in the development of an ebb shoal feature (warm colors) seaward of the pass, into the Gulf of Mexico. This is due to the improved tidal exchange between Pine Island Sound and the Gulf of Mexico, and the ability for the increased flow to suspend sediments and transport them further out of the inlet. Likewise, the fill placement and improved bypassing results in a shallower feature (warm colors) on the north end of Sanibel Island.

In contrast, Final Alternatives 2 and 3 include the connection through Sunset Bay to Pine Island Sound; whereas, Final Alternative 1 does not. The establishment of the connection through the existing land mass northeast of the Blind Pass bridge results in more energetic flows and morphological changes at the junction of the two channels. As the new connection of Final Alternative 2 equilibrates under these conditions, erosion is depicted in the delta plots as deeper areas (cool colors) along the new channel margins when compared to Final Alternative 1. However, this effect is moderated in Final Alternative 3 due to a smaller (narrower and shallower) connection being made to Sunset Bay.

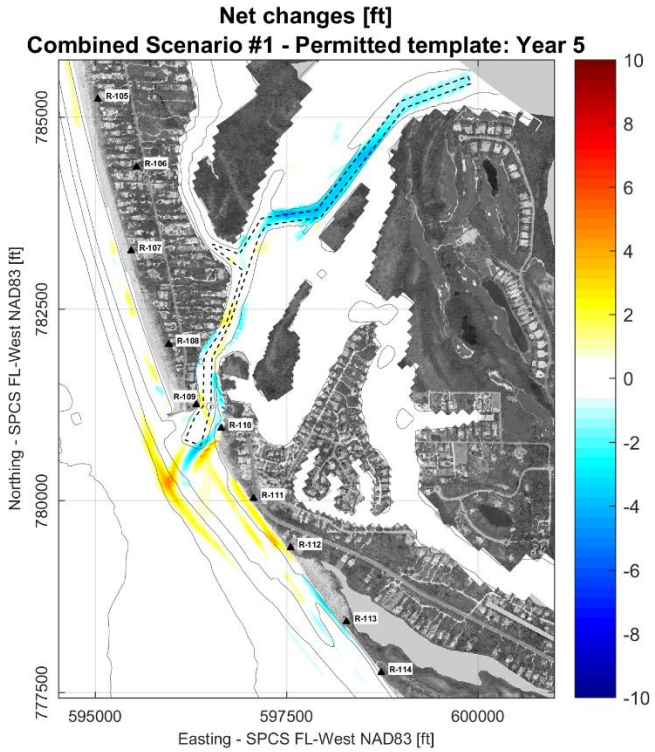

Figure 3-1. Final Alternative 1 - net morphology changes relative to permitted template.

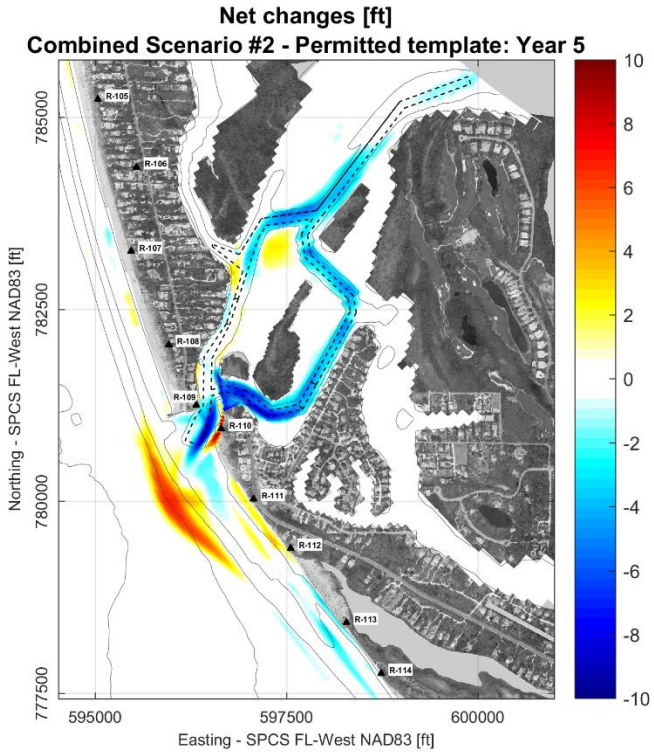

Figure 3-2. Final Alternative 2 - net morphology changes relative to permitted template.

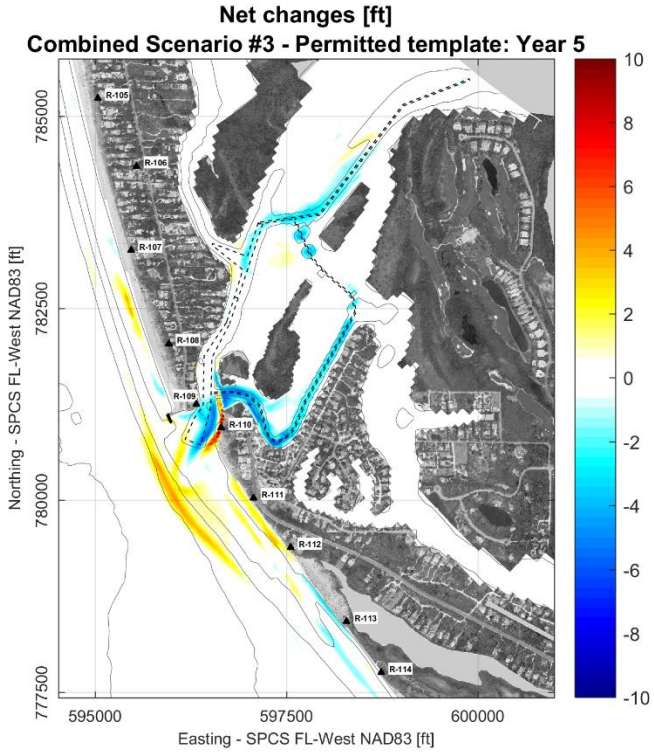

Figure 3-3. Final Alternative 3 - net morphology changes relative to permitted template.

3.2.5 Volume Change Results

Volume changes for each of the final alternatives (F-Alt 1, F-Alt 2, F-Alt 3) were evaluated in a quantitative manner, relative to the simulations of the permitted template (Alt 3a). Figure 3-4 shows the net alongshore volume changes above -13 ft NAVD relative to the permitted template for the 5 year simulation period. Positive volumes indicate more volume at the end of 5 years than the permitted template (to the left of 0). Negative changes indicate less volume at the end of 5 years than the permitted template (to the right of 0).

As in the morphology plots above, the final alternatives show the similar volumetric trends when compared to each other. Likewise, the magnitude of the volume changes for Final Alternative 3 are generally between Final Alternative 1 and Final Alternative 2 as shown in Figure 3-4.

The model simulations demonstrate negligible effects on the south end of Captiva Island (Figure 3-4), and positive effects north of R-112 on Sanibel. In this area, the volume results at individual profiles R-110.5 (Figure 3-5), R-111 (Figure 3-6), and R-112 (Figure 3-7) show that all final alternatives performed better than permitted template. South of R-112, the results transition to a comparable or slightly negative effect, i.e. at R-113 (Figure 3-8).

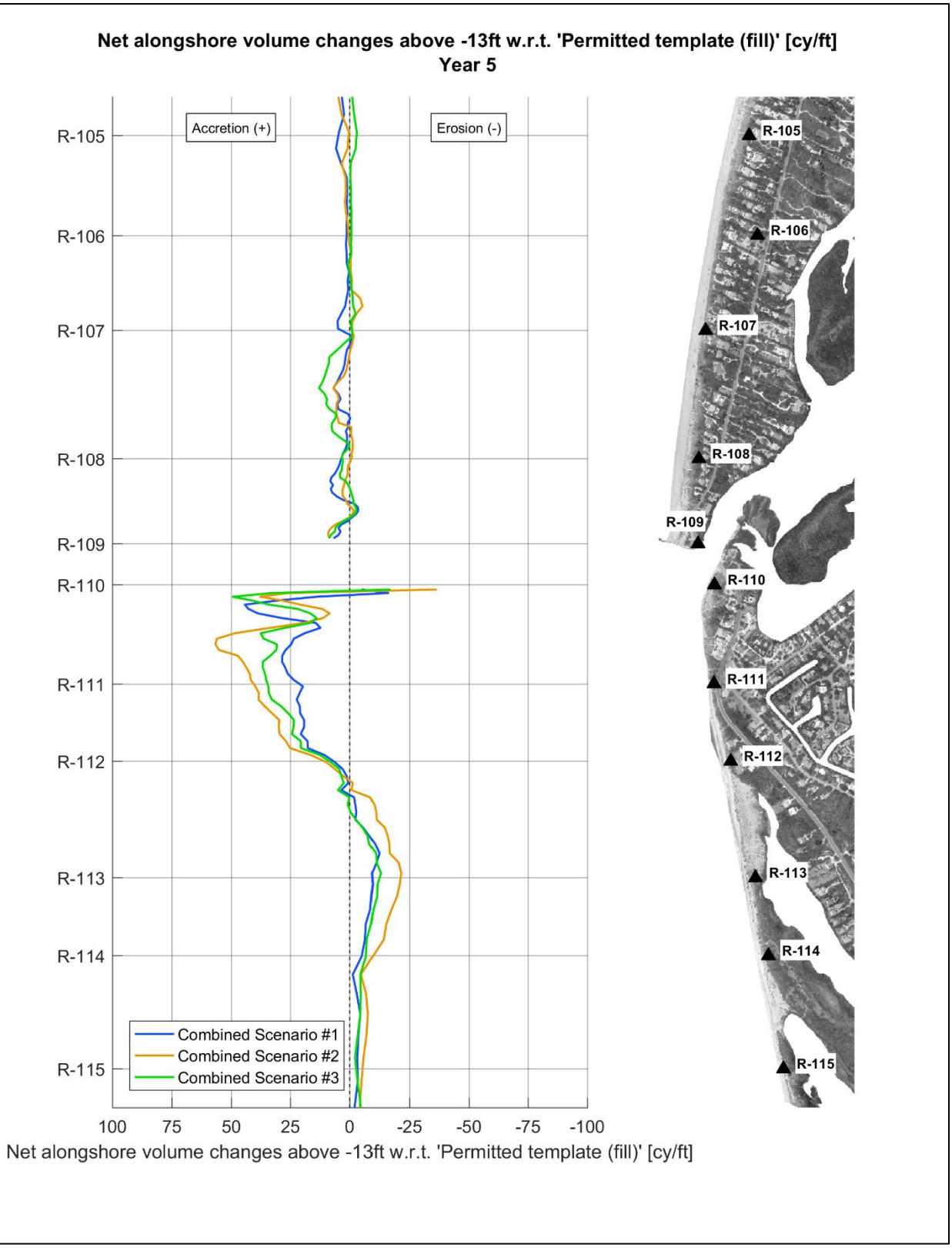

Figure 3-4. Net alongshore volume changes relative to the permitted template (cy/ft).

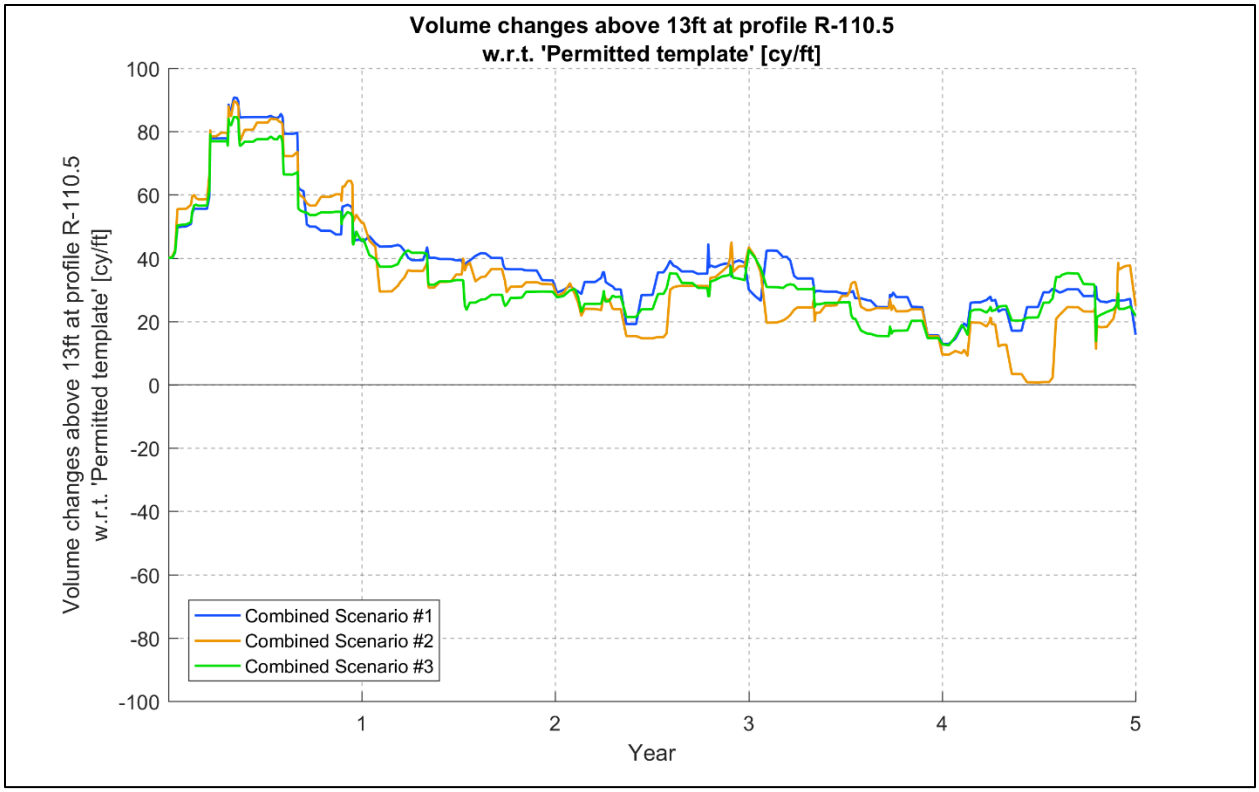

Figure 3-5. Net volume changes at R-110.5 relative to the permitted template (cy/ft).

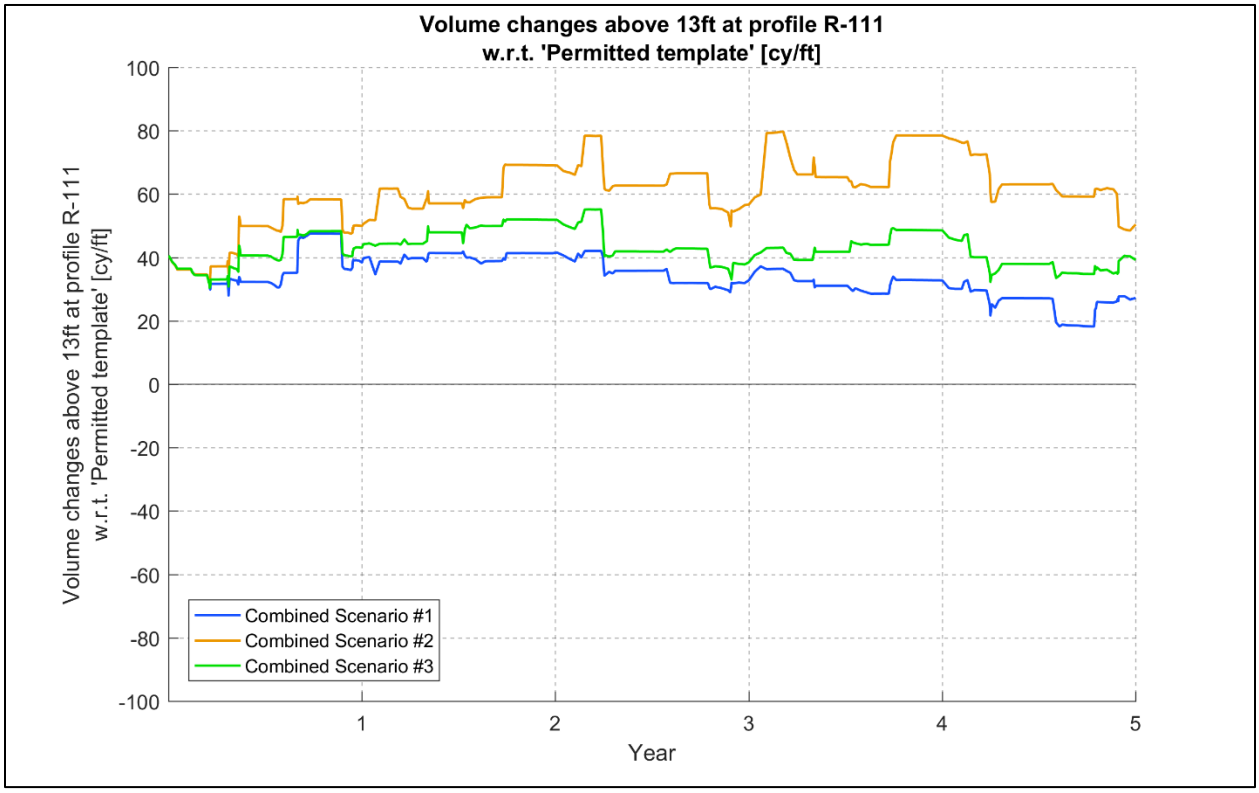

Figure 3-6. Net volume changes at R-111 relative to the permitted template (cy/ft).

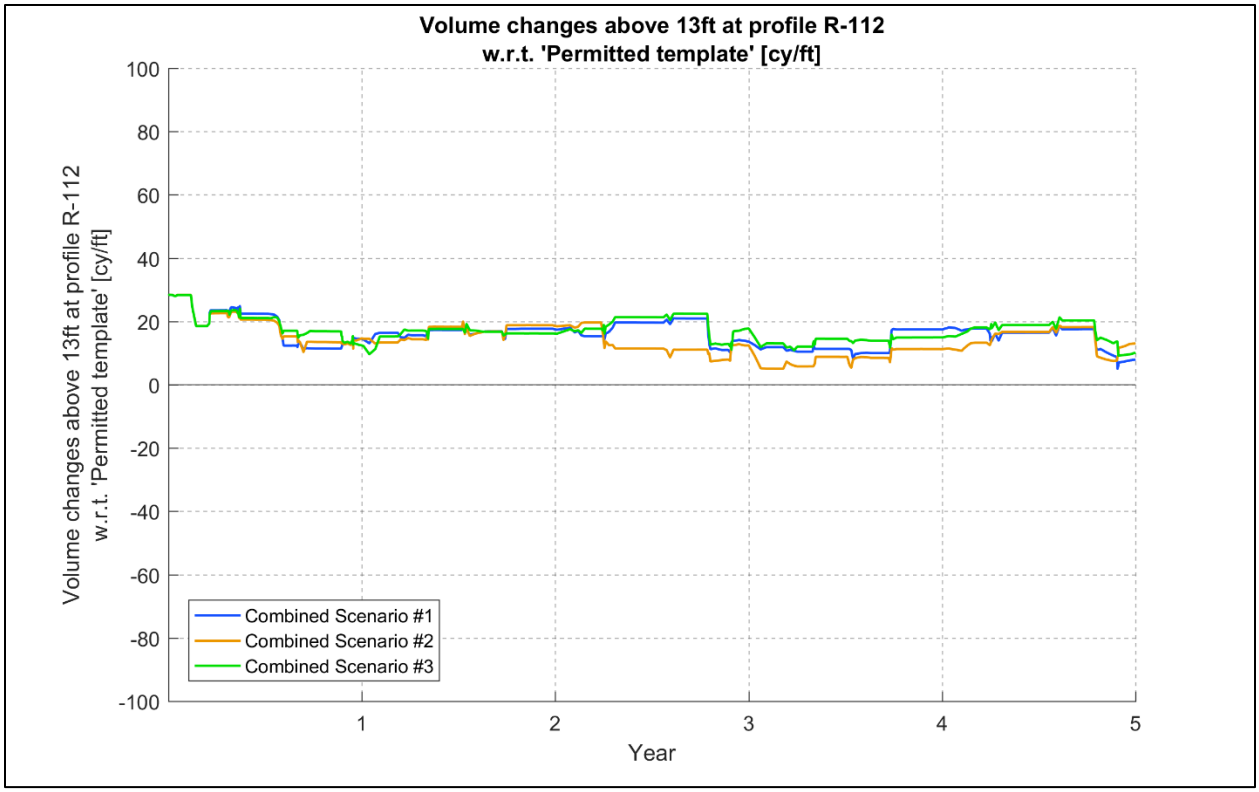

Figure 3-7. Net volume changes at R-112 relative to the permitted template (cy/ft).

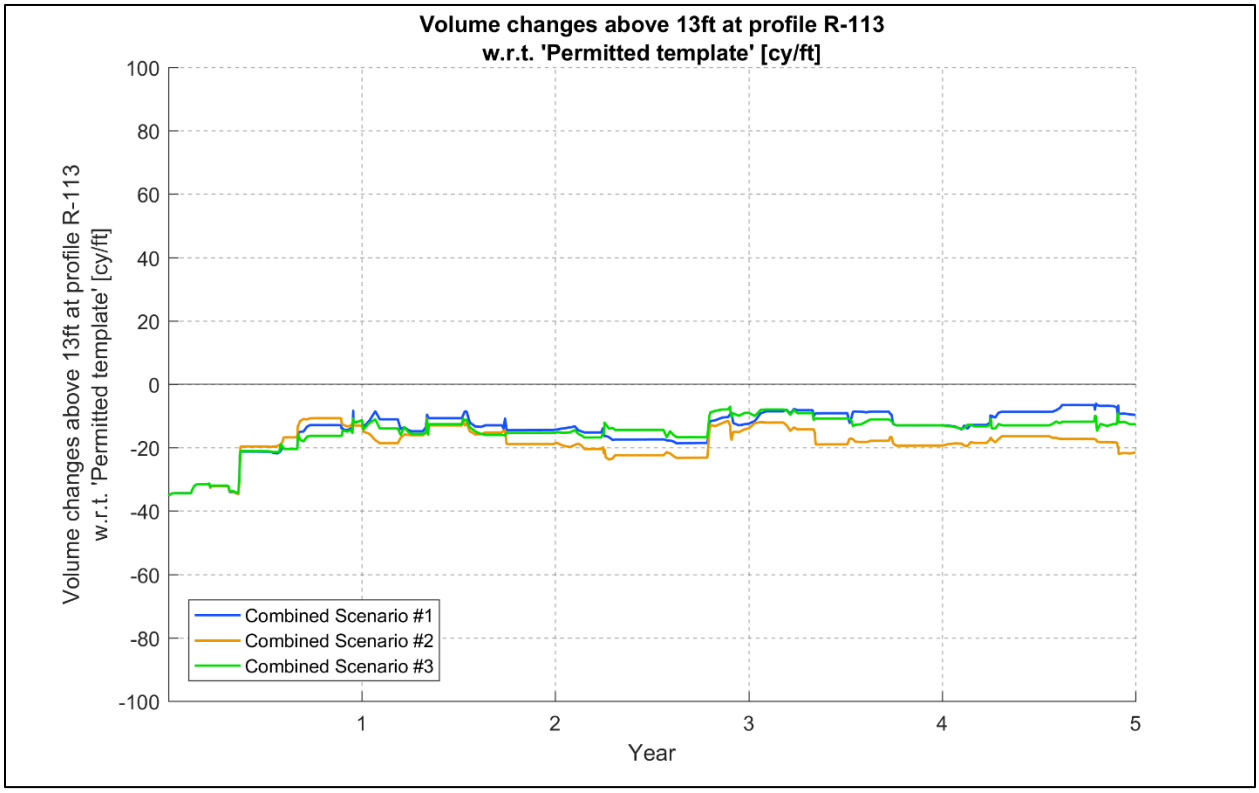

Figure 3-8. Net volume changes at R-113 relative to the permitted template (cy/ft).

3.2.6 Channel Stability Analysis

The channel stability was also evaluated in a quantitative manner by plotting the minimum cross-sectional area in the inlet channel over the 5 year simulation (Figure 3-9). The analysis was limited to the area approximately 400 ft to the east and west of the channel centerline on both sides of the bridge, where the channel restriction exists. As in all other analyses, the final alternatives (F-Alt 1, F-Alt 2, F-Alt 3) were compared to the permitted template (Alt 3a).

The model shows that Final Alternative 1 performs similar to the permitted template, and Final Alternatives 2 and 3 performed better than the permitted template. Final Alternative 2 has the largest cross-sectional area throughout the simulation period.

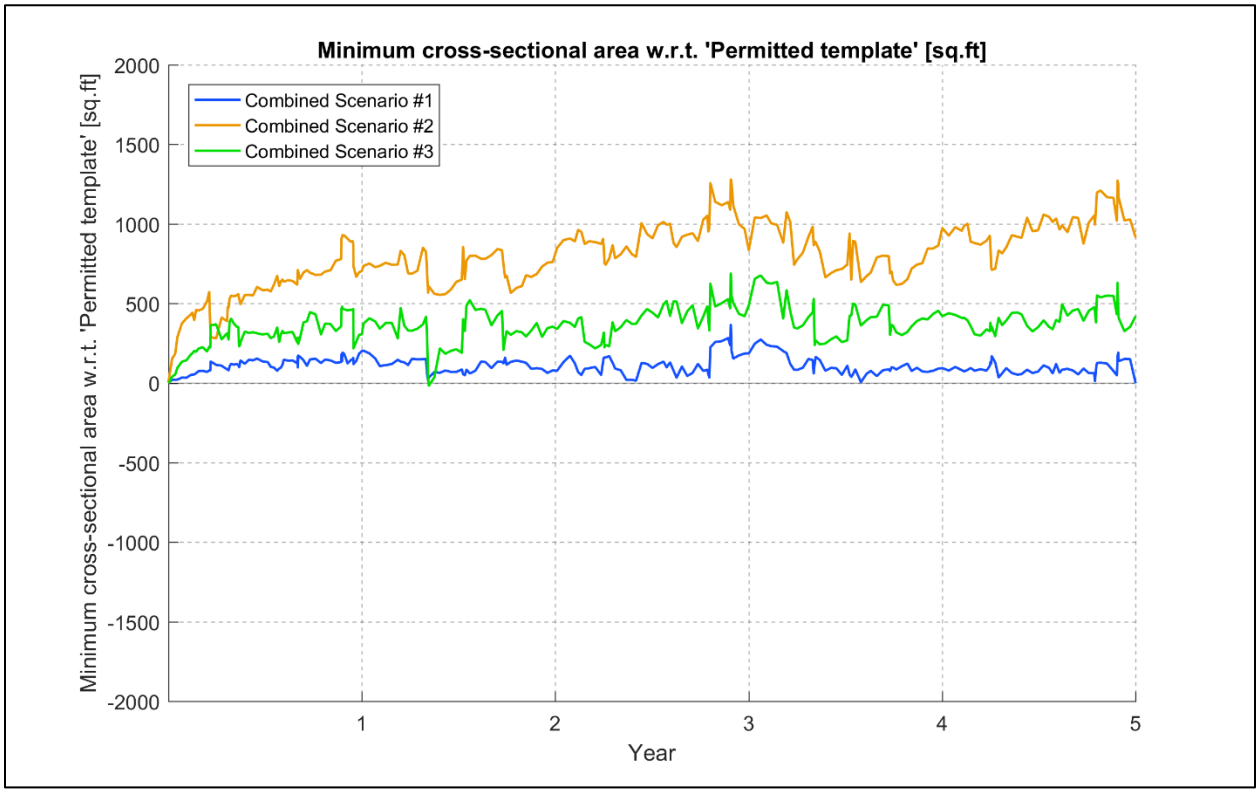

Figure 3-9. Minimum cross-sectional area relative to the permitted template (sq. ft.)

3.2.7 Storm Simulation Assessments

As a final assessment of potential performance under extreme conditions, the final alternatives were evaluated under two storm scenarios. The two storm simulations were selected to represent winter conditions (January 2016 cold front) and summer conditions (Hurricane Charley in 2004).

The model reproduced the severe conditions of Hurricane Charley as an extreme event (Category 4) with the capability to cause widespread changes, as demonstrated by morphological effects that

were simulated throughout the entire model domain. The Hurricane Charley model simulations had a similar effect on all the final alternatives. Due to the severity of the storm, the widespread effects overwhelm the incremental changes of the final alternatives compared to the permitted template. Under all scenarios simulated, including No Action, the Hurricane Charley conditions scoured the channel and increased the cross-sectional area of the channel by double or more. This is also consistent with historic reports of severe storms being credited with reopening Blind Pass in times of closure.

The cold front simulation was based on a typical winter storm that occurred in January 2016. It was a comparatively smaller event then Hurricane Charley and only resulted in isolated changes. The cold front had a similar effect on all the final alternatives. Under all scenarios, including No Action, the cold front effects were limited to the areas seaward of the bridge (outer section of the channel) and downdrift. The truncated template results remained deeper than the comparative permitted template simulation, and the bypassing bar feature of the truncated template resulted in benefits downdrift. Therefore, the final alternatives do not appear to result in any negative effects on the channel stability or the adjacent beaches under typical cold front conditions beyond what could be experience following implementation of the permitted template.

3.2.8 Summary of Final Alternatives Results

Following the preliminary alternatives analysis, a combination of the most effective management strategies were identified for further consideration based on the initial study findings. Three final alternatives were selected as "Combined Scenarios" that were evaluated in a step-wise fashion in an effort to optimize the benefits of each particular component.

Final Alternative 1 includes the truncated dredge template, extended connection to Pine Island Sound through Wulfert Channel, and a more northerly fill placement on Sanibel Island. Final Alternative 2 includes everything in Final Alternative 1, plus the re-establishment of the connection to Sunset Bay. Final Alternative 3 is a moderated version of Final Alternative 2 with refined channel depths and adds a 100 ft long spur at the end of the existing Blind Pass Jetty.

Each final alternative was simulated for a period of 5 years and for two storm conditions as described above and in further detail in Appendix A. Model results were analyzed qualitatively and quantitatively with primary focus on sediment transport through evaluation of morphology, volume changes, channel stability and storm response. Results for all the final alternatives are presented relative to Alternative 3a (permitted template), which is a baseline condition used to assess the net effects associated with each final alternative compared to the existing program.

The overall findings are summarized by key location in the comparison matrix shown in Table 3-3 to facilitate interpretation of the results relative to the current plan. The matrix is set-up by location, going north to south within the study area, and includes the south end of Captiva Island,

inlet channel, interior shoreline northeast of the Blind Pass bridge, Sanibel Island north of R-112, and Sanibel Island south of R-112.

Table 3-3: Combined Alternatives Comparison Matrix.

Location	F-Alt 1	F-Alt 1	F-Alt 1
Captiva Island (south end)	o	o	o
Blind Pass channel	o	+ +	+
Interior shoreline (NE of bridge)	o	- -	-
Sanibel Island (north of R-112)	+	+ + +	+ +
Sanibel Island (R-112 to R-114)	-	- -	-

Notes: "o" = similar, "+" = positive, "-" = negative. The findings matrix is intended for qualitative comparisons of the Final Alternatives results relative to the permitted template; for example, two "+" signs is not meant to imply twice the positive effect.

In general, the final alternatives show similar morphological trends and comparable benefits to each other, with the main difference being the magnitude of changes. Compared to the permitted plan, all of the final alternatives exhibit benefits in one or more locations, as summarized below:

1. Final Alternative 1 performs similar to the permitted template for Captiva Island and Blind Pass, and presents an improvement to the beach north of R-112 on Sanibel Island with minor potential downdrift impacts.

2. Final Alternative 2 performs similar to the permitted template for Captiva Island and has significant improvements for Blind Pass channel stability, but introduces the potential for erosion on the interior shoreline northeast of the bridge. This alternative also exhibits the most significant improvement to the beach north of R-112 on Sanibel Island, but with a greater potential for downdrift impacts.

3. Final Alternative 3 performs similar to the permitted template for Captiva Island, has moderate improvements for Blind Pass channel stability, and lessens the potential for erosion on the interior shoreline northeast of the bridge. This alternative also exhibits improvement to the beach north of R-112 on Sanibel Island with less potential for downdrift impacts.

3.3 Supplemental Analyses

In addition to the foregoing technical analyses, there are additional considerations that should be factored into the management steps in seeking the adoption of the inlet management plan by the State. These include the following:

3.3.1 Permitting Considerations

The Blind Pass Maintenance Dredging Project Joint Coastal Permit No. 0265943-001-JC was issued to Lee County (County) in June 2008 for maintenance dredging on a planned interval of 5 years. An excerpt from Activity Description in the Final Order is provided below for reference:

> "The project is to conduct maintenance dredging of the Blind Pass Channel and the connection to Roosevelt Channel. The channel will extend from the -10' NAVD contour in the Gulf of Mexico into the interior waters of the Pine Island Sound. The channel will have a maximum width of 330 feet in the Gulf and will narrow to 160 feet as it enters the Pass and continues into Pine Island Sound. In the initial maintenance dredging event, approximately 127,286 cubic yards of material will be removed from the Pass and interior system. Beach compatible material will be placed on downdrift beaches, between R-112 to R-114, suitable material will be placed in the nearshore between R-112 and R-114, and non-beach compatible material will be temporarily dewatered at a beach containment site, and then transported to an upland disposal site. Maintenance dredging of Blind Pass is expected to occur on a 5- year periodic schedule. Direct impacts from the initial dredging include 0.72 acres of seagrass, 0.157 acres of mangrove, and a 1.3 acre loss of sandy beach. As mitigation, dune areas on Captiva Island will be restored, mangroves will be planted in Clam Bayou, and a No Motor Zone will be created near Wulfert Keys to promote the recovery of seagrasses damaged by prop-scars."

The original permit had the construction phase due to expire in June 2013, but the permit was modified a number of times, including a major modification No. 0265943-003-JM issued in December 2011 and extended the permit to June 2017. In December 2016, the County requested another extension of the expiration date to December 2026, 15 years from issuance of the Major Modification (0265943-003-JM). In February 2017, the FDEP issued Minor Permit Modification No. 0265943-008-JN, which has extended the permit authorization to December 9, 2026.

Considering that the County has an existing permit for the Blind Pass Maintenance Dredging Project that is valid for several more years, it is likely that some of the features proposed in the final alternatives can be authorized without seeking a new permit. For example, the truncated template may be implemented with a Notice to Proceed request, or may require a "minor" modification. Likewise, the additional dredging connections and fill placement adjustments may be added to the existing authorization, but would likely require a "major" modification (as in 2011). The structural modification of the Blind Pass Jetty would also require a "major" modification or separate (new) permit for authorization.

The existing permit also included mitigation for impacts to seagrass and mangroves. Additional mitigation may be required for permitting the Wulfert Channel extension (potentially for seagrass) and the connection to Sunset Bay (potentially for seagrass and mangroves). Field investigations may be requested to assess the existing natural resources and geotechnical analyses will be needed to characterize the sediments to be dredged in the new/expanded areas.

The FDEP and federal regulatory agencies should be consulted further in pre-application coordination/meetings to identify the appropriate permitting process, pending the County's proposed actions and schedule following review of this study for adoption and implementation.

3.3.2 Preliminary Cost Benefit Considerations

In order to assess the potential cost benefit of each of the final alternatives, the simulated volumetric benefits of each was compared to the permitted template based on the cost derived from the 2017 Blind Pass Maintenance Dredging bid prices. The base bids for that project ranged between a low bid of $1.42M and a high bid of $2.90M, with the average of the three lowest bids being approximately $1.76M. To obtain a comparative all-in (mobilization, dredge and fill, environmental protection) estimate for comparing project costs, the average of $1.76M for placement of 108,300 cy suggests total unit price of approximately $16 per cubic yard.

The estimated dredging volumes from the modeling scenarios are provided in Table 3-4 below. Based on the assumed cost of $16/cy, the permitted template would have an estimated construction cost of $1.45M for the removal of 90,900 cy. The truncation of the Blind Pass dredging template reduces the dredging volume by approximately 34,000 cy relative to the permitted channel template, which corresponds to approximately 38% of savings in each dredging project. Therefore, the alternatives require less volume to be removed from the Blind Pass channel due to the truncated template, resulting in a comparative cost of $900,000 for the removal of 56,600 cy (all else equal). It is important to note that the Blind Pass channel volume is a recurring maintenance requirement; whereas, the additional channel connections (Wulfert Channel & Sunset Bay) reflect initial dredging requirements. While the additional connections would result in an initial cost, the maintenance requirements would be less.

Table 3-4. Estimated Alternative Dredging Volumes

Dredging volume (cy)				
Scenario	**Blind Pass**	**Wulfert Channel**	**Sunset Bay**	**Total**
Permitted Template	90,900	0.0	0.0	**90,900**
Final Alternative 1	56,600	51,000	0.0	**107,600**
Final Alternative 2	56,600	51,000	103,800	**211,400**
Final Alternative 3	56,600	11,800	30,400	**98,700**

To assess project benefits, an estimate of the quantity of material bypassed naturally with each alternative was extracted from the final combined model scenarios as shown in Table 3-5. The cost savings is estimated by the increased natural bypassing quantity compared to the cost of mechanically bypassing at $16/cy. For example, the comparative monetary benefit for Final Alternative 3 is $148,000 in the first year and $176,000 over 5 years ($35,200 per year).

Table 3-5. Estimated Bypassing Benefits

Effect on Bypassing (cy/year)			
Scenario	**Year 1**	**Year 3**	**Year 5**
Permitted Template	0	0	0
Final Alternative 1	6,900	2,400	400
Final Alternative 2	13,600	4,500	2,500
Final Alternative 3	9,300	3,800	2,200

It is important to note that the maximum benefit of all the final alternatives occurs within the first year, and decreases on an average annual basis. During the first year after dredging, high infilling rates are observed for the permitted template (especially seaward of bridge) directly affecting sand bypassing. After the bathymetry configuration of the channel converges to a more equilibrated configuration, bypassing rates start to become reestablished and the benefits, in terms of bypassing rates, of the alternatives is less with each consecutive year.

The increased bypassing in the first year also suggests that less material infills the dredged channel, potentially increasing the period between maintenance projects. In the longer-term after dredging, the effects on bypassing rates are reduced as the dredge hole fills in and bypassing rates resume. If the inlet can be maintained in a more stable open position, the equilibrium condition for the channel is closer to the desired conditions (i.e. immediately post-dredging), and therefore less frequent maintenance will be required.

Installation of the spur in Final Alternative 3 is not directly comparable to dredging template modifications in terms of cubic yards, but it is expected to have a cost benefit by promoting natural bypassing over the long term. Subject to further engineering and refinement, the 100 ft long spur can be assumed to have a construction cost of approximately $2M (in 2018 dollars), if constructed with locally available limestone and a typical foundation. Based on a modest 30-year lifespan, the average annual cost of the spur would be in the range of $67,000 per year. Considering that the unit cost to maintain Blind Pass by dredging will increase significantly during that same timeframe, the structural investment could be covered by savings in dredge costs due to reduced infilling rates.

3.3.3 Funding Opportunities and Interlocal Coordination

The previous Inlet Management Plan for Blind Pass (CPE, 1993) identified potential cost-sharing partners including: Lee County, The City of Sanibel, the CEPD, and the West Coast Inland Navigation District (WCIND). Since then, the County has taken on the responsibility as the lead government in maintaining Blind Pass in an open condition by obtaining the regulatory authorizations, securing contractors to complete the work, and performing the project monitoring. While the County has maintained this commitment, outside funding opportunities should continue to be sought in implementing the selected modifications.

Lee County entered into an interlocal agreement with the CEPD and the City of Sanibel in April 2000 for Blind Pass. The purpose of this 15-year interlocal agreement was to provide for a method for allocation of future costs and responsibilities associated with the 1988/89 and 1996 CEPD projects and as defined in the previous 1995 interlocal agreement that was based on the 1993 Inlet Management Plan. The agreement resulted in multiple nourishments of the northern end of Sanibel Island with sand from offshore borrow areas during the Captiva Island nourishments, but expired in 2015 and has not been renewed.

In response to the closure of Blind Pass, the local governments partnered again to develop a comprehensive plan to restore Blind Pass. On June 22, 2004, Lee County, the CEPD, and the City of Sanibel entered into an interlocal agreement to cooperate in the permitting, financing and construction of the Blind Pass Ecozone Restoration Project, which was an update to the 2000 interlocal agreement. Lee County has maintained its role as the sponsor for the permit application process and project management. The 2004 agreement led to the dredging of Blind Pass and expired in April 2015. The results of this study may be used to support continued interlocal coordination and sand placement protocols related to Blind Pass.

4. STUDY FINDINGS

Blind Pass is a natural tidal inlet that has migrated and closed at various times. The early history, relevant coastal processes, and initial inlet management strategies are described in the previous Blind Pass Inlet Management Plan (CPE, 1993). Between August 1998 and October 1999, Blind Pass closed due to natural processes. The pass was opened in a limited effort seaward of the bridge in early 2001, but the inlet closed after the project and periodically reopened and closed several times since.

In December 2008, Lee County began dredging to re-open Blind Pass, which was accomplished pursuant to the original inlet management plan and interlocal agreements with the state contributing financial support. With ongoing maintenance dredging, the pass has remained open and the dredge material has been placed downdrift on Sanibel Island. Lee County has undertaken the study described herein with an advanced 3D numerical modeling effort to evaluate options to

refine the management of the pass on a scientific basis. In addition, the study considered protecting the existing infrastructure, maintaining the existing level of recreation access and use, maintaining Blind Pass in an open condition, and avoiding potential impacts to navigation.

Based on a review of the previous inlet management plan, along with the overall history, aerial photographs, monitoring data, sediment budget analysis and input from the TAC and local stakeholders, a comprehensive alternatives analysis was performed with the Delft3D numerical model. Eighteen (18) preliminary alternatives were evaluated to identify the most-effective management options and screen out the less effective measures. Based on the results of the preliminary alternatives, the most effective components were combined into three final alternatives for comparison of inlet management strategies. The scenarios include combinations of a truncated dredge template, connections to Pine Island Sound, beach fill on Sanibel Island and a structural spur at end of the Blind Pass jetty.

The overall findings presented throughout the report and appendices are summarized as follows:

1. Blind Pass is an unstable inlet that is likely to close in the absence of continued maintenance. When open, the pass can have negative effects on northern Sanibel Island shoreline depending on channel location and depth.

2. The current inlet maintenance approach based on the permitted maintenance dredging plan has been effective in bypassing material and keeping the inlet open, but temporarily disrupts the natural transport to northern Sanibel.

3. Flow improvements between the Gulf of Mexico and Pine Island Sound can be achieved by extending and re-connecting interior channels that support the primary channel stability.

4. The inlet system is in balance with the existing Blind Pass Jetty (Captiva Island terminal groin) and fill placement on both Captiva and Sanibel benefits the adjacent beaches without a considerable effect on inlet stability.

5. Captiva Island can be negatively affected by Blind Pass during times of reversed (south to north) transport, but the effect is comparatively small, localized and temporary. Continued nourishment of Captiva Island according to the CEPD's management protocols will support the overall sediment budget and bypassing objectives.

6. Structural installations along the inlet facing shoreline on northern Sanibel (revetment, jetty, groins etc.) would offer protection from episodic erosion related to channel variability, but would have little effect on the channel stability. Stabilization structures may be needed if the Sunset Bay connection is re-opened.

7. The sediment budget suggests that approximately 21,000 cy/yr of sand is captured by the inlet from the natural longshore (predominantly north to south) transport, but does not account for the entire net deficit along Sanibel Island.

8. A combination of refined actions can be implemented to decrease the long-term dredging requirements by improving the inlet stability, and reduce the shoreline variability on Sanibel Island related to the temporary interruption of transport caused by the present maintenance plan.

9. The final combined alternatives have negligible effects on the south end of Captiva Island, benefit the channel stability as a result of improved tidal exchange and bypassing, and have mixed effects on Sanibel Island, shown by the changes in erosion/sedimentation patterns.

10. Overall, the final combined alternatives show similar morphological trends and comparable benefits to each other, with the main difference being the magnitude of changes. Compared to the permitted plan, the recommended components of the final alternatives are:

- Truncated Template - The truncated template partially maintains the natural bypassing bar, which would reduce the disruption of sediment transport and moderate the negative effect on the downdrift beaches that occurs after dredging.

- Sand Placement - Material dredged from Blind Pass inlet is already being bypassed to the downdrift beach of Sanibel Island in an effort to balance the sediment budget. Bypassing alone will not completely offset the erosion on Sanibel Island, but the placement location can be moved north to optimize offsetting the erosion signature.

- Connections to Pine Island Sound - Enhancing the connection between the Gulf of Mexico and Pine Island Sound increases the tidal flux, which would improve the inlet stability.

- Blind Pass Jetty Spur - A spur at the end of the Blind Pass jetty enhances channel stability by redirecting a portion of the flow (and sediment transport) away from the inlet, thereby reducing channel migration to the south.

These study findings are based on the updated sediment budget and an improved understanding of the coastal dynamics of the Blind Pass inlet system and adjacent beaches through the use of numerical modeling as further described in Appendix A. The results should be used in conjunction with other coastal engineering assessments and prudent engineering judgment. Further engineering is recommended prior to implementation.

5. RECOMMENDED INLET MANAGEMENT PLAN UPDATE

The recommended inlet management plan presented below is based on the objectives of balancing the sediment budget between the inlet and adjacent beaches, improving channel stability to maintain Blind Pass in an open condition, and addressing the inlet related erosion so that sediment bypassing is more effective.

5.1 Sediment Budget Update

The 1993 Blind Pass Inlet Management Plan included multiple sediment budgets that spanned several decades. The most comparable time period to the present situation followed the 1988/89 Captiva Island nourishment project, which suggested that Captiva Island lost 51,000 cy/year and the inlet ebb shoal gained 24,000 cy/yr between 1988 and 1991. However, the inlet closed and open several times since then, reflecting a significantly different coastal system.

Beginning in 2008-2009, Lee County implemented the Blind Pass Restoration Project with the objective of maintaining Blind Pass in an open condition. Therefore, the sediment budget update for this analysis is based on data from 2009 to 2015 and includes the southern portion of Captiva Island, Blind Pass and the north portion of Sanibel Island.

Approximately 51,000 cy/yr was transported from Captiva Island to Blind Pass inlet from 2009-2015. During this time, the inlet seaward of the bridge gained 20,000 cy/yr and 1,000 cy/yr was measured in the flood shoal. This sediment budget update suggests that the inlet complex (seaward and landward of the bridge) captures approximately 21,000 cy/yr, which is comparable to the 24,000 cy/yr measured between 1988 and 1991 (CPE, 1993). Likewise, the losses from Captiva Island are comparable, with both timeframes (1988-1991 and 2009-2015) suggesting 51,000 cy/yr.

South of the inlet Sanibel Island was erosional during the assessment period, losing 14,000 cy/yr from R-110.5 to R-112 and 58,000 cy/yr from R-112 to R-116. Approximately 95,000 cy/yr crosses the southern boundary of that cell at R-116, where the trend on Sanibel Island changed to accretional with the section between R-116 and R-121 having gained 6,000 cy/yr. Beyond that location, approximately 89,000 cy/yr was transported south of R-121.

Based on the updated sediment budget, approximately 51,000 cy/yr is transported toward Blind Pass from the north (Captiva Island) and 89,000 cy/yr is transported south of Bowman's Beach (Sanibel Island). This indicates a sediment deficit of 38,000 cy/yr within the study area on Sanibel Island. The material being captured by Blind Pass is already being dredged and placed entirely within the calculation limits, which supports the objective of bypassing 100% of the 21,000 cy/yr of inlet material to the south. The approved northerly placement area should be modified to address the erosion signature on northern Sanibel by widening the template from R-112 to R-110.5.

5.2 Recommended Management Plan Components

Based on the results of the study and the findings presented herein, Final (combined) Alternative 3 is the selected recommended management plan update. This alternative achieves the objectives of the study, while balancing feasibility and regulatory expectations. The recommended plan includes:

- Truncated dredge template based on Preliminary Alternative 3c with the variable dredging depth along the inner channel.

- Sanibel Island beach fill based on Preliminary Alternative 6a with the fill template between R-110.5 and R-112.5.

- Modified connections to Pine Island Sound with a re-established connection to Sunset Bay and Wulfert Channel extension.

- Spur at Blind Pass Jetty as a 100 ft long extension in a north-south orientation.

Further discussions between the County, CEPD, the City of Sanibel, FDEP and other commenting agencies may result in modifications to this recommendation.

5.3 Implementation Plan

Considering that the County has an existing permit for the Blind Pass Maintenance Dredging Project that is valid for several more years, it is likely that some of the features proposed in the recommended plan can be implemented with the next maintenance dredging event. These include:

- Continue to dredge Blind Pass to authorized depths in approved locations according to existing permit authorizations.

- Seek regulatory approval through a Notice to Proceed request (or permit modification, if required) to truncate the seaward end of the current dredge template to test the natural bypassing pathway.

- Continue to bypass 100% of the material dredged from Blind Pass to Sanibel Island. Consider seeking a permit modification to expand the northerly fill template for additional flexibility based on the severity of erosion at the time of dredging.

- The remaining components of the plan would require major permit modifications (or a new permit) and can implemented in a phased approach based on the performance of the initial features. These include:

- Extend the current dredge template landward through Wulfert Channel to Pine Island Sound. This could be done as a modification to the existing permit. Potential seagrass impacts would need to be addressed and geotechnical testing would likely be required.

- Reestablish the connection to Sunset Bay, and continue the connection landward to Pine Island Sound. This could be done as a modification to the existing permit. Potential seagrass and mangrove impacts would need to be addressed and geotechnical testing would likely be required.

- Install a spur at the end of Blind Pass jetty. This may be done as a modification to the existing permit but could require a new permit pending agency review. Additional engineering would be required to design the structure to a level sufficient for regulatory review and construction.

Other ongoing actions with regard to the inlet maintenance should continue and be updated as appropriate, such as a monitoring program and navigational notices related to implementation of the plan.

6. REFERENCES

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