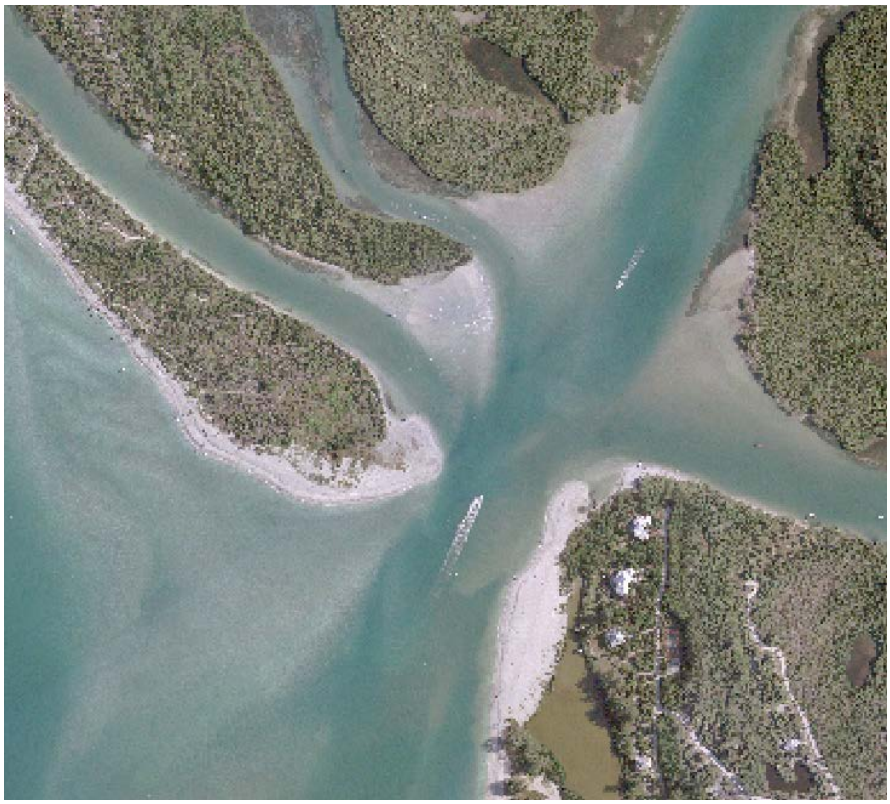
CHARLOTTE COUNTY 10-YEAR BEACH AND INLET MANAGEMENT PLAN: ALTERNATIVES ANALYSIS REPORT



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COASTAL TECH

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1. INTRODUCTION

On October 31, 2013, Coastal Engineering Consultants, Inc. (CEC) conducted a webinar and presented to the Florida Department of Environmental Protection (FDEP), Florida Park Service, and Florida Fish and Wildlife Conservation Commission an alternatives analysis following the submittal of the Alternatives Analysis Report (CEC, 2013) as part of the Charlotte County 10-year Beach and Inlet Management Plan.

The following items were discussed during the presentation:

- Goals and Objectives
- Structural Desktop Summary
- Stakeholder Input
- Alternatives Development
- Numerical Model Study
- Performance Evaluation
- Concept Plans/Structure Options
- Fiscal Analysis
- Offshore Borrow Areas
- Recommendations
- Projected Schedule

To summarize, four (4) alternatives were analyzed and presented:

- Alternative 1 – Includes beach renourishment of the updrift beach fill (UBF), north beach fill (NBF), and south beach fill (SBF) utilizing the inlet and ebb shoal borrow areas and a terminal groin on the south end of Manasota Key
- Alternative 2 – Includes beach renourishment of the UBF, NBF, and SBF utilizing the inlet and ebb shoal borrow areas and a permeable groin field on the south end of Manasota Key
- Alternative 3 – Includes beach renourishment of the UBF, NBF, and SBF utilizing the inlet and ebb shoal borrow areas and a combination of one terminal groin on the south end of Manasota Key and a T-groin field along the northern shoreline of Palm Island
- Alternative 4 – Includes beach renourishment of the UBF, NBF, and SBF utilizing the inlet and ebb shoal borrow areas and Stump Pass ebb shoal restoration

The performance of the modeled alternatives was evaluated based on a number of criteria including acreage changes, volumetric changes, borrow area infilling, downdrift impacts, impacts to controlling depth for navigation, and construction budgets. A scoring summary for all alternatives is presented in Table 1. This performance evaluation analysis is presented in detail in CEC and CTC (2013).

Table 1. Alternatives Scoring Summary.

ALTERNATIVE	ACREAGE CHANGE			VOLUME CHANGE			BORROW AREA INFILLING	DOWNDRIFT EFFECTS	CONTROLLING DEPTH	CONSTRUCTION BUDGET	TOTAL SCORE	RANK
	UBF	NBF	SBF	UBF	NBF	SBF						
0	0	0	0	0	0	12	7	20	30	0	70	**#5**
1	7	0	12	19	14	10	5	10	30	25	132	**#4**
2	31	0	11	47	8	0	34	10	30	28	199	**#1**
3	6	3	13	18	45	16	20	0	30	23	174	**#2**
4	26	0	0	53	2	15	0	20	30	18	164	**#3**

Alternative 0: Baseline, includes the County continuing its beach and inlet management plan following the past 10 years of activities including beach renourishment of the UBF, NBF, and SBF utilizing the inlet and ebb shoal borrow areas without the addition of structural complements or usage of offshore borrow areas

Alternative 1: Includes beach renourishment of the UBF, NBF, and SBF utilizing the inlet and ebb shoal borrow areas and a terminal groin on the south end of Manasota Key

Alternative 2: Includes beach renourishment of the UBF, NBF, and SBF utilizing the inlet and ebb shoal borrow areas and a permeable groin field on the south end of Manasota Key

Alternative 3: Includes beach renourishment of the UBF, NBF, and SBF utilizing the inlet and ebb shoal borrow areas and a combination of one terminal groin on the south end of Manasota Key and a T-groin field along the northern shoreline of Palm Island

Alternative 4: Includes beach renourishment of the UBF, NBF, and SBF utilizing the inlet and ebb shoal borrow areas and Stump Pass ebb shoal restoration

Based on the discussion among the participants, the Consulting Team sought their input on:

- Range of structure options examined
- Parameters used to evaluate options
- Their "institutional constraints" to advance selection of preferred option (e.g., aesthetics) for southern end of Manasota Key
- Proposed adaptive management plan to include future implementation of alternatives including structure modifications (e.g., adjust permeability / bypassing function of groin field / terminal groin), addition of structures on downdrift shoreline to address dynamic shoreline responses, placement of sand on ebb shoal platform to aid in recovery.

The Consulting Team reviewed feedback from the state agencies and concluded that Alternative 1 was considered favorable, however, concerns of downdrift impacts immediately south of the

proposed terminal groin (within the State Park Beach) were expressed by Florida Park Service and additional modeling was suggested.

2. ALTERNATIVE 1

2.1. Development

Alternative 1 was developed to include beach nourishment of UBF, NBF, and SBF utilizing the offshore borrow areas and a terminal groin on the south end of Manasota Key (CEC and CTC, 2013). The design premise for the UBF template and siting of the terminal structure was based on a review of the inlet system with the goal to restore the inlet shorelines to a quasi-stable point in history corresponding to the early 1980's. It is noted by the late 1980's, through the 1990's, and into the early 2000's the inlet channel and adjacent shorelines experienced significant changes (CEC, 2001; CTC and CEC, 2003). Channel infilling reduced navigational access, spit migration off Manasota Key resulted in significant erosion on the Palm Island (downdrift) shoreline, and breaching was observed both on the State Park Beach as well as the gulf-front beaches downdrift of Stump Pass.

Figure 1 presents a plan view of three shoreline positions on Manasota Key: 1982, 2003, and 2013 superimposed on the 2013 aerial photograph and the proposed beach fill plan and terminal groin. This exhibit helps to explain the basis for the UBF design and siting of the structure. An inflection in the 1982 shoreline indicates a point where the shoreline re-curves to form the south end of Manasota Key’s "drumstick". The structure was sited at the inflection point to help recreate the quasi-stable 1980's conditions north of the structure. The figure also depicts the proposed UBF concept plan. Figures 2 and 3 present historic profiles and the proposed design template at the R-monuments within the State Park Beach. A comparison of the historic profiles indicates that the 2013 beach is wider and higher compared to the 1982 conditions north of R-19. Thus the north end of the proposed fill begins at R-19 and extends south to the structure with the goal to restore the 1980's shoreline position.

Figure 1. Comparisons of Historic Shorelines on South End of Manasota Key.

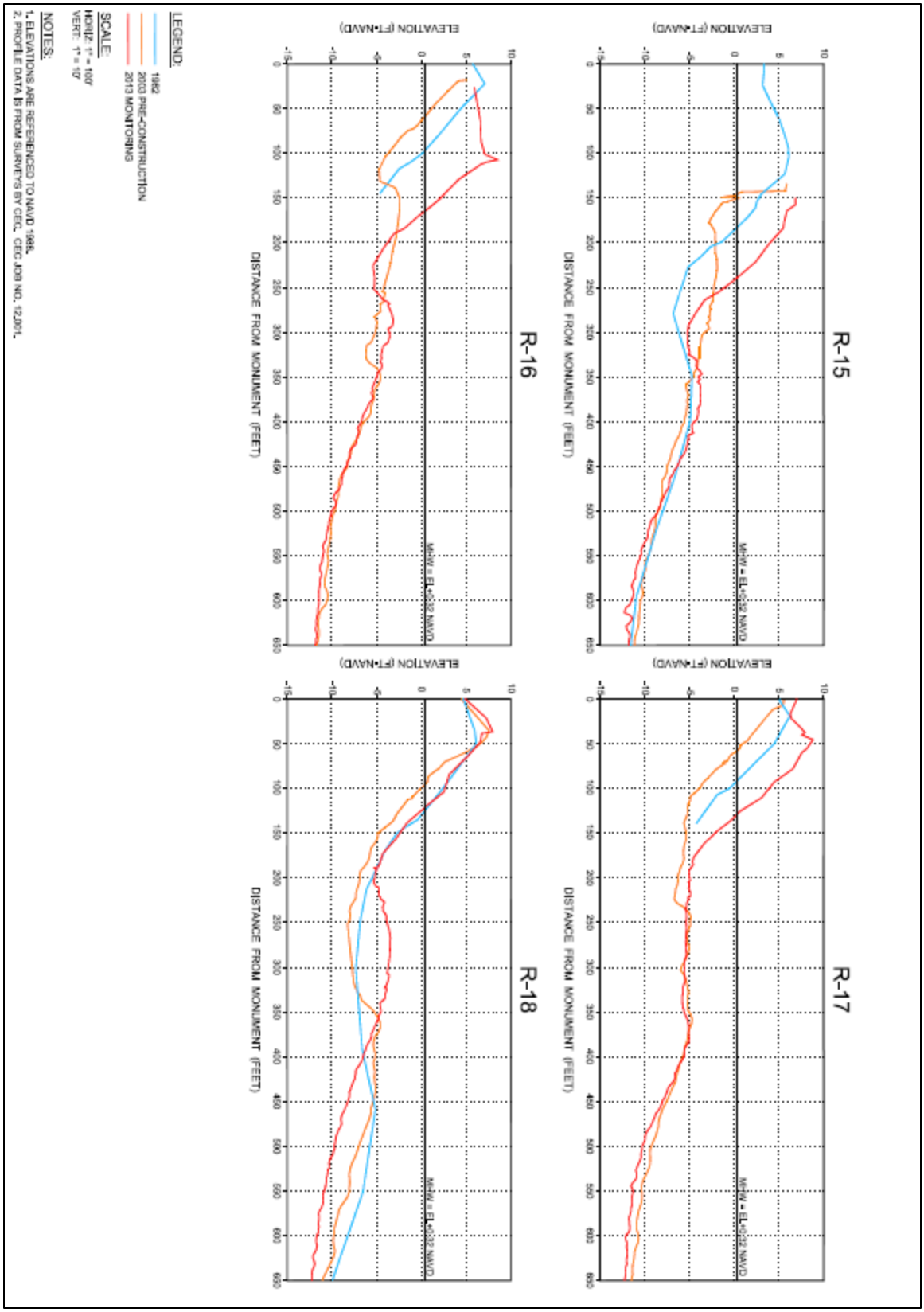

Figure 2. Comparisons of Historic Profiles on South End of Manasota Key, R-15 through R-18.

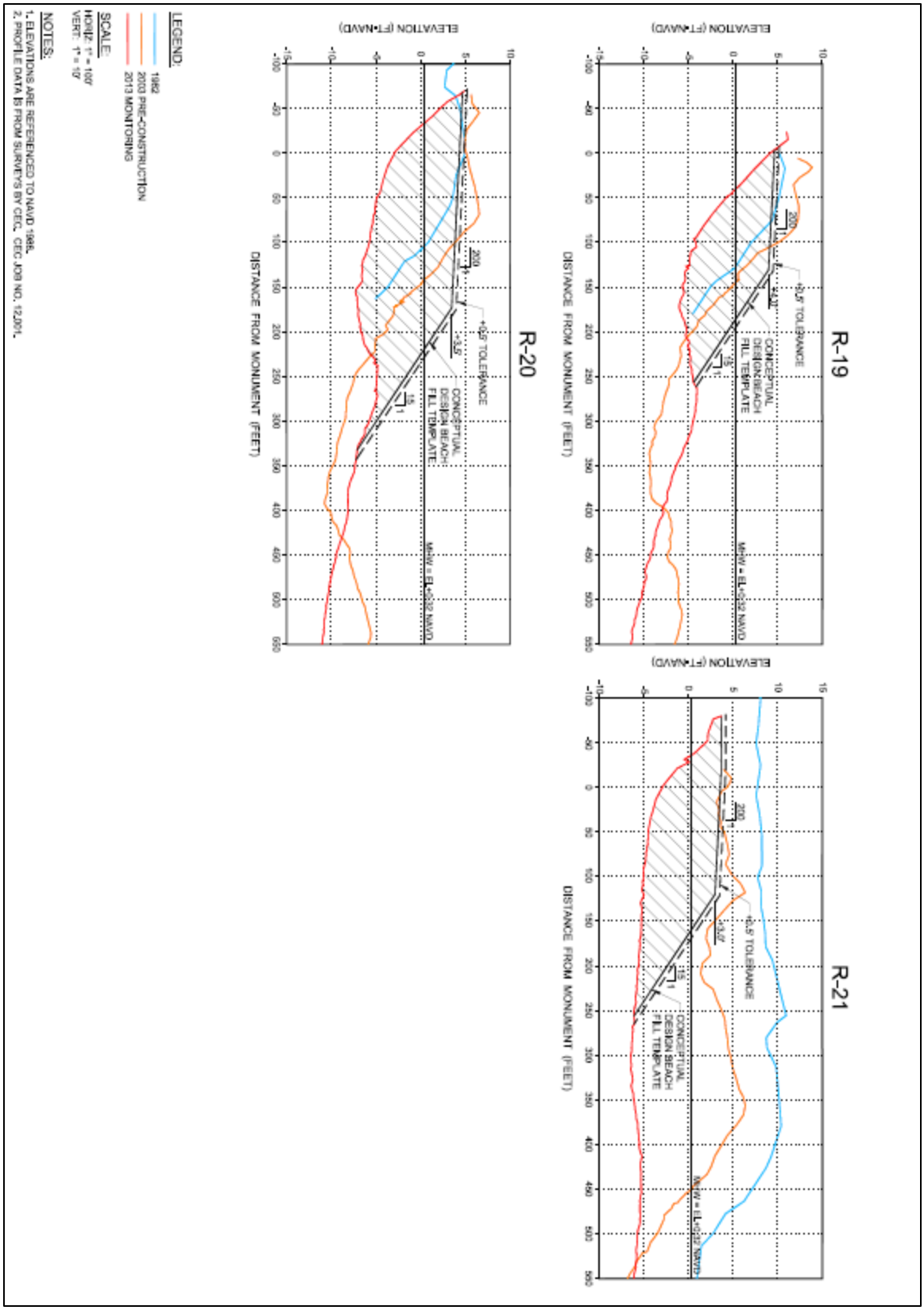

Figure 3. Comparisons of Historic Profiles on South End of Manasota Key, R-19 through R-21.

2.2. Modeling

Alternative 1 includes an impermeable terminal groin extending 400 feet seaward of the Mean High Water (MHW) with a crest elevation of +4 feet North American Vertical Datum of 1988 (NAVD88). It was sited on the southern end of Manasota Key, approximately 250 feet south of R-21 (Figure 4), at the terminus of the proposed beach fill.

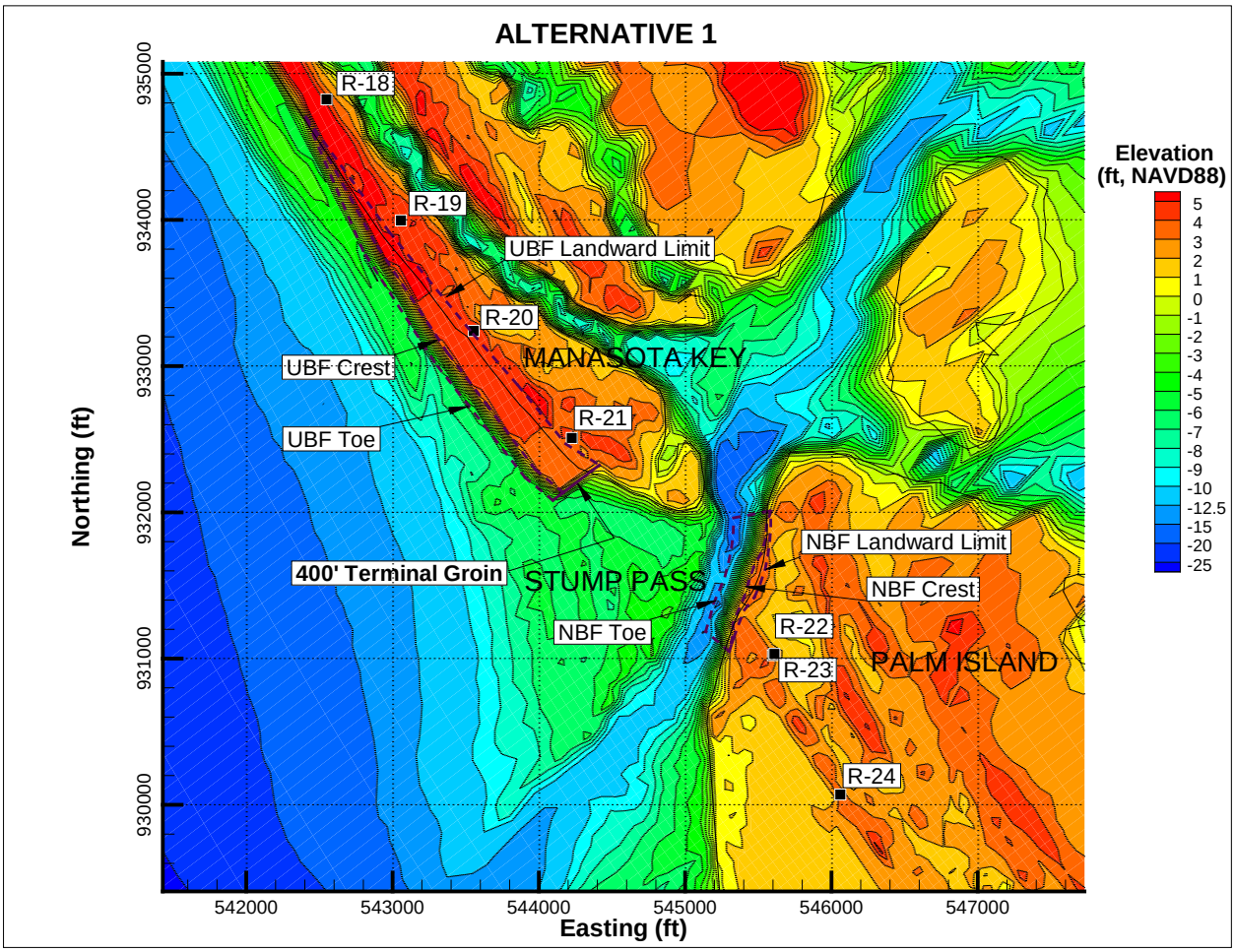

Figure 4. Alternative 1: 400-foot Long Impermeable Terminal Groin on South End of Manasota Key Concept Plan (CEC, 2013).

3. Additional Numerical Modeling

3.1. Development of Additional Alternatives

To address the State Park concerns, the County had the Consulting Team perform additional numerical modeling through various modifications of the terminal groin in Alternative 1 including its length, crest height, location, permeability, and orientation. A total of seven (7) additional alternatives, 1A through 1G, were developed, modeled, analyzed, and evaluated using the same evaluation methodology presented in CEC and CTC (2013).

A summary list of the seven additional alternatives modeled is presented below followed by a more detailed description of each and the modeling results:

Alternative 1A: Includes beach renourishment of the UBF, NBF, and SBF and a 600' long impermeable terminal groin with +4' NAVD88 crest

Alternative 1B: Includes beach renourishment of the UBF, NBF, and SBF and a 400' long impermeable terminal groin with +4' NAVD88 crest shifted 250' south compared to Alternative 1

Alternative 1C: Includes beach renourishment of the UBF, NBF, and SBF and a 400' long impermeable terminal groin with +4' NAVD88 crest shifted 500' south compared to Alternative 1

Alternative 1D: Includes beach renourishment of the UBF, NBF, and SBF and a 400' long impermeable terminal groin with +4' NAVD88 crest having a 45-deg shift in orientation compared to Alternative 1

Alternative 1E: Includes beach renourishment of the UBF, NBF, and SBF and a 400' long permeable terminal groin with +4' NAVD88 crest and 20% permeability

Alternative 1F: Includes beach renourishment of the UBF, NBF, and SBF and a 400' long permeable terminal groin with +4' NAVD88 crest and 40% permeability

Alternative 1G: Includes beach renourishment of the UBF, NBF, and SBF and a 400' long impermeable terminal groin with +2.5' NAVD88 crest

3.1.1. Alternative 1A

This alternative includes an impermeable terminal groin extending 600 feet seaward of MHW, which is 200 feet longer than the Original Alternative 1 groin, with a crest elevation of +4 feet NAVD88. It was sited on the southern end of Manasota Key, approximately 250 feet south of R-21 (Figure 5), at the terminus of the proposed beach fill. The premise for this design is to keep more sand on the updrift side of the structure and reduce shoaling of the Stump Pass channel without causing adverse impacts on the shorelines downdrift of the pass. Due to the increase in the structure's length, its cost increases by approximately 44% compared to the Original Alternative 1; however, the cost of beach fill placement remains the same.

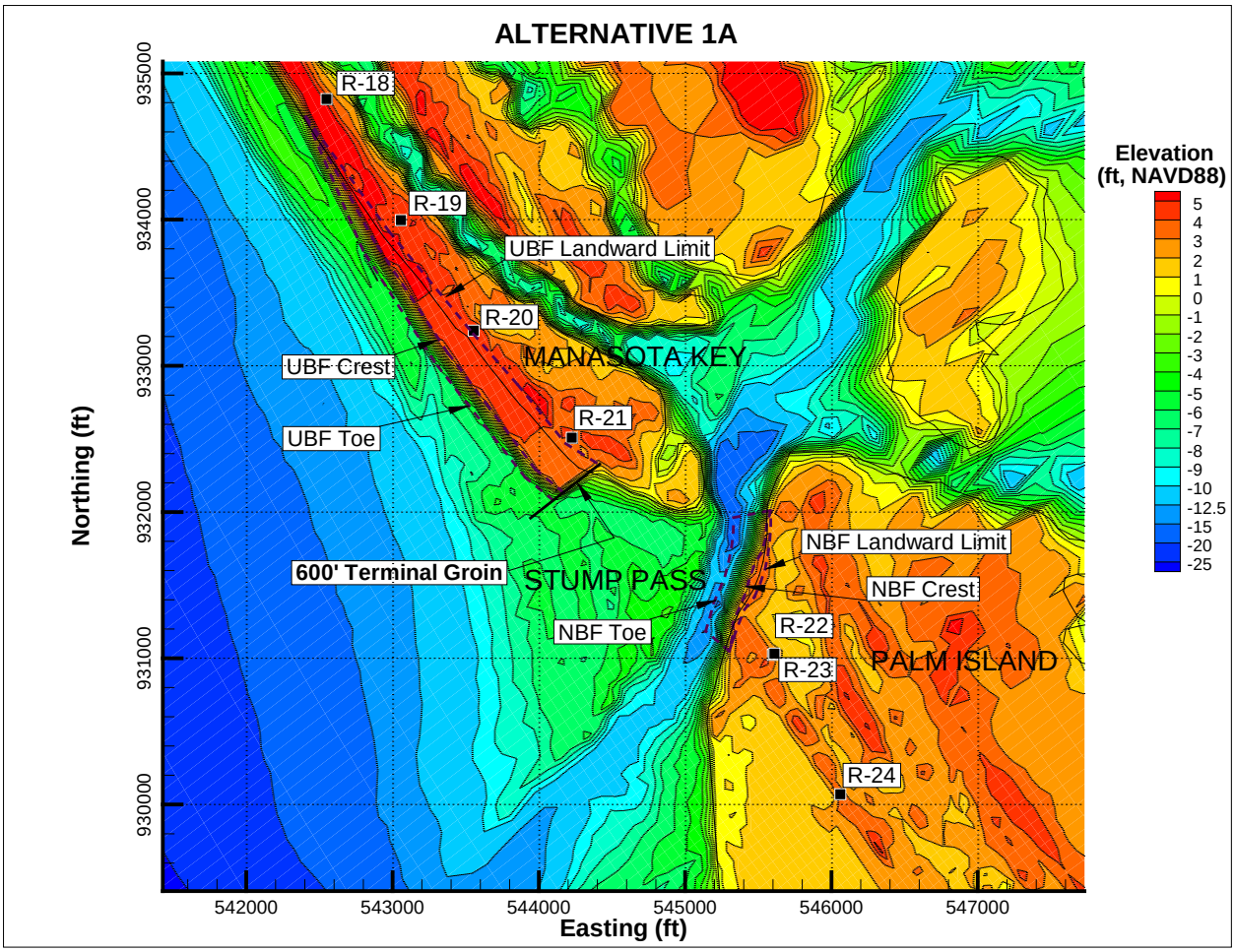

Figure 5. Alternative 1A: 600-foot Long Impermeable Terminal Groin on South End of Manasota Key Concept Plan (200 feet longer compared to Original Alternative 1).

3.1.2. Alternative 1B

This alternative includes an impermeable terminal groin extending 400 feet seaward of MHW with a crest elevation of +4 feet NAVD88. It was sited on the southern end of Manasota Key, approximately 500 feet south of R-21, equivalent to a 250-foot shift to the south compared to the Original Alternative 1 groin (Figure 6), at the terminus of the proposed beach fill. The premise for this design is to extend and maintain the beach further south and assess potential impacts to the inlet and the downdrift shorelines (Palm, Knight, and Don Pedro Islands) from the structure shift. Due to the increase in the updrift beach fill limits and thus fill volume, the cost of sand placement and renourishment increases by approximately 4% compared to the Original Alternative 1, however, the cost of the terminal groin remains the same.

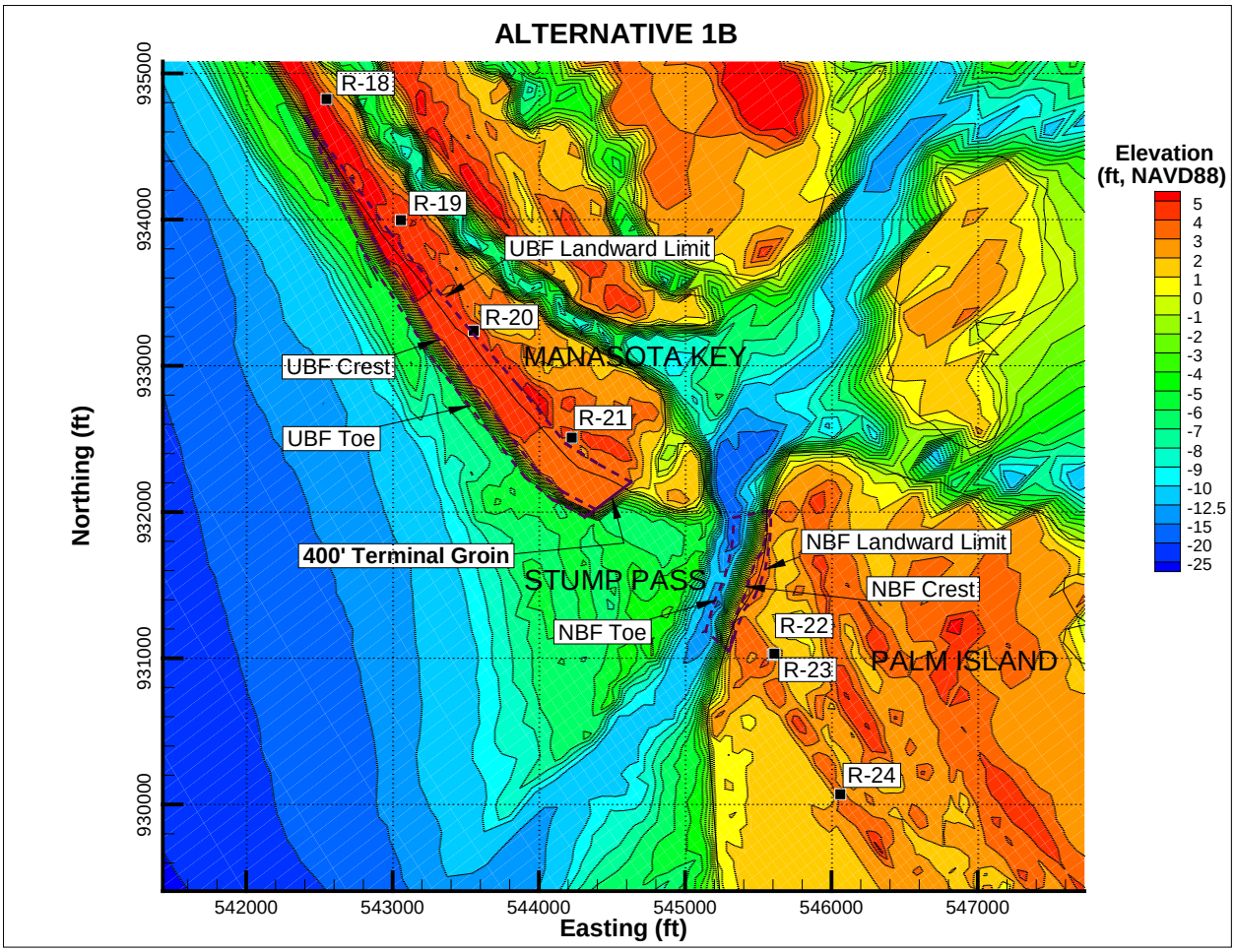

Figure 6. Alternative 1B: 400-foot Long Impermeable Terminal Groin on South End of Manasota Key Concept Plan (shifted south 250 feet compared to Original Alternative 1).

3.1.3. Alternative 1C

This alternative includes an impermeable terminal groin extending 400 feet seaward of MHW with a crest elevation of +4 feet NAVD88. It was sited on the southern end of Manasota Key, approximately 750 feet south of R-21, equivalent to a 500-foot shift to the south compared to the Original Alternative 1 groin (Figure 7), at the terminus of the proposed beach fill. The premise for this design is to extend and maintain the beach further south and assess potential impacts to the inlet and the downdrift shorelines (Palm, Knight, and Don Pedro Islands) from the structure shift. Due to the increase in the updrift beach fill limits and thus fill volume, the cost of sand placement and renourishment increases by approximately 8% compared to the Original Alternative 1, however, the cost of the terminal groin remains the same.

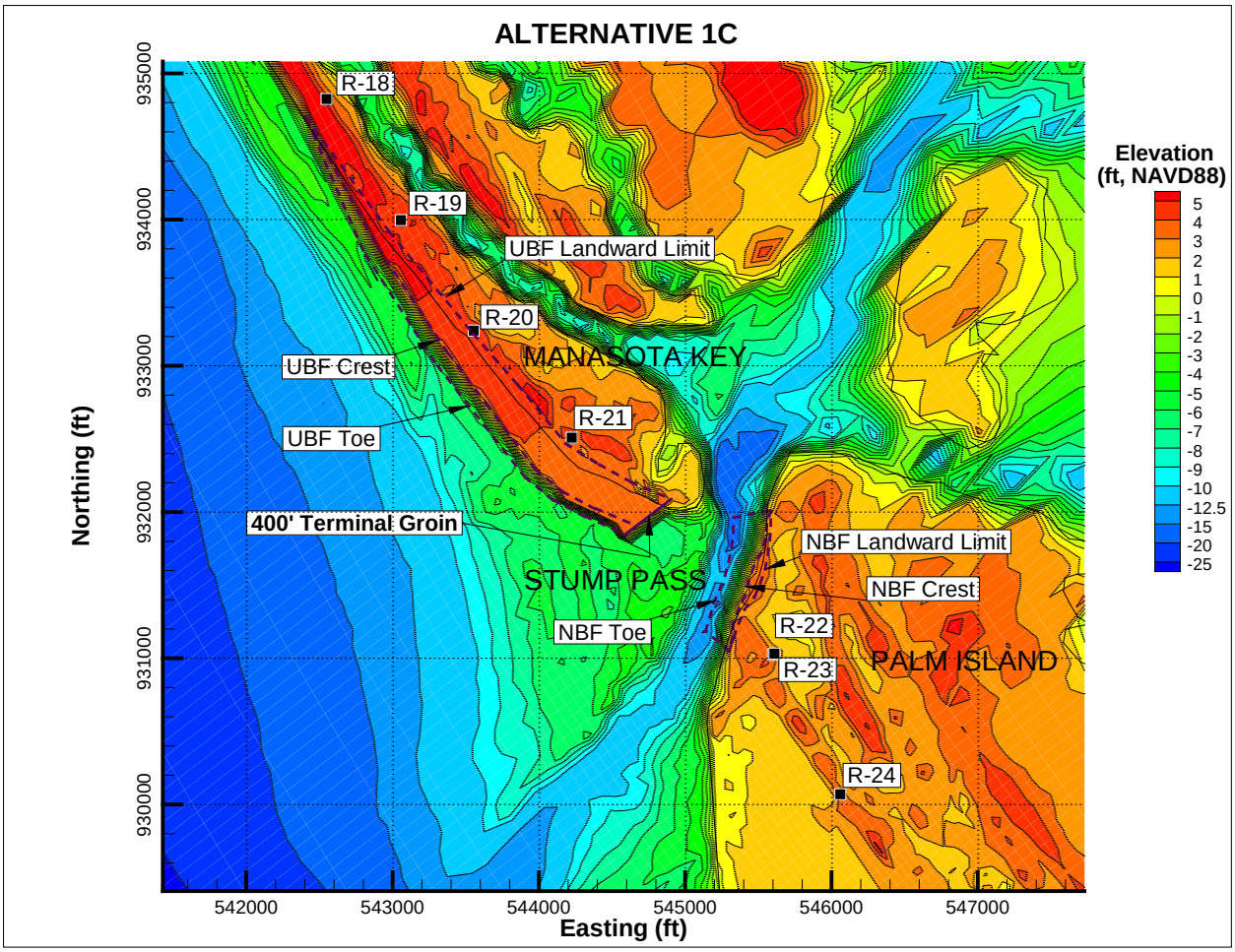

Figure 7. Alternative 1C: 400-foot Long Impermeable Terminal Groin on South End of Manasota Key Concept Plan (shifted south 500 feet compared to Original Alternative 1).

3.1.4. Alternative 1D

This alternative includes an impermeable terminal groin extending 400 feet seaward of MHW with a crest elevation of +4 feet NAVD88. It was sited on the southern end of Manasota Key, approximately 250 feet south of R-21, and rotated about the shoreline approximately 45° compared to the Original Alternative 1 groin (Figure 8), at the terminus of the proposed beach fill. The premise for this design is to determine through numerical modeling whether the change in the groin's orientation would mitigate downdrift effects to the south of the structure. The reorientation was aligned more closely to the alignment of the Stump Pass channel dredge template (i.e., 2003 – 2011 Primary Borrow Area). Due to the increase in the updrift beach fill limits and thus fill volume, the cost of sand placement and renourishment increases by approximately 3% compared to the Original Alternative 1, however, the cost of the terminal groin remains the same.

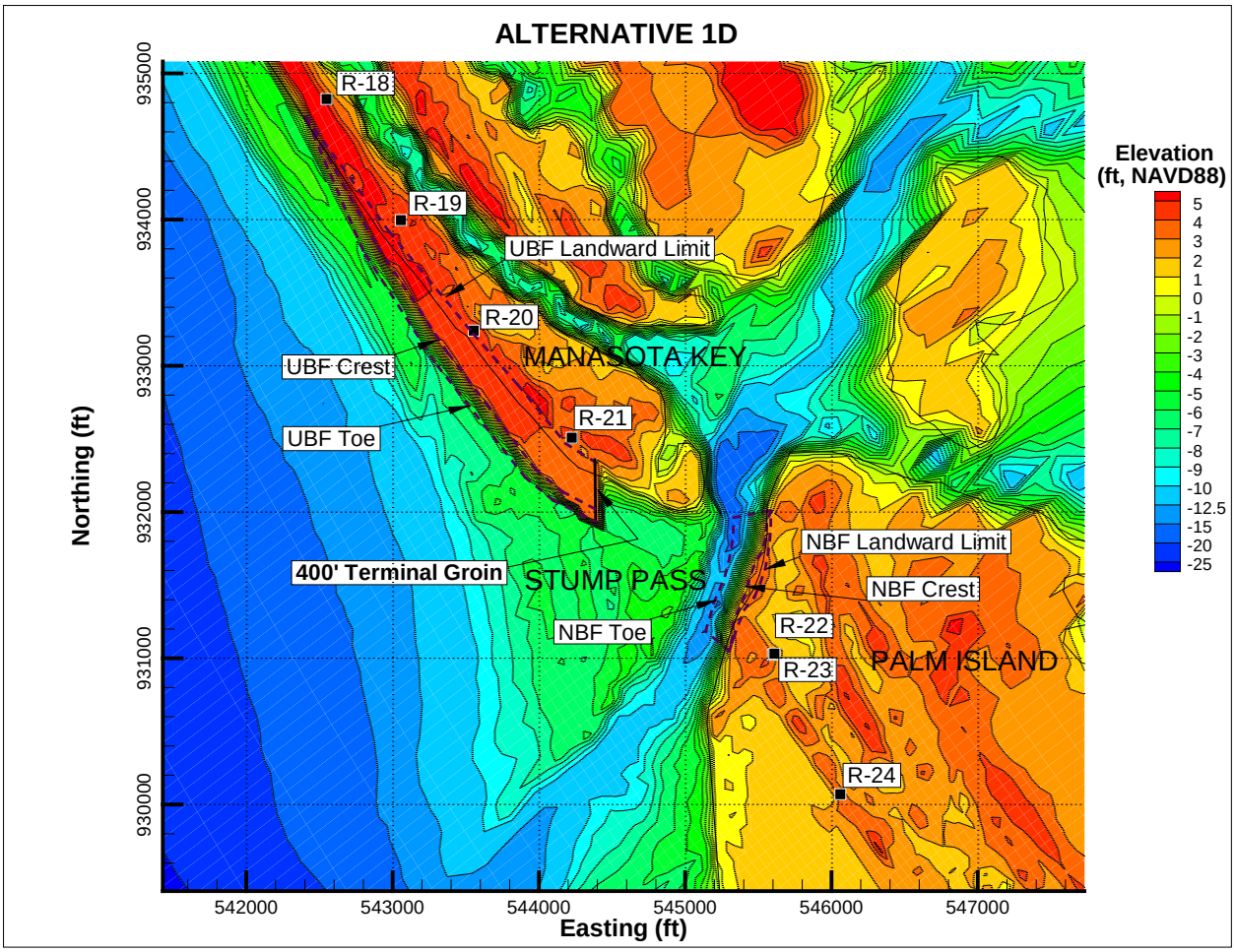

Figure 8. Alternative 1D: 400-foot Long Impermeable Terminal Groin on South End of Manasota Key Concept Plan (45-degree shift in orientation compared to Original Alternative 1).

3.1.5. Alternative 1E

This alternative includes a permeable terminal groin extending 400 feet seaward of MHW with a crest elevation of +4 feet NAVD88. It was sited on the southern end of Manasota Key, approximately 250 feet south of R-21 (Figure 9), at the terminus of the proposed beach fill. The groin's permeability is 20% compared to 0% permeability of the impermeable groin in the Original Alternative 1. The premise for this design is to allow sand bypassing through the permeable groin to reduce the impact immediately downdrift of the structure (on Manasota Key). Due to the decrease in the structure's materials, its cost also decreases by approximately 7% compared to the Original Alternative 1; however, the cost of beach fill placement remains the same. The groin's permeability was implemented in the Delft3D model through the use of the porous plate feature (Deltares, 2011). This feature was used in CEC and CTC (2013) to model Alternative 2 which included a permeable groin field.

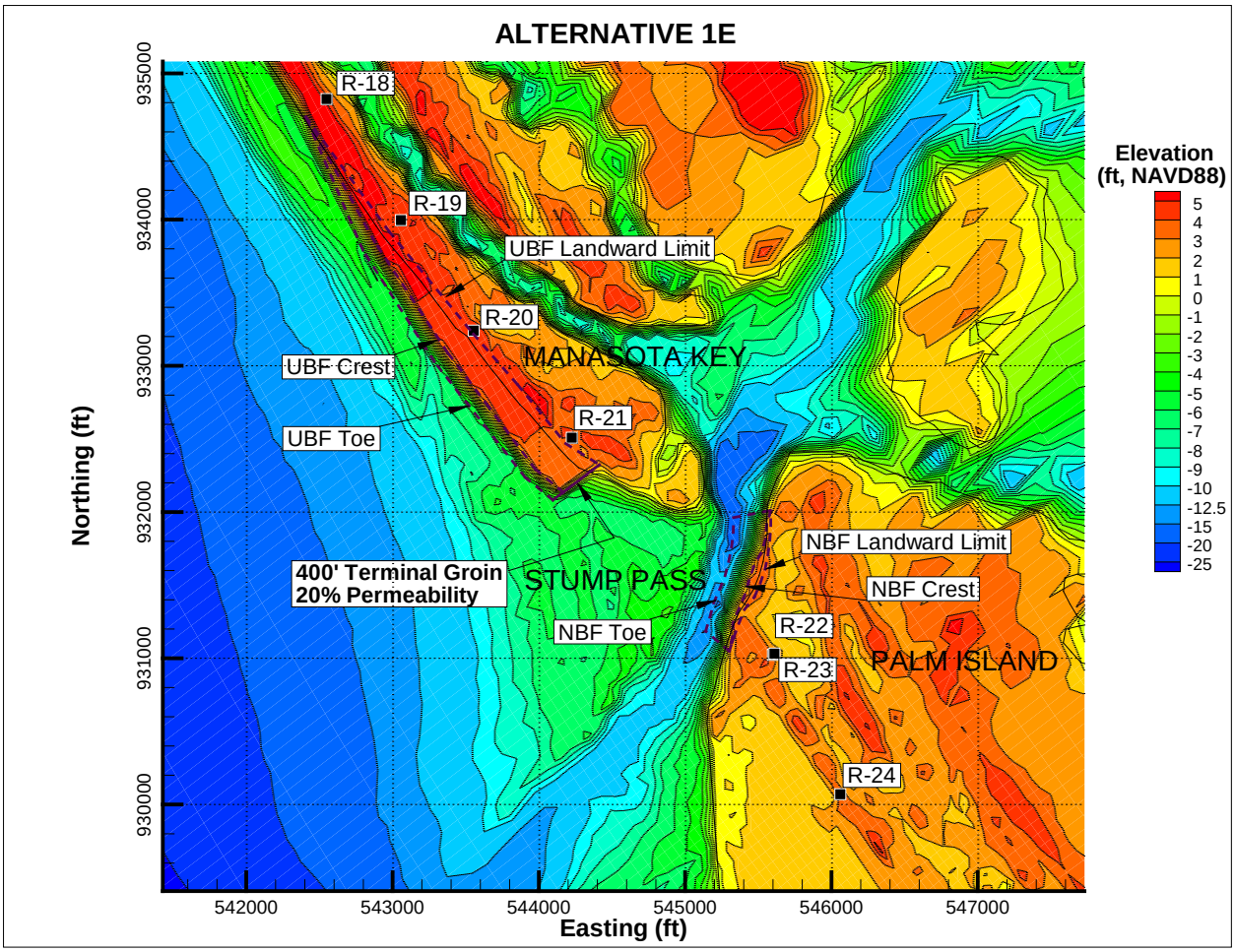

Figure 9. Alternative 1E: 400-foot Long Permeable Terminal Groin on South End of Manasota Key Concept Plan (20% permeability compared to Original Alternative 1).

3.1.6. Alternative 1F

This alternative includes a permeable terminal groin extending 400 feet seaward of MHW with a crest elevation of +4 feet NAVD88. It was sited on the southern end of Manasota Key, approximately 250 feet south of R-21 (Figure 10), at the terminus of the proposed beach fill. The groin's permeability is 40% compared to 0% permeability of the impermeable groin in the Original Alternative 1 and 20% permeability in Alternative 1E. The premise for this design is to allow more sand bypassing through the permeable groin to reduce the impact immediately downdrift of the structure (on Manasota Key). Due to the decrease in the structure's materials, its cost decreases by approximately 14% compared to the Original Alternative 1; however, the cost of beach fill placement remains the same.

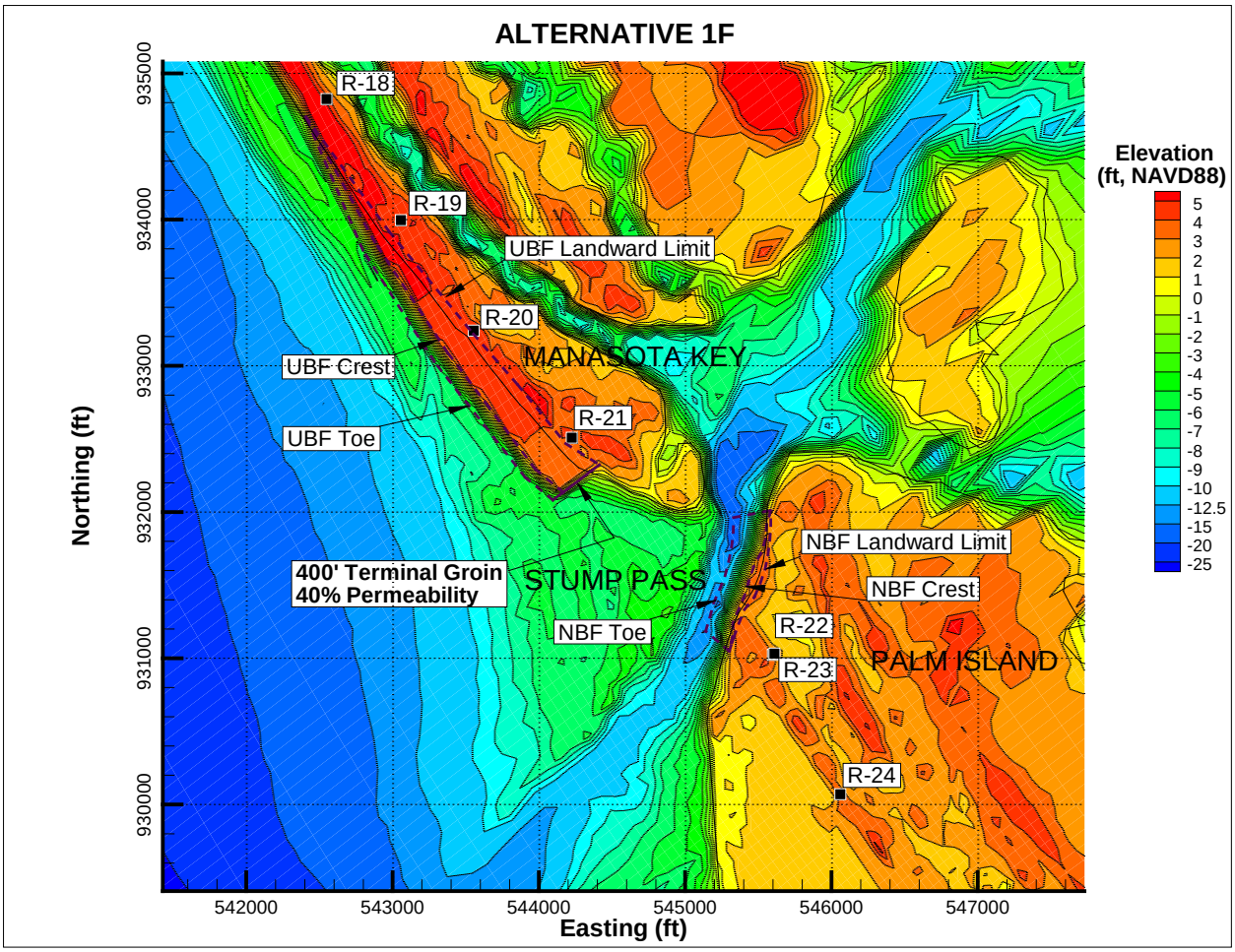

Figure 10. Alternative 1F: 400-foot Long Permeable Terminal Groin on South End of Manasota Key Concept Plan (40% permeability compared to Original Alternative 1).

3.1.7. Alternative 1G

This alternative includes an impermeable terminal groin extending 400 feet seaward of MHW, with a crest elevation of +2.5 feet NAVD88, which is 1.5 feet lower compared to the Original Alternative 1. It was sited on the southern end of Manasota Key, approximately 250 feet south of R-21 (Figure 10), at the terminus of the proposed beach fill. The premise for this design is to allow sand bypassing over the lower groin to reduce the impact immediately downdrift of the structure (on Manasota Key). Due to the decrease in the structure's crest elevation, its cost decreases by approximately 9% compared to the Original Alternative 1, and the cost of beach fill placement also slightly decreases by approximately 1% because the updrift fill is tapered to the lower elevation at the terminal groin.

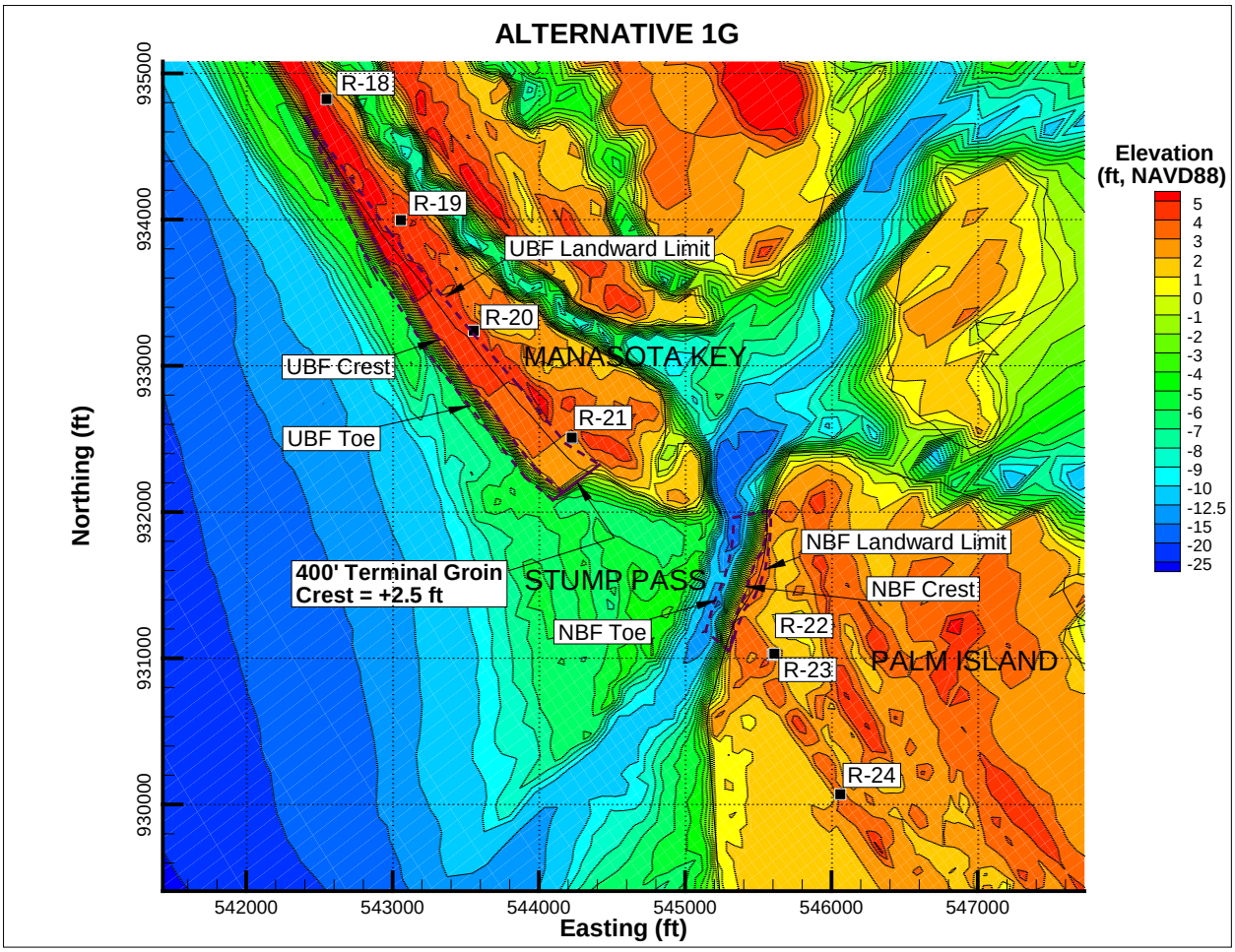

Figure 11. Alternative 1G: 400-foot Long Impermeable Terminal Groin on South End of Manasota Key Concept Plan (1.5-foot lower groin crest elevation compared to Original Alternative 1).

3.2. Additional Alternatives Analysis

Alternatives 1A through 1G were simulated using the Delft3D model for the same 4-year period used to model Alternative 1 in CEC and CTC (2013). Alternative 1 was used as a baseline alternative to which model results of Alternatives 1A through 1G were compared. The objectives of the simulations were:

1) Predict bathymetric and shoreline changes, beach fill diffusion, and sediment transport response to the measures; and
2) Qualitatively evaluate the expected performance, advantages, and disadvantages of Alternatives 1A through 1G over Alternative 1.

3.2.1. Morphology Change Analysis

Alternative 1A vs. Alternative 1 (Longer Terminal Groin)

Figure 12 presents the comparison of differences in morphologic elevations between Alternatives 1 and 1A at the end of the 4-year simulation. This comparison was created by subtracting the modeled Alternative 1 surface from that of Alternative 1A. Yellow/red colors indicate higher elevations for Alternative 1A, and blue/cyan colors indicate higher elevations for Alternative 1. Blank color indicates no changes or insignificant changes not exceeding 0.1 feet.

As expected, the longer terminal groin in Alternative 1A retained more sand on the updrift/north side of the structure and reduced shoaling of the channel. However, the results indicate reduced bypassing of sand immediately downdrift of the structure on Manasota Key compared to Alternative 1 resulting in more impact on the south end of Manasota Key. On the north end of Palm Island, the effect of Alternative 1A was positive compared to Alternative 1 as more sand was retained within the NBF.

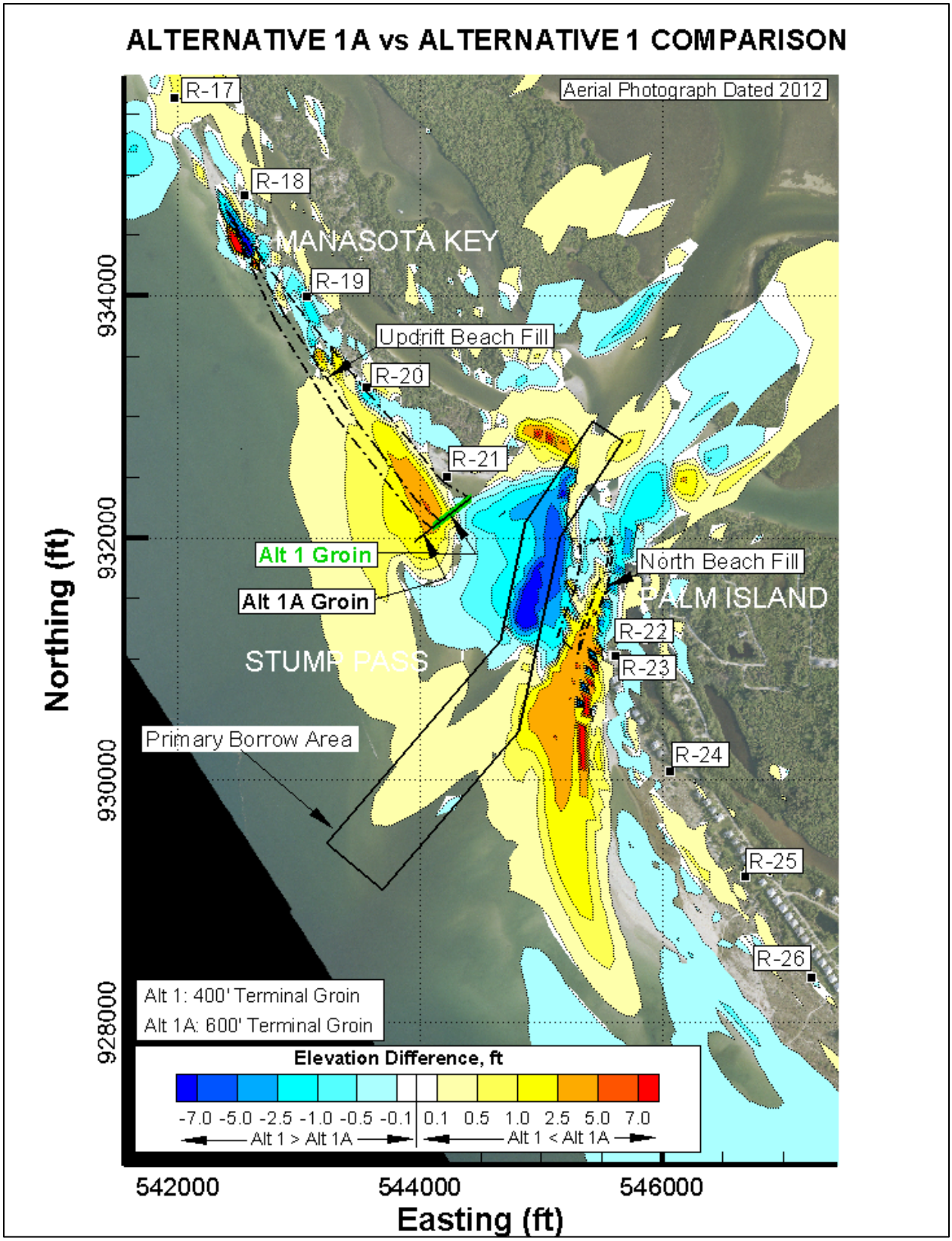

Figure 12. Alternative 1A vs. Alternative 1 Morphologic Change Comparison.

Alternative 1B vs. Alternative 1 (Terminal Groin Shifted South 250 Feet)

Figure 13 presents the comparison of differences in morphologic elevations between Alternatives 1 and 1B at the end of the 4-year simulation. Yellow/red colors indicate higher elevations for Alternative 1B, and blue/cyan colors indicate higher elevations for Alternative 1.

The terminal groin shifted south in Alternative 1B retained more sand immediately north of the shifted structure, however, it retained less sand further north within the UBF. The results also indicate increased bypassing of sand immediately downdrift of the structure compared to Alternative 1 resulting in less impact on the south end of Manasota Key. However, on Palm Island, the effect of Alternative 1B was negative compared to Alternative 1 as less sand was retained within the NBF.

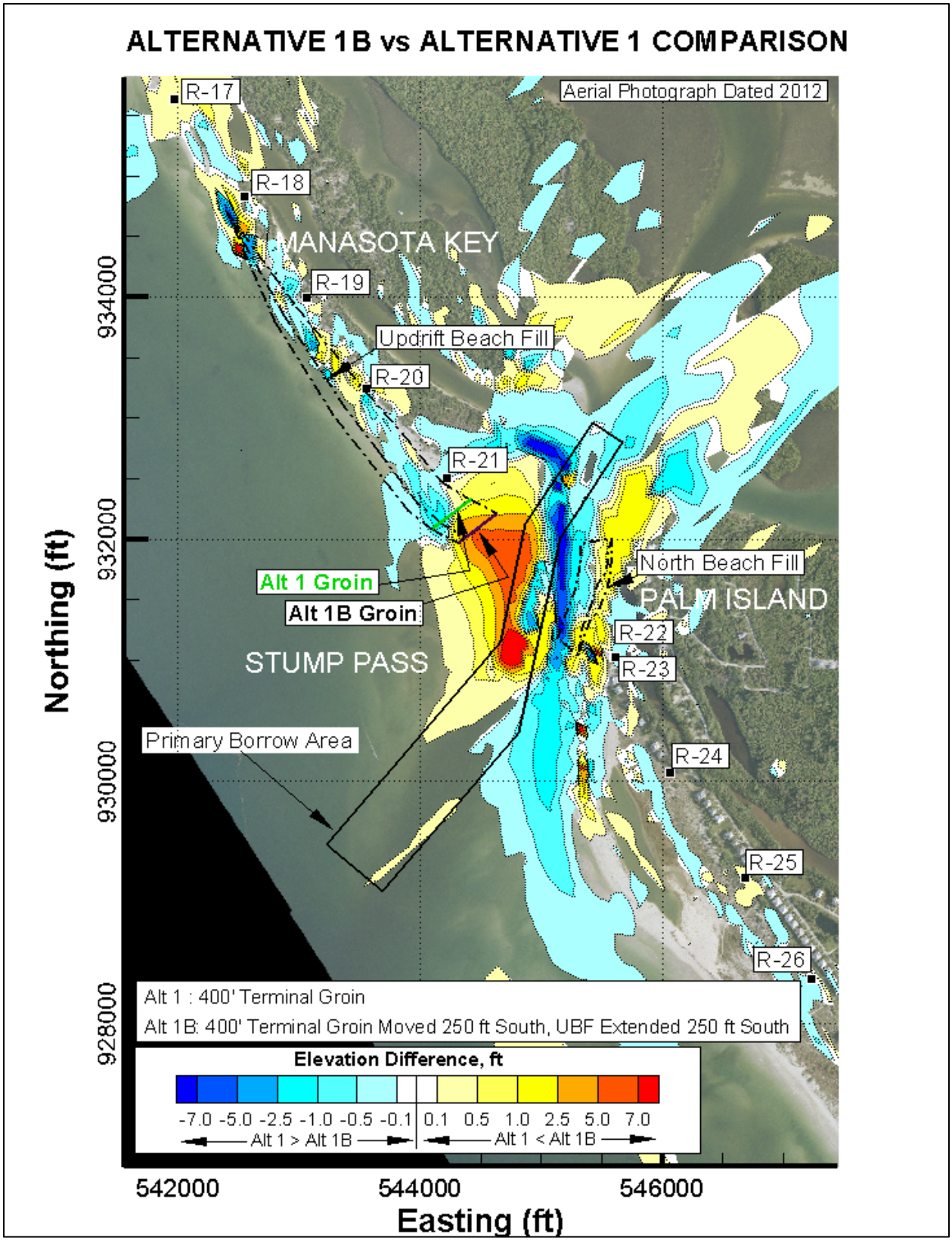

Figure 13. Alternative 1B vs. Alternative 1 Morphologic Change Comparison.

Alternative 1C vs. Alternative 1 (Terminal Groin Shifted South 500 Feet)

Figure 14 presents the comparison of differences in morphologic elevations between Alternatives 1 and 1C at the end of the 4-year simulation. Yellow/red colors indicate higher elevations for Alternative 1C, and blue/cyan colors indicate higher elevations for Alternative 1.

The terminal groin shifted further south in Alternative 1C retained more sand immediately north of the shifted structure, however, it retained less sand further north within the UBF. The results also indicate increased bypassing of sand immediately downdrift of the structure compared to Alternative 1 resulting in less impact on the south end of Manasota Key. However, on the north end of Palm Island, the effect of Alternative 1C was negative compared to Alternative 1 as less sand was retained within the NBF.

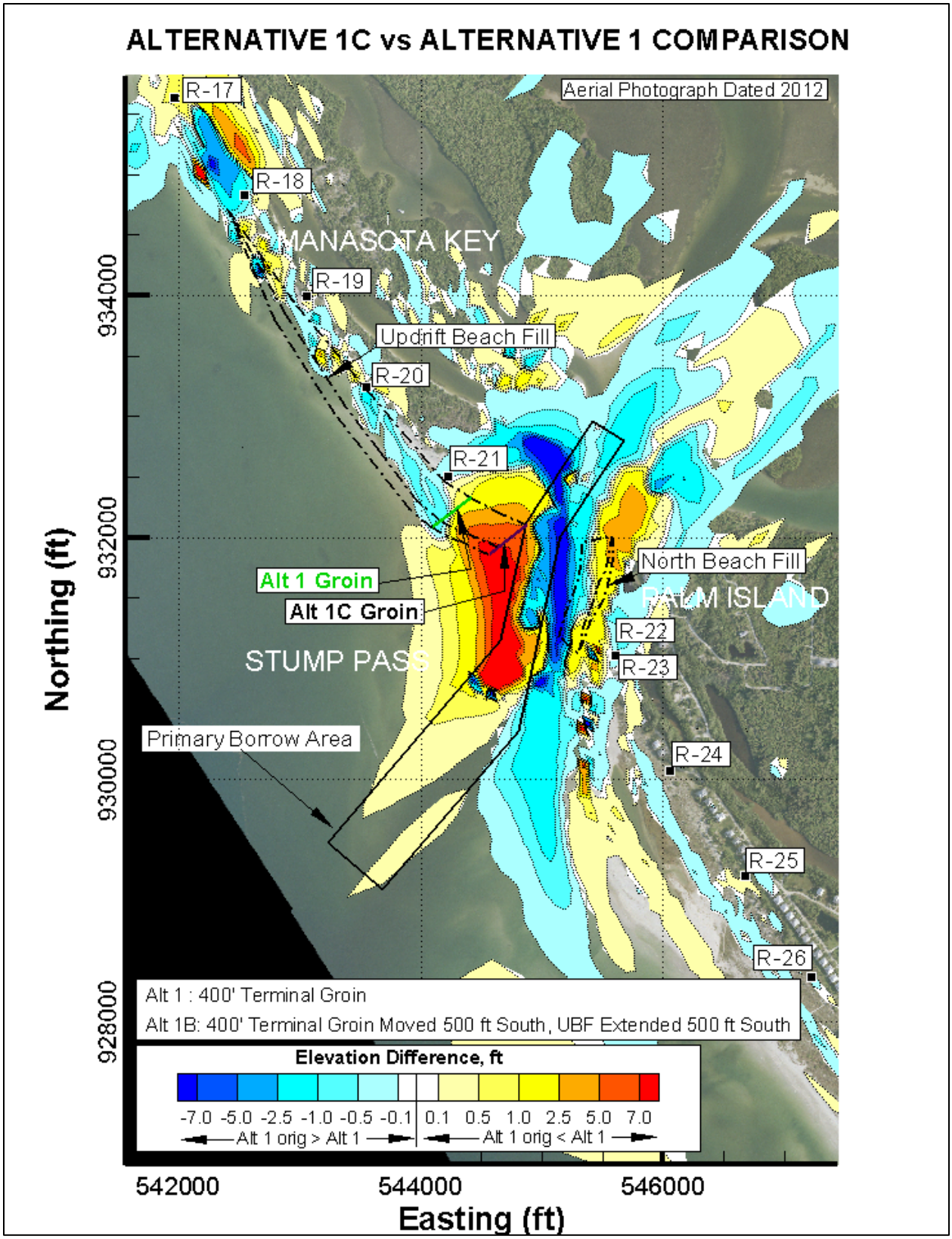

Figure 14. Alternative 1C vs. Alternative 1 Morphologic Change Comparison.

Alternative 1D vs. Alternative 1 (Oblique Terminal Groin)

Figure 15 presents the comparison of differences in morphologic elevations between Alternatives 1 and 1D at the end of the 4-year simulation. Yellow/red colors indicate higher elevations for Alternative 1D, and blue/cyan colors indicate higher elevations for Alternative 1.

The oblique terminal groin in Alternative 1D rotated approximately 45° compared to Alternative 1 retained more sand immediately north of the structure, however, it retained less sand further north within the UBF. The results also indicate increased bypassing of sand immediately downdrift of the structure compared to Alternative 1 resulting in less impact on the south end of Manasota Key. However, on the north end of Palm Island, the effect of Alternative 1D was negative compared to Alternative 1 as less sand was retained within the NBF.

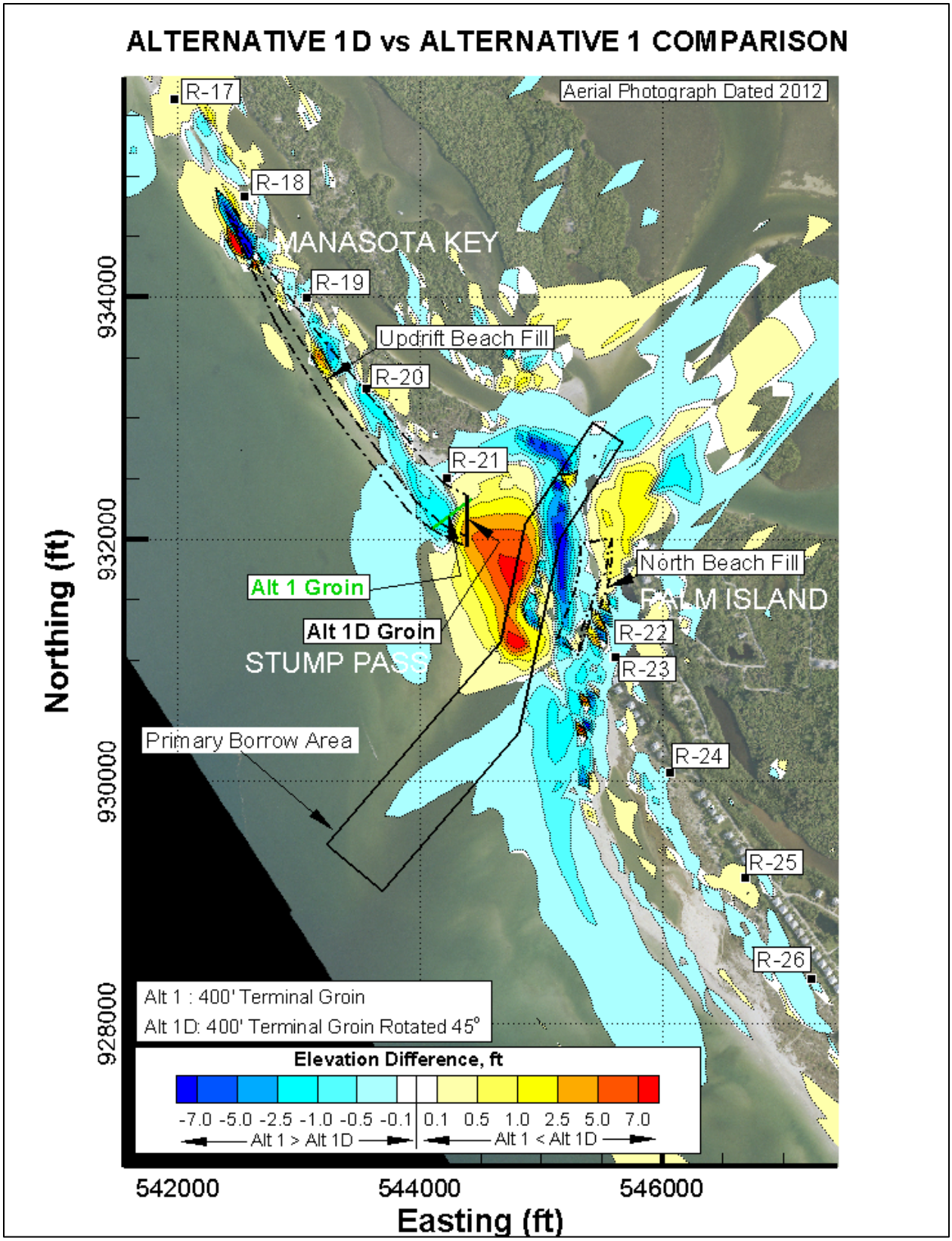

Figure 15. Alternative 1D vs. Alternative 1 Morphologic Change Comparison.

Alternative 1E vs. Alternative 1 (Permeable Terminal Groin with 20% Permeability)

Figure 16 presents the comparison of differences in morphologic elevations between Alternatives 1 and 1E at the end of the 4-year simulation. Yellow/red colors indicate higher elevations for Alternative 1E, and blue/cyan colors indicate higher elevations for Alternative 1.

As expected, the permeable terminal groin in Alternative 1E allowed more bypassing of sand to the downdrift side of the structure on Manasota Key's south end. Other changes within the inlet including the north side of Palm Island were not significant.

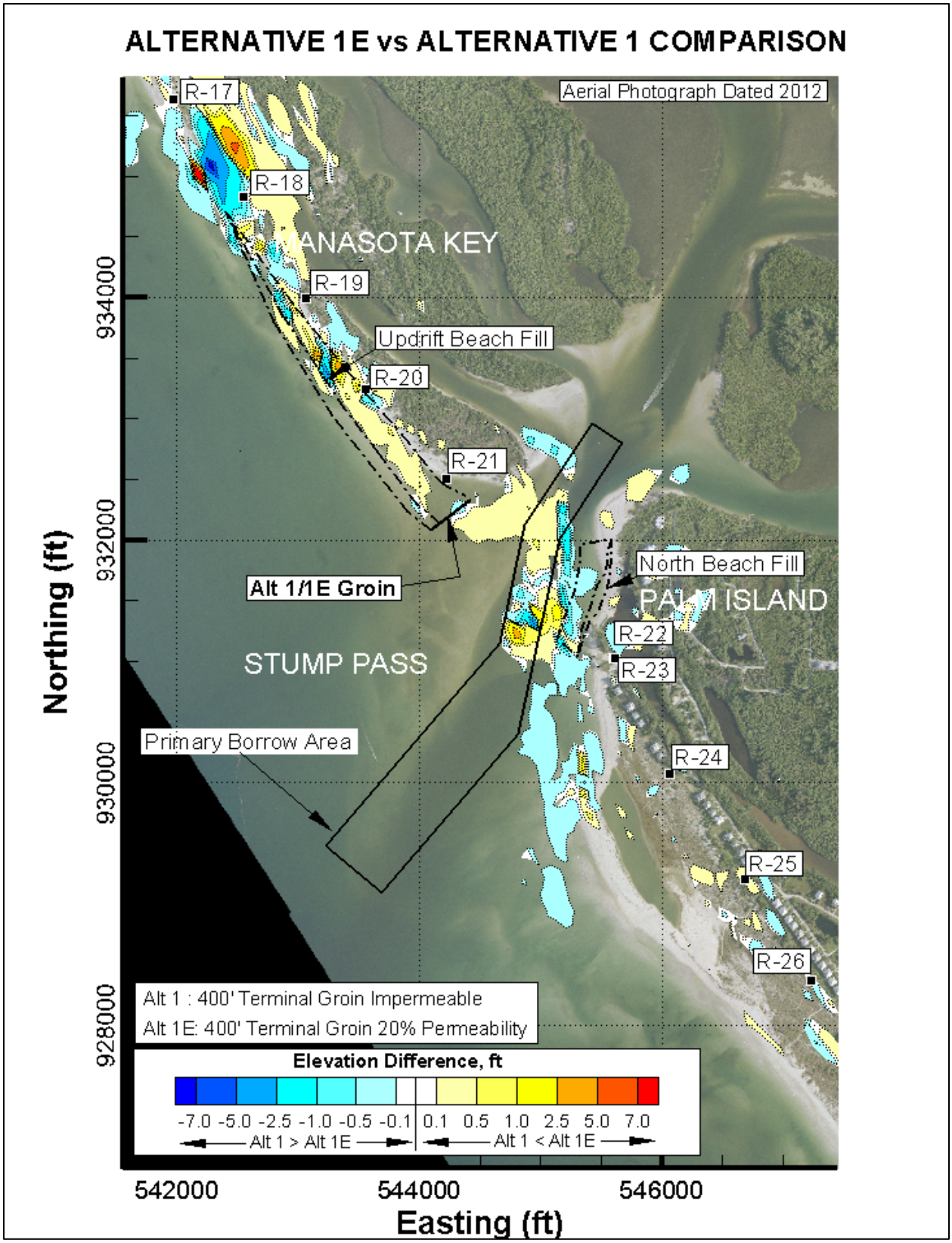

Figure 16. Alternative 1E vs. Alternative 1 Morphologic Change Comparison.

Alternative 1F vs. Alternative 1 (Permeable Terminal Groin with 40% Permeability)

Figure 17 presents the comparison of differences in morphologic elevations between Alternatives 1 and 1F at the end of the 4-year simulation. Yellow/red colors indicate higher elevations for Alternative 1F, and blue/cyan colors indicate higher elevations for Alternative 1.

As expected, the permeable terminal groin in Alternative 1F allowed bypassing of sand to the downdrift side of the structure on Manasota Key's south end and into the channel. Compared to Alternative 1E with lower groin permeability, Alternative 1F resulted in more bypassing. Changes on the north end of Palm Island were both positive (on the inland side of the NBF limits) and negative (on the gulfward side of the NBF limits).

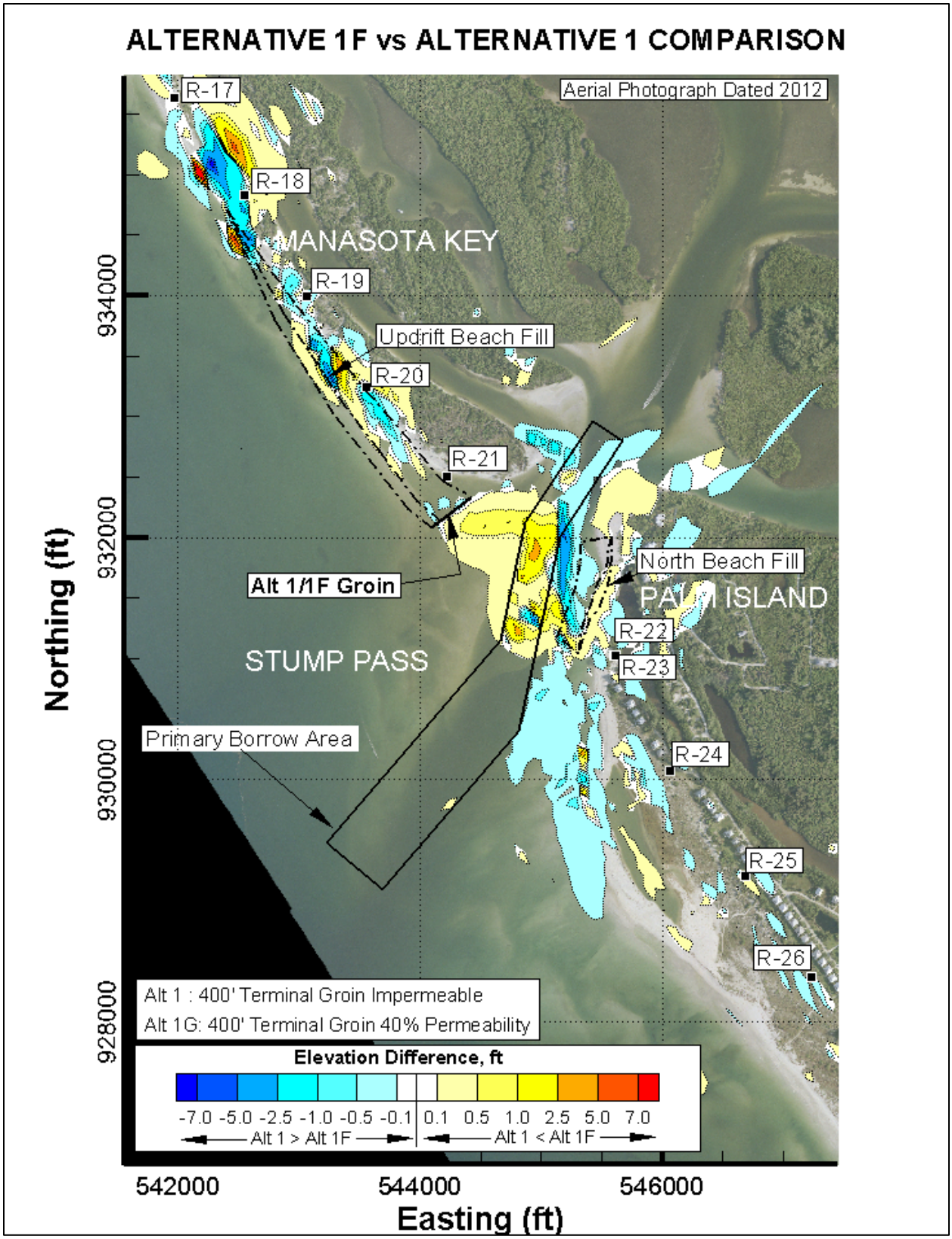

Figure 17. Alternative 1F vs. Alternative 1 Morphologic Change Comparison.

Alternative 1G vs. Alternative 1 (Lower Terminal Groin)

Figure 18 presents the comparison of differences in morphologic elevations between Alternatives 1 and 1G at the end of the 4-year simulation. Yellow/red colors indicate higher elevations for Alternative 1G, and blue/cyan colors indicate higher elevations for Alternative 1.

As expected, the lower terminal groin in Alternative 1G retained less sand within the UBF limits compared to Alternative 1. While the shoreline change response appears to be more impactive, the volume change comparison indicates more bypassing of sand to the downdrift side of the structure on Manasota Key's south end. Alternative 1G decreased shoaling of the Stump Pass channel and had a positive effect on north Palm Island as more sand was retained within the NBF.

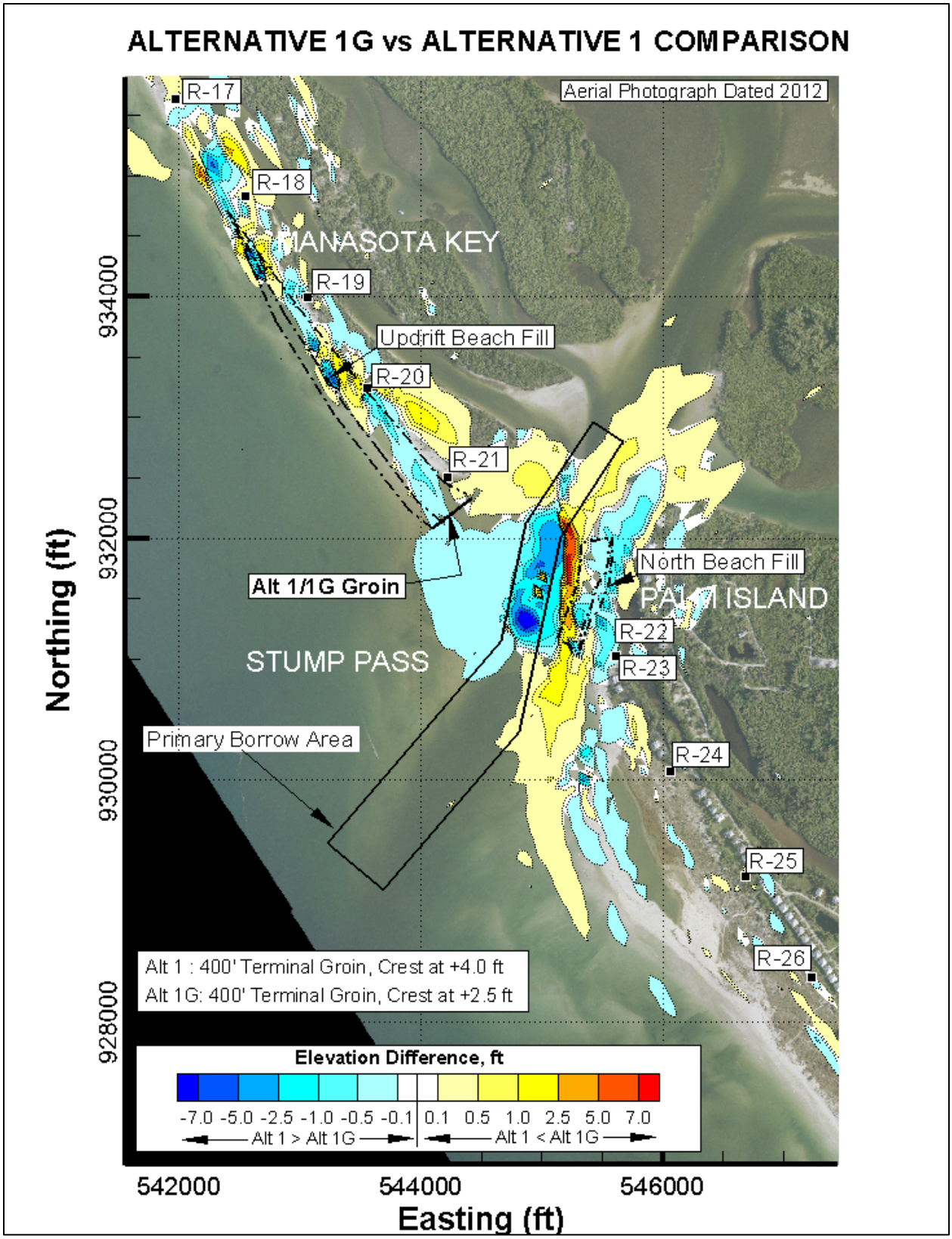

Figure 18. Alternative 1G vs. Alternative 1 Morphologic Change Comparison.

3.2.2. Shoreline Change Analysis on Manasota Key

A shoreline change analysis was performed to further evaluate effects of the alternatives immediately downdrift of the structure on Manasota Key's south end. Each of the alternatives shoreline positions at the end of the 4-year simulation were compared to their corresponding initial shoreline positions at the beginning of the simulation and differences (i.e., shoreline changes) were calculated. The shoreline changes south of R-17 are presented in Figure 19. Figure 20 presents the same graph in more detail south of R-20.

The comparison analysis indicates that Alternative 1A resulted in the most significant impact to the shoreline south of the structure predicted by the model. On the other hand, Alternative 1A was the best performing alternative on the updrift side of the groin keeping it stable and advancing it in the vicinity of the structure. Alternatives 1B, 1C, and 1D had a positive effect resulting in shoreline accretion south of the structure. These alternatives, however, did not perform as well on the updrift side of the structure as the Original Alternative 1. Alternative 1E had a similar effect updrift of the groin and a more positive effect on the south side of the structure compared to Alternative 1. Alternative 1F was similar to 1E noting some losses within the UBF due to higher permeability of the structure and had even more positive effect on the south side of the structure compared to Alternative 1. Alternative 1G had a similar effect updrift of the groin but more of an impact on the south side of the structure compared to Alternative 1 based on shoreline response.

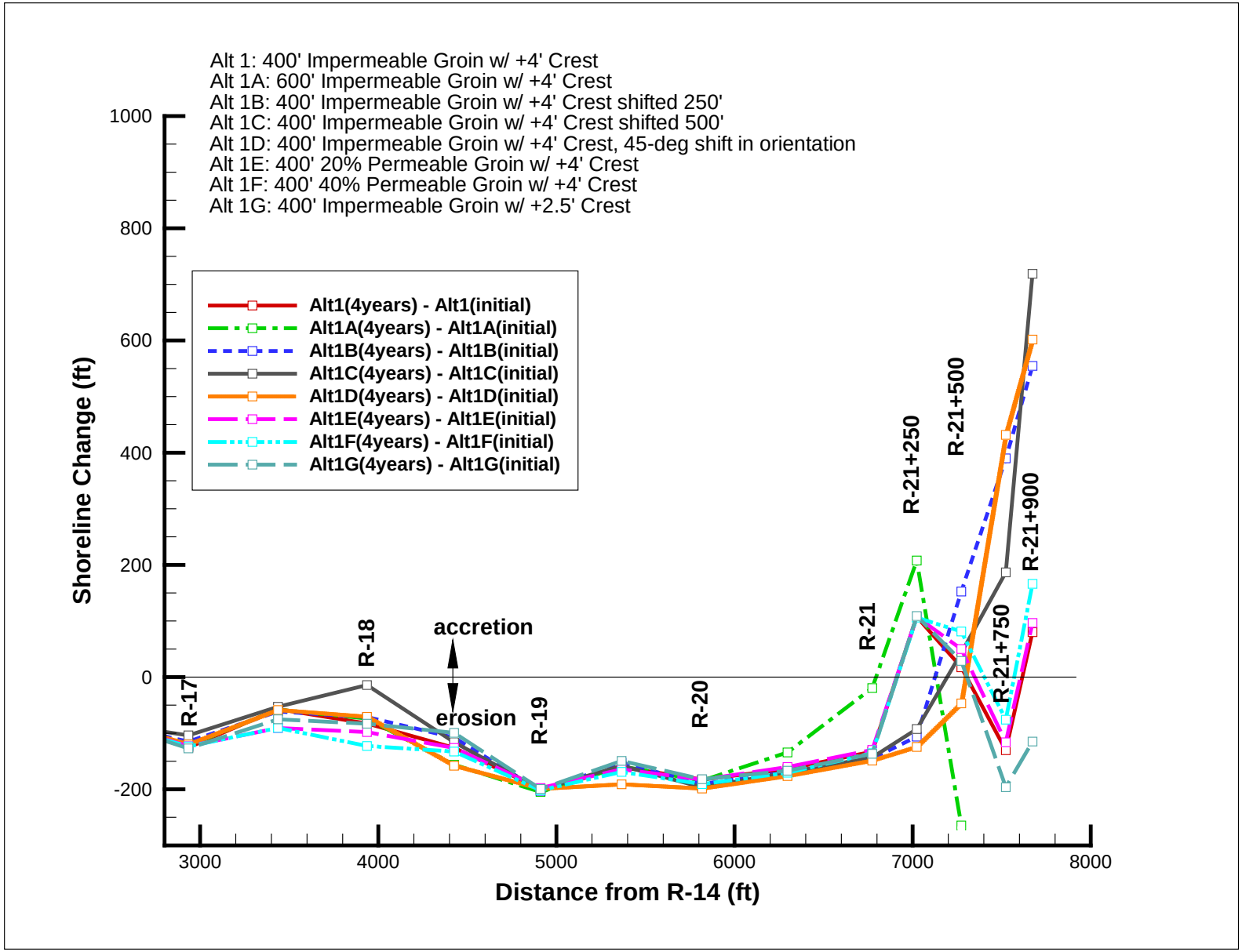

Figure 19. Alternatives Shoreline Changes South of R-17.

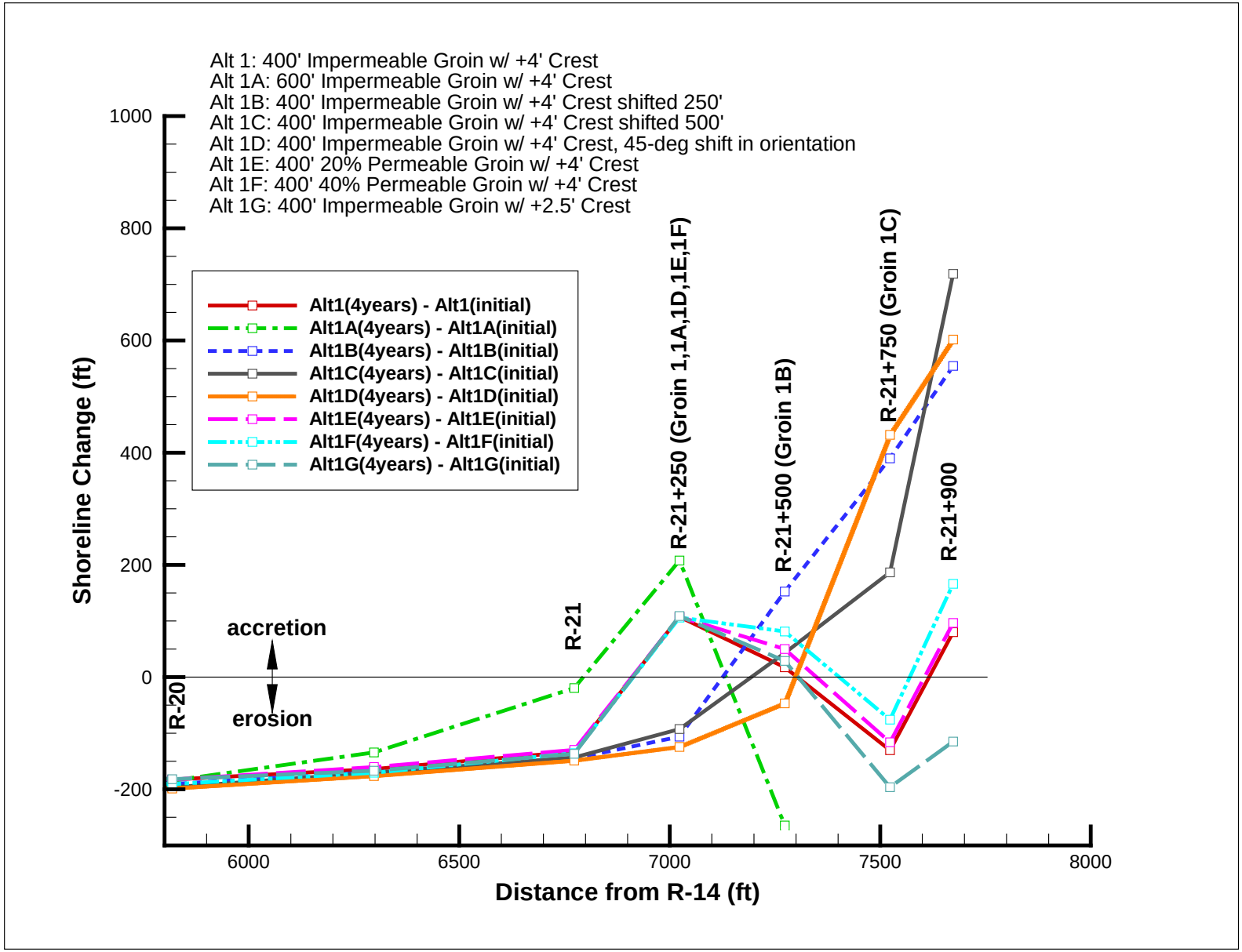

Figure 20. Alternatives Shoreline Changes South of R-20.

3.2.3. Evaluation Analysis

The performance of the alternatives was evaluated based on a number of criteria including acreage changes, volume changes, downdrift effects, borrow area infilling, impacts to controlling depth for navigation, and construction budgets. These criteria are described in more detail in CEC and CTC (2013).

The downdrift impact scores were separated into two components, those affecting the south end of Manasota Key (south of the structure) and those affecting the north end of Palm Island. Scoring for the south end of Manasota Key was derived based on the shoreline change analysis presented in Section 3.2.2. Scoring for the north end of Palm Island was developed based on volumetric changes along this shoreline segment.

Table 2 presents a scoring summary for all alternatives. Based on the modeling results no impacts to the SBF and controlling depth were predicted by the model, and the predicted impacts to the NBF acreage changes were identical, thus the NBF acreage changes, SBF acreage and volume changes, and controlling depth scores were not included in Table 2 as they would not affect the outcome.

Alternative 1A ranked the highest with the most positive effect updrift of the structure, a positive effect on the north end of Palm Island, and reduced channel infilling. However; the model predicted this alternative resulted in the most significant impact south of the structure on Manasota Key and was the second most expensive alternative.

Alternative 1G ranked second with a positive effect updrift of the structure, a positive effect on the north end of Palm Island, reduced channel infilling, and was one of the least expensive alternatives. The model predicted this alternative resulted in a positive effect in terms of volume change but a negative impact based on shoreline response south of the structure on Manasota Key.

Alternative 1E ranked third noting its very close performance within the UBF and NBF compared to the Original Alternative 1. Alternative 1E had a positive effect south of the structure on the south end of Manasota Key. It was one of the least expensive alternatives.

Alternative 1F ranked fourth compared to the Original Alternative 1. While Alternative 1F had a positive effect south of the structure on the south end of Manasota Key, it had an impact within the UBF compared to the Original Alternative 1. It was the least expensive alternative.

Alternatives 1B, 1C, and 1D had positive effects updrift of the structure noting the higher costs due to larger fill volumes placed within the UBF. They model predicted positive effects south of the structure on Manasota Key, negative impacts on the north end of Palm Island, and higher channel infilling rates compared to the Original Alternative 1.

Table 2. Scoring Summary of Structural Alternatives.

ALTERNATIVE	ACREAGE CHANGE	VOLUME CHANGE		DOWNDRIFT EFFECTS*		BORROW AREA INFILLING	CONSTRUCTION BUDGET	TOTAL SCORE	RANK
	UBF	UBF	NBF	MK†	PI‡				
1	4	3	11	15	15	15	28	91	**#6**
1A	18	25	14	0	22	42	12	133	**#1**
1B	15	14	0	24	0	4	17	74	**#7**
1C	28	38	2	21	5	0	0	94	**#5**
1D	3	2	2	18	4	11	18	58	**#8**
1E	4	5	10	27	13	14	31	104	**#3**
1F	0	0	10	33	13	11	33	100	**#4**
1G	4	5	13	6	19	27	33	107	**#2**

† denotes south end of Manasota Key
‡ denotes north end of Palm Island
* higher score denotes less downdrift impact

Alternative 1: Includes beach renourishment of the UBF, NBF, and SBF and a 400' long impermeable terminal groin with +4' NAVD88 crest
Alternative 1A: Includes beach renourishment of the UBF, NBF, and SBF and a 600' long impermeable terminal groin with +4' NAVD88 crest
Alternative 1B: Includes beach renourishment of the UBF, NBF, and SBF and a 400' long impermeable terminal groin with +4' NAVD88 crest shifted 250' south compared to Alternative 1
Alternative 1C: Includes beach renourishment of the UBF, NBF, and SBF and a 400' long impermeable terminal groin with +4' NAVD88 crest shifted 500' south compared to Alternative 1
Alternative 1D: Includes beach renourishment of the UBF, NBF, and SBF and a 400' long impermeable terminal groin with +4' NAVD88 crest having a 45-deg shift in orientation compared to Alternative 1
Alternative 1E: Includes beach renourishment of the UBF, NBF, and SBF and a 400' long permeable terminal groin with +4' NAVD88 crest and 20% permeability
Alternative 1F: Includes beach renourishment of the UBF, NBF, and SBF and a 400' long permeable terminal groin with +4' NAVD88 crest and 40% permeability
Alternative 1G: Includes beach renourishment of the UBF, NBF, and SBF and a 400' long impermeable terminal groin with +2.5' NAVD88 crest

4. CONCLUSION AND RECOMMENDATION

A detailed numerical model study was undertaken in the Alternatives Analysis task as part of the Charlotte County 10-year Beach and Inlet Management Plan. The study assessed the performance of various structural complements to the County's existing program to stabilize the south end of Manasota Key and reduce channel infilling thereby reducing maintenance dredging

needs. In reviewing the alternatives and their performance, input from the agency stakeholders led to a supplemental modeling effort that focused on options to the preferred structural alternative, that being, an impermeable terminal groin denoted as the Original Alternative 1.

Varying lengths, alignments, locations, permeability, and crest elevation were developed to produce seven (7) optional structure alternatives denoted by Alternative 1A through 1G for comparison to the Original Alternative 1. The model was rerun to yield the predictions of shoreline and volume change, downdrift effects, and channel infilling; and construction budgets were produced for each alternative. The results were compared to Alternative 1 based upon these specific evaluation parameters.

Based on the evaluation, Alternative 1A which included a 200-ft extension of the original structure scored the highest. However, it is not recommended as it is the most expensive alternative and was predicted to have the most significant impact south of the structure on Manasota Key which is a focal point of the Florida Park Service. Alternatives 1B through 1D which included southern shifts and / or alignment changes from the original structure were predicted to have positive effects south of the structure on Manasota Key but are not recommended because they are also predicted to have higher impacts on the downdrift inlet shoreline on Palm Island as well as higher rates of channel infilling.

Alternatives 1E through 1G which included increased permeability (1E and 1F) or reduced crest elevation (1G) overall performed better compared to the Original Alternative 1. The model predicted improved shoreline response south of the structure on Manasota Key compared to Alternative 1 for the increased permeability alternatives as expected. While the model predicted an impact south of the structure for the lower crest alternative (1G) based on shoreline response, intuitively more sand should bypass the structure for a lower crest design which was supported by the model prediction of positive volume change. It is noted these three alternatives are less expensive than the Original Alternative 1.

Based on professional judgment and experience of the Consulting Team, results of the numerical modeling study, and fiscal analysis, Alternatives 1E and 1F (increased permeability) as well as Alternative 1G (lower crest elevation) are recommended for consideration. It is recommended that input from the FDEP and Florida Park Service be sought and collectively the permeability and crest elevation of the proposed structure be selected.

5. REFERENCES

Coastal Engineering Consultants, 2001. Stump Pass Inlet Management Study.

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Deltares, 2011. Delft3D-FLOW User Manual Version 3.15.