BEACH EROSION STUDY ON
MANASOTA KEY NORTH

Prepared for:

Charlotte County Board of County Commissioners
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COASTAL
ENGINEERING
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INC

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1.0 INTRODUCTION

Between 2001 and 2003 Charlotte County, in partnership with Sarasota County, completed a regional study of beach erosion that included the Manasota Key Planning Area. This study examined the critical erosion along the Manasota Key Planning Area shoreline from Florida Department of Environmental Protection (FDEP) reference monument (R-monument) R-168 in Sarasota County to R-21 in Charlotte County (Figure 1), developed conceptual restoration plans to address the erosion processes, conducted extensive stakeholder coordination, and developed funding strategies to pay for the restoration plans.

Most recently, the Charlotte County stakeholders, including residents and businesses along the north end of Manasota Key extending from the County line to south of the Beach Complex, have brought to the attention of the County Commissioners, Administrators, and staff that their erosion problem has become so severe that their shoreline armoring is failing. Accordingly, the County has embarked on a new Beach Erosion Study (Study) to update the 2001-03 study elements that pertain to the Charlotte County segment of Manasota Key herein defined as the Study Area and referred to as Manasota Key North (Figure 2).

The County recently completed a new 10-year management plan for Stump Pass and its adjacent beaches and is near complete with the permitting of the recommended plan entitled the Charlotte County Erosion Control Project. The Erosion Control Project includes authorization for future beach fill placement from Stump Pass to R-9 correlating to the Stump Pass area of inlet influence and the County's Chadwick Park.

The Study Area extends from the Charlotte – Sarasota County line at R-1 for approximately 14,100 feet to R-15 to coincide with the northern limit of fill placement under the County's previous 2003, 2006, and 2011 beach nourishment and inlet dredging projects. The overlap between the Study Area and the Erosion Control Project, R-9 to R-15, enables examination of the critically eroding beach identified within this reach and evaluation of the synergy between the Study and future beach nourishment on Manasota Key.

Charlotte County authorized Coastal Engineering Consultants, Inc. (CEC) to assist them examine the critical erosion that has occurred along Manasota Key North, update the key elements of the 2001-03 study specific to the Study Area, conduct stakeholder coordination, and provide technical support services specific to funding approaches. The authorization was awarded pursuant to RLI#10-335 entitled *Engineering Services for a Beach Erosion Study on Manasota Key North*, Work Order #126, File #15-263, dated May 5, 2015.

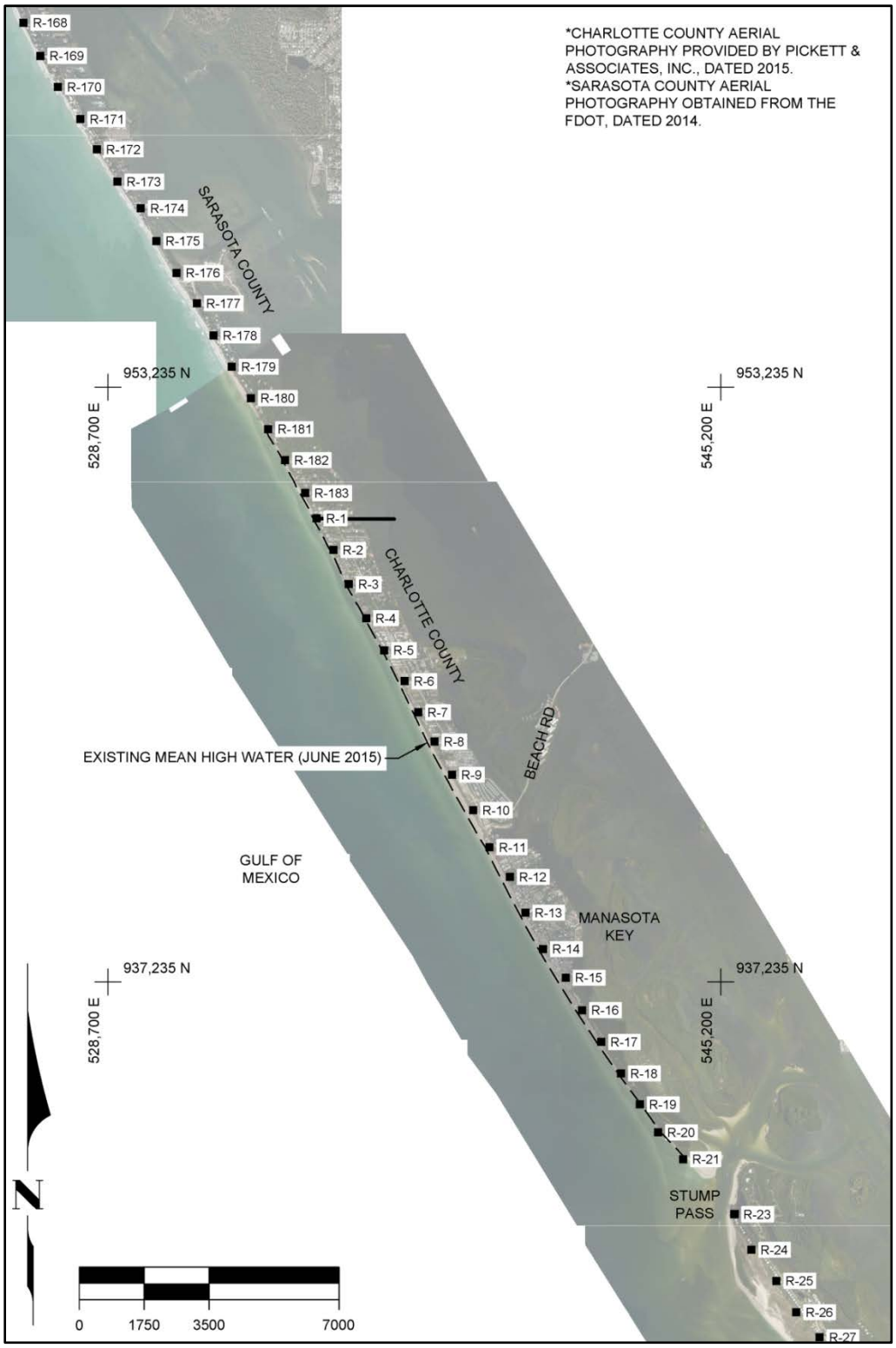

Figure 1. Manasota Key Location Map.

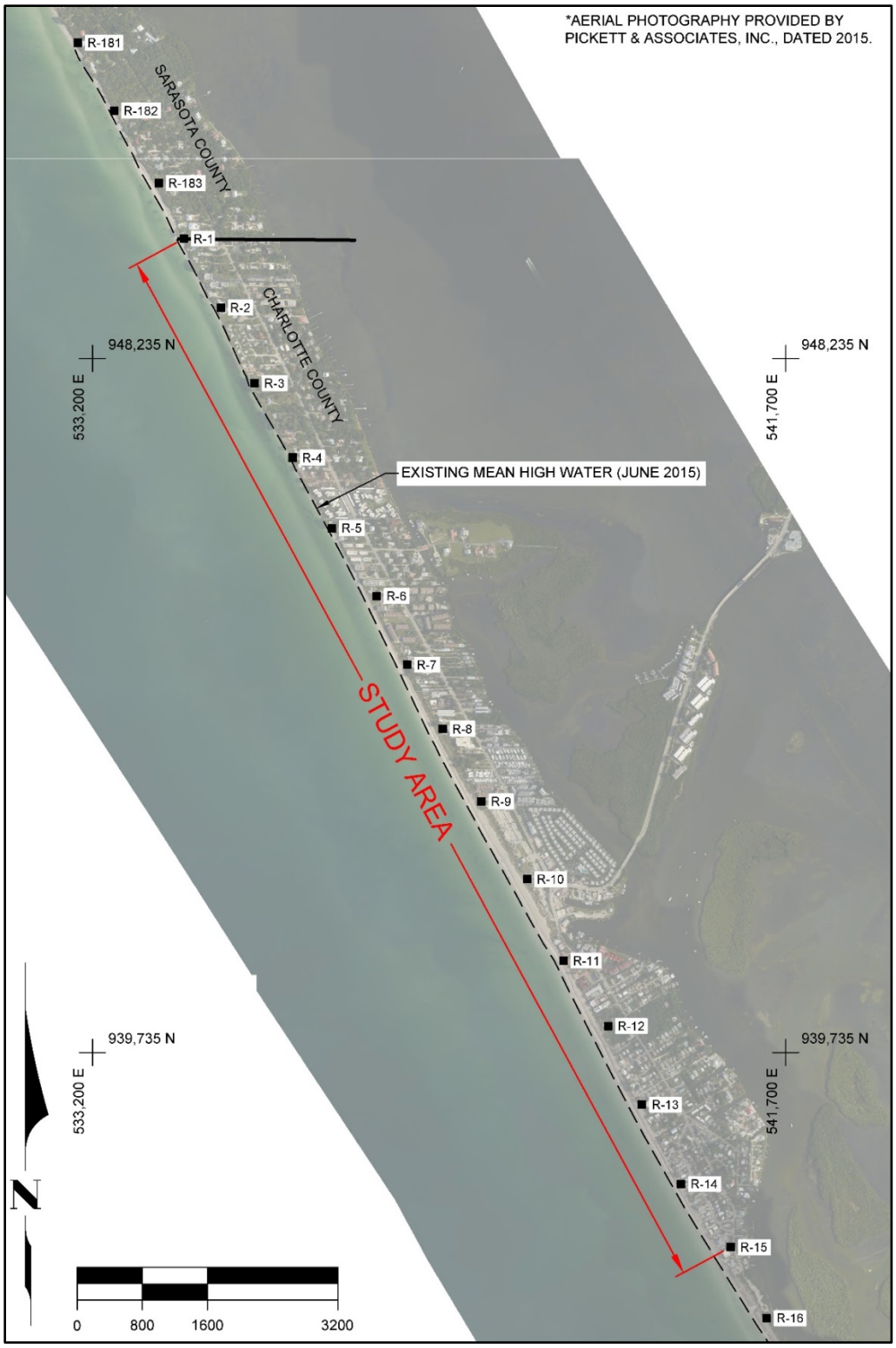

Figure 2. Manasota Key North Study Area.

2.0 SCOPE OF WORK

The Study scope of work includes the following tasks.

I. Beach Profile Surveys: Conduct topographic and bathymetric surveys of the Manasota Key North Study Area, plus three monuments north into Sarasota County to document conditions of the adjacent updrift beach. The surveys shall be performed to meet BBCS Technical Standards established in the latest BBCS Monitoring Standard for Beach Erosion Control Projects and USACE hydrographic standards. The surveys shall reference the Florida West Zone 1983 (horizontal) and North American Vertical Datum of 1988 (vertical). Perform a datum conversion of the historic surveys for these monuments to enable the comparisons and analyses described herein.

II. Erosion Analysis: Utilizing the beach profile survey data collected in Task I and the historic profile data developed in the 2001-03 study, conduct a shoreline and volumetric change analysis to determine historical erosion losses along the Study Area since 2001. Update the schematic sediment budget in the 2001-03 study based on the volumetric change calculations.

III. Conceptual Restoration Plans: Utilizing the beach profile surveys from Task I and the erosion analysis and sediment budget from Task II, update and refine the recommended alternative defined in the 2001-03 study for the Study Area. Examine the synergy between the County's Erosion Control Project which includes the adjacent downdrift beaches and prepare a complementary alternative for the Study Area. Prepare conceptual restoration plans and beach fill templates for the two alternatives. Estimate the sand volume and renourishment interval which might be required to maintain a stable beach for each alternative. Review the offshore borrow area sand search completed for the Erosion Control Project and compute the target volume of sand needed to be identified to meet the needs for the Study Area over a ten year period. Prepare project descriptions for the alternatives.

IV. Natural Resources: Analyze existing aerial photography to delineate the approximate location of nearshore hardbottom along the shoreline within the Study Area. Utilizing a combination of remote sensing techniques and diver surveys, conduct a reconnaissance level mapping and characterization of the nearshore hardbottom resources. The side-scan sonar survey shall consist of collecting sonar imagery and analyzing it for surficial bottom features that can indicate the presence of hardbottom other bottom features that may interfere with the permitting process or future beach fill placement.

V. Permit Feasibility: Perform a conceptual environmental assessment of potential impacts to nearshore hardbottom from restoring and maintaining a stable beach and qualify potential mitigation features to offset these impacts. Characterize the permit feasibility of the restoration measures. Based on the results of the assessment and characterization, refine the conceptual plans to avoid or minimize environmental impacts to the extent practicable while meeting the project goals for beach restoration and sustainability.

VI. Opinion of Project Cost: Prepare a conceptual order of magnitude opinion of project cost including design, permitting, bidding, construction, and monitoring for an initial restoration project and a subsequent renourishment project for a ten year period for the two alternatives. The construction costs shall be broken down by feature such as mobilization and demobilization, borrow area excavation, sediment transport and re-handling, beach fill, fill containment, and other features that may develop. Recommend a cost contingency based on the conceptual design plans. Provide a list of all assumptions and conditions (e.g. weather and sea conditions, distances to borrow areas, dredging techniques, equipment types, and access issues).

VII. Funding Approaches: Prepare an inventory of public accesses and facilities within and immediately adjacent to the Study Area following the State of Florida's definition for public access as it relates to eligibility for state cost sharing under the State's Beach Management Funding Assistance Program (BMFAP). Utilizing the ranking criteria from BMFAP, results of the Erosion Analysis, and Conceptual Plan elements, compute the various parameters and provide a professional opinion on each alternative's scoring opportunity along with where it would rank within the State's 2015-2016 priority list in the BMFAP as a means to evaluate the potential for future state cost sharing. Assist the County evaluate long-term funding strategies for each alternative for the Study Area including local (Tourist Development Tax, MSTU, MSBU, other), State (BMFAP), and Federal. Provide technical assistance to the County to develop funding approaches using one or more of these strategies and prepare presentation materials for stakeholder meetings.

VIII. Stakeholder Meetings: Assist the County arrange, prepare for, and attend two stakeholder meetings to be held on Manasota Key to present the conceptual plans, project descriptions, and funding strategies; and assess the local community's willingness to cost share a restoration project. Attend and serve as Charlotte County's representative at one meeting with Sarasota County to investigate the opportunity for the two counties to develop a regional project. Provide technical support services for the County specific to stakeholder coordination.

IX. Final Report: Conduct a qualitative alternatives analysis of the technical, environmental, fiscal, and societal parameters for the two alternatives. Based upon this analysis, render a professional recommendation of the optimal alternative. Prepare a letter report summarizing the Study and presenting the recommendation. Prepare for, attend, and present at one Board of County Commissioners Meeting.

3.0 MANASOTA KEY RESTORATION HISTORY

3.1 Englewood Beach Nourishment / 1980 Stump Pass Dredging

In September 1976, the West Coast Inland Navigation District (WCIND) proposed to the U.S. Army Corps of Engineers (USACE) a regional study of Southwest Florida's inlets, and selected the primary inlets including Stump Pass for the study. In December 1977, Congressional approval for the study was granted. However, in 1978, the USACE indicated the study would take four (4) to six (6) years to complete. Realizing the dynamic nature of the pass, severity of shoaling resulting in hazards for navigation, and public demand for a maintained channel brought about by the increase in boating, the County and WCIND elected to co-sponsor and fund a dredge project at the pass. The initial dredging of Stump Pass, completed in 1980, removed approximately 140,000 cubic yards of sand along three (3) dredge cuts, totaling approximately 8,350 feet in length, from the Gulf of Mexico east to the Gulf Intra-Coastal Waterway. Approximately 110,000 cubic yards of beach-compatible sand were placed updrift of the inlet to restore Englewood Beach on Manasota Key. The remaining material, consisting of finer sediments, was deposited in a disposal area created on Grove City Key (CEC, 2001).

3.2 Charlotte County Beach Restoration and Stump Pass Navigation Channel Improvements

Between 2002 and 2003, Charlotte County completed the design and permitting of their major beach restoration project utilizing Stump Pass as the primary sand source. To date, the initial nourishment (2003) and two renourishment events (2006, 2011) have been completed. These three construction events placed a total of over 400,000 cubic yards of sand on the south end of Manasota Key between R-14.5 and R-20. A summary of these events is presented in Table 1.

Table 1. Manasota Key Beach Fill Placement (2003 through 2011).

Year	Volume (CY)	Reach (R-Mon)
2003	100,000	R-14.5 to R-17
2006	145,000	R14.5 to R-18
2011	156,000	R-14.5 to R-20
Total	401,000	

3.3 Charlotte County Erosion Control Project

The County has embarked on their next 10-year management plan for Stump Pass and the beaches within its area of inlet influence and Chadwick Park. CEC is serving as the lead firm to conduct the consulting services. Two new components are included in the next management plan. First, a regional sand source search has been completed to locate and define beach compatible sand bodies to address the sand needs of the County's program for the next decade. Second, a detailed numerical model study was undertaken to evaluate coastal structures to

reduce end losses and improve project performance by stabilizing the erosional shorelines adjacent to Stump Pass. Hydrodynamic and morphologic change modeling was performed on the no action, continued maintenance dredging / beach renourishment, and renourishment complemented with various structures alternatives to compare and contrast performance and develop criteria for the design and permitting phases. Design and permitting are near complete for long-term beach nourishment including Manasota Key from R-9 to the pass and the beaches downdrift of Stump Pass extending to R-40, a stabilizing structure at the south end of Manasota Key (end of littoral cell), routine maintenance dredging of Stump Pass, and a comprehensive operations, maintenance, and monitoring program. The initial project includes placement of approximately 180,000 cubic yards on the south end of Manasota Key within the Updrift Beach Fill from R-18 to R-21 (Figure 3). Construction is scheduled to begin later this year and be complete by early 2017.

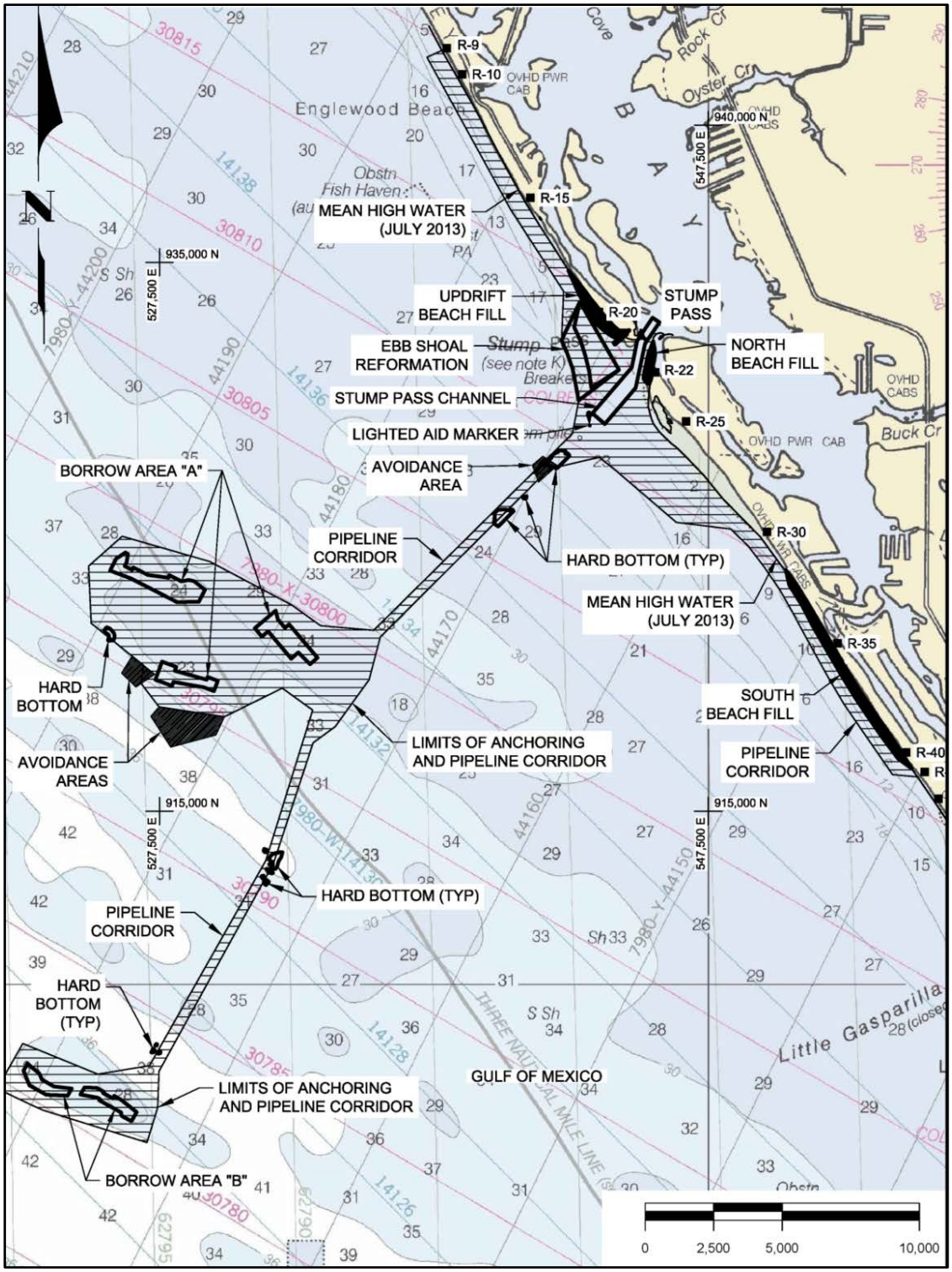

Figure 3. Charlotte County Erosion Control Project Location Map.

4.0 2001-2003 SARASOTA-CHARLOTTE BEACH EROSION STUDY

4.1 Introduction

Between 2001 and 2003 Charlotte County, in partnership with Sarasota County, completed a regional study of beach erosion that included the Manasota Key Planning Area extending from R-168 (Sarasota) to R-16.5 (Charlotte) corresponding to the shoreline segments designated as critically eroded by the FDEP. The study examined the critical erosion, developed conceptual restoration plans to address the erosion processes, conducted extensive stakeholder coordination, and developed funding strategies to pay for the restoration plans. The planning area is unique in that it is shared by both Sarasota and Charlotte Counties, and includes Sarasota County's Blind Pass Park, Charlotte County's Chadwick Park, and a portion of the Stump Pass Beach State Park. It is noted this planning area correlates to the Manasota Key North Study Area.

4.2 Shoreline and Beach Profile Characteristics

The shoreline is of varying dry beach width from very narrow, less than 20 feet, to fairly wide, over 150 feet. Several sections are armored with revetments and seawalls to protect the upland development consisting of single-family homes and multi-family condominiums. A review of historical photographs indicated the majority of the armoring corresponds to shoreline locations with little to no dry beach. A nearshore sandbar was exhibited on the significant majority of the profiles; however, its offshore location, size, and shape varied throughout the reach. Shallow hardbottom features were identified between R-168 and R-169 (Sarasota), between R-170 to R-173 (Sarasota), and at R-1 (Charlotte). These features were observed by the survey crew and were evident in the profiles. The study reported that additional hardbottom areas may be present. The overall lack of nearshore data is due mainly to the fact that beach nourishment projects have been rare in this region, and reports provided during the permitting process have been the primary source of information regarding the nearshore area (CTC and CEC, 2003).

The average Mean High Water (MHW) shoreline change was -0.9 feet per year for the time period 1982 (Charlotte)/1987 (Sarasota) to 2001. The total volume change rate and average volume density between 1982 (Charlotte)/1987 (Sarasota) and 2001 were -34,170 cubic yards per year and -1.1 cubic yards per foot per year, respectively. Although some dry beach recovery along the armored sections of shoreline was observed, on average the beach has experienced historical erosion. In recent years, multiple breaches and overwashes occurred within the Stump Pass Beach State Park, between R-15 and R-16.5, causing significant beach and dune erosion (CTC and CEC, 2003).

4.3 Beach Restoration Alternatives

Two of the alternatives considered in the 2001-03 study included the Manasota Key North Study Area. Alternative 2 of the 2001-03 study proposed beach restoration along 13,200 feet of shoreline extending from R-173 (Sarasota) to R-3 (Charlotte). The fill template would widen the beach approximately 130 to 140 feet measured at the waterline and include a 150-foot wide storm protection berm at elevation +5 feet North American Vertical Datum of 1988 (NAVD88) to buffer the uplands from the erosional effects of a 10-15 year return interval storm (CTC and CEC, 2003). The proposed fill volume was 660,000 cubic yards equating to an average fill density on the order of 50 cubic yards per shoreline foot. This volume included advanced nourishment to offset background erosion between nourishment events. The nourishment interval was assumed to be 10 years. The Opinion of Probable Cost was computed to be on the order of $7,300,000, equal to $11.06 per cubic yard, expressed in 2003 dollars.

Alternative 4 was developed as an overall expansion of Alternative 2. Beach restoration was proposed along 42,600 feet of shoreline including an 18,500 foot extension into Sarasota County and an extension south to R-13. The fill template would widen the beach approximately 130 to 140 feet measured at the waterline and include a 150-foot wide storm protection berm at elevation +5 feet NAVD88 to buffer the uplands from the erosional effects of a 10-15 year return interval storm (CTC and CEC, 2003). The proposed fill volume was 2,200,000 cubic yards equating to an average fill density on the order of 52 cubic yards per shoreline foot. This volume included advanced nourishment to offset background erosion between nourishment events. The nourishment interval was assumed to be 10 years. The Opinion of Probable Cost was computed to be on the order of $22,000,000, equal to $10.00 per cubic yard, expressed in 2003 dollars. No mitigation was included in this alternative.

4.4 Stakeholders

During the stakeholder meetings, the residents of the Manasota Key Planning Area had differing viewpoints regarding the proposed restoration plans. While 50% of the participants applauded the County's efforts to pursue a beach management program, 50% of the participants opposed the County's efforts. The opposing views included "restoration is too costly," "the existing small 'pocket beaches' are just fine as the public generally stays away from this beach area," and "distrust of anything the local government proposes." A survey conducted by the Manasota Key Association in August 2002 indicated that the majority of the residents and property owners did not want a beach project.

4.5 Summary

While the Counties' consulting team identified several alternatives to address the chronic erosion problem on Manasota Key, the lack of majority consensus for a beach project resulted in the Charlotte County Board of County Commissioners not advancing a project.

5.0 MANASOTA KEY NORTH EROSION ANALYSIS

5.1 Survey Data

CEC conducted a topographic and bathymetric survey of the R-monuments from R-181 (Sarasota) to R-15 (Charlotte) in June 2015. The data were reduced to the 1983 North American Datum (horizontal) and NAVD88 (vertical). The 2001 surveys collected for the 2001-03 study were imported into AutoCAD and manually adjusted to NAVD88 for consistency with the 2015 survey. Appendix A presents the beach profiles measured at each R-monument for the 2001 and 2015 surveys.

Upon reviewing the profile comparisons it was noted that in several of the profiles, the offshore portions for the 2001 survey year did not overlap nor close with the 2015 survey indicating vertical inaccuracies in the offshore portions of the 2001 data set. To address the inaccuracies, the following method was employed using AutoCAD. The 2001 survey data were examined to determine the seawardmost upland point collected and landwardmost offshore point collected. The 2001 data were trimmed between these two points. Next, the offshore portions of the 2001 profiles were adjusted vertically to overlap the 2015 profiles, while the upland portions remained the same. Finally, the offshore portions of the 2001 profiles were reconnected with straight lines to the upland portions. Appendix A contains comparison plots of the unedited versus edited profiles for each monument adjusted.

5.2 Shoreline Change Analysis

5.2.1 2001 to 2015 Shoreline Changes

Table 2 presents the 2001 and 2015 shoreline positions at MHW, and the shoreline changes that occurred between the surveys. Figure 4 presents the 2015 MHW positions relative to the 2001 MWH positions. The change rates ranged from shoreline advance of 7.1 feet per year at R-14 to shoreline recession of -7.0 feet per year at R-6, with an average of -1.0 feet per year of recession. An analysis of shoreline changes by reach is presented below. The reaches were divided based upon shoreline features.

Northern Reach (R-181 to R183)
The reach extending along the northern end of the Study Area between R-181 and R-183 experienced an average recession rate of -1.3 feet per year which is on the order of the historical rate.

Rock Revetment Reach (R-1 to R-5)
Appendix B presents maps of the existing conditions along the Manasota Key North shoreline prepared by CEC. These maps depict the locations of the shoreline armoring (rock revetments) along R-1 to R-5. These revetments influence the erosion and accretion rates. The shoreline in

this reach has eroded landward to the rock revetment such that there is little to no dry beach. This mutes the MWH change rates during this period. The average rate equaled -2.6 feet per year of recession which is almost three times the historical rate. This reach is experiencing a sediment deficit.

Table 2. Mean High Water Shoreline Change Rates (2001 - 2015).

R-Mon	Position	Position	Change	Change Rate (FT/YR)
	2001 (FT)	2015 (FT)	2001-2015 (FT)	2001-2015
R-181	87.9	82.3	-5.7	-0.4
R-182	80.7	51.3	-29.4	-2.1
R-183	142.6	121.2	-21.4	-1.5
R-1	82.2	85.3	3.0	0.2
R-2	104.9	78.2	-26.7	-1.9
R-3	74.3	63.5	-10.8	-0.8
R-4	95.3	28.3	-67.1	-4.8
R-5	135.1	57.1	-78.0	-5.6
R-6	252.5	154.7	-97.8	-7.0
R-7	189.8	126.2	-63.6	-4.5
R-8	225.1	179.2	-45.9	-3.3
R-9	218.9	187.1	-31.9	-2.3
R-10	231.8	208.1	-23.7	-1.7
R-11	128.9	100.4	-28.4	-2.0
R-12	192.5	230.7	38.2	2.7
R-13	86.6	158.9	72.3	5.2
R-14	7.8	107.2	99.4	7.1
R-15	157.5	231.4	74.0	5.3

Downdrift Erosional Shadow (R-6 to R-11)

Based upon the comparisons of the historical profiles and shoreline changes, the reach downdrift of the revetments, extending from R-6 to R-11, experienced the highest average rate of recession equal to -3.5 feet per year. This erosional shadow is attributed to the rock revetments reducing or preventing natural alongshore sediment transport. If left unaddressed, this shoreline recession trend is expected to continue and possibly increase over time due to the lack of sediment supply entering the Study Area. It is noted this reach includes the County Park (R-9 to R-10.6) which was improved during this time period. The improvements included importing sand for dune construction which may have contributed to reduced recession along the park shoreline.

Southern Reach (R-12 to R-15)
The reach extending along the southern end of the Study Area from R-12 to R-15 experienced an average shoreline advance rate of 5.1 feet per year. This reach benefitted from alongshore sediment transport from the updrift eroding beach which naturally nourished the shoreline. Further, as described above, over 400,000 cubic yards of sand were placed between R-14.5 and R-20 between 2003 and 2011 which definitely contributed to the positive shoreline responses in this reach.

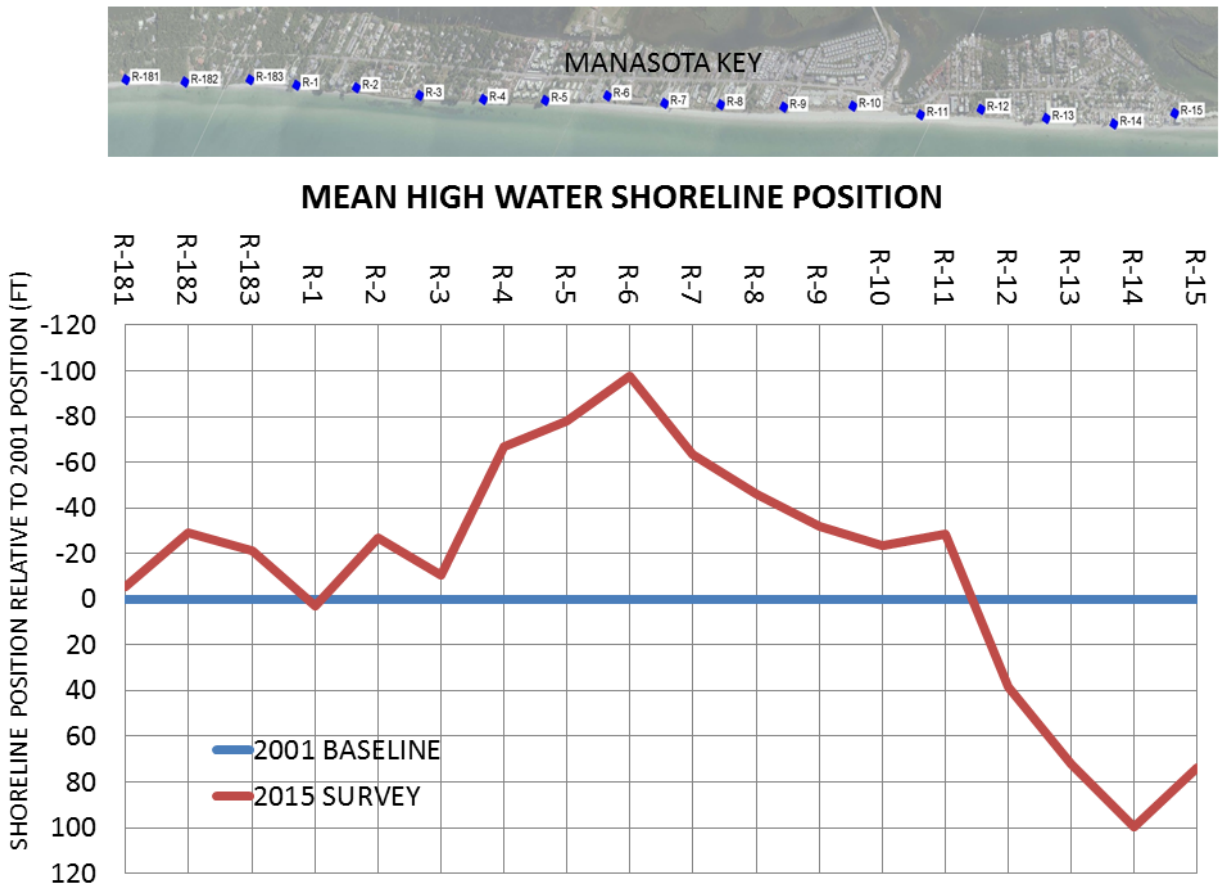

Figure 4. 2015 MHW Positions Relative to 2001 MHW Positions.

5.2.2 Design Shoreline Change Rate

Examining the shoreline erosion rates, based upon professional judgment and taking into account the muted recession rates between R-1 and R-3 attributed to the revetments and the beach fill projects placed from R-14.5 south, the recommended shoreline change rate for the

conceptual restoration plans is -3.9 feet per year which is the average rate between R-4 and R-11.

5.3 Volume Change Analysis

5.3.1 2001 to 2015 Volume Changes

Table 3 and Figure 5 present the overall volume changes calculated to the depth of closure from comparing the 2001 and 2015 surveys. The volume change rates ranged from accretion of 3,030 cubic yards per year between R-10 and R-11 to erosion of -2,420 cubic yards per year between R-5 and R-6. The Study Area experienced a net accretion of 32,500 cubic yards equal to an average of 2,322 cubic yards per year over the 14-year period. Across the Study Area, this equated to an average density of 1.9 cubic yards per foot per year of net accretion. An analysis of volume changes by reach as defined above is presented below.

Table 3. Volume Changes to Depth of Closure (2001 - 2015).

	R-mon	Area	Avg Area	Length	Volume	Change Rate
		(CY/FT)	(CY/FT)	(FT)	(CY)	(CY/YR)
Northern	R-181	-18.9				
			-13.6	943	-12,823	-916
	R-182	-8.3				
			-17.7	1,036	-18,278	-1,306
	R-183	-27.0				
			-5.0	747	-3,764	-269
Rock Revetments	R-1	17.0				
			1.8	957	1,746	125
	R-2	-13.3				
			-12.5	1,016	-12,699	-907
	R-3	-11.7				
			-18.7	1,021	-19,058	-1,361
	R-4	-25.6				
			-32.1	987	-31,641	-2,260
	R-5	-38.5				
Downdrift Erosional Shadow			-34.4	987	-33,910	-2,422
	R-6	-30.2				
			-14.5	918	-13,334	-952
	R-7	1.2				
			4.9	898	4,428	316
	R-8	8.7				
			16.5	1,009	16,630	1,188
	R-9	24.3				
			26.0	1,102	28,676	2,048
	R-10	27.8				
			38.8	1,094	42,444	3,032
	R-11	49.8				
			37.2	978	36,344	2,596
	R-12	24.5				
Southern			18.6	1,046	19,473	1,391
	R-13	12.7				
			14.2	1,083	15,407	1,100
	R-14	15.7				
			13.1	984	12,859	919
	R-15	10.4				
				TOTAL	**32,502**	

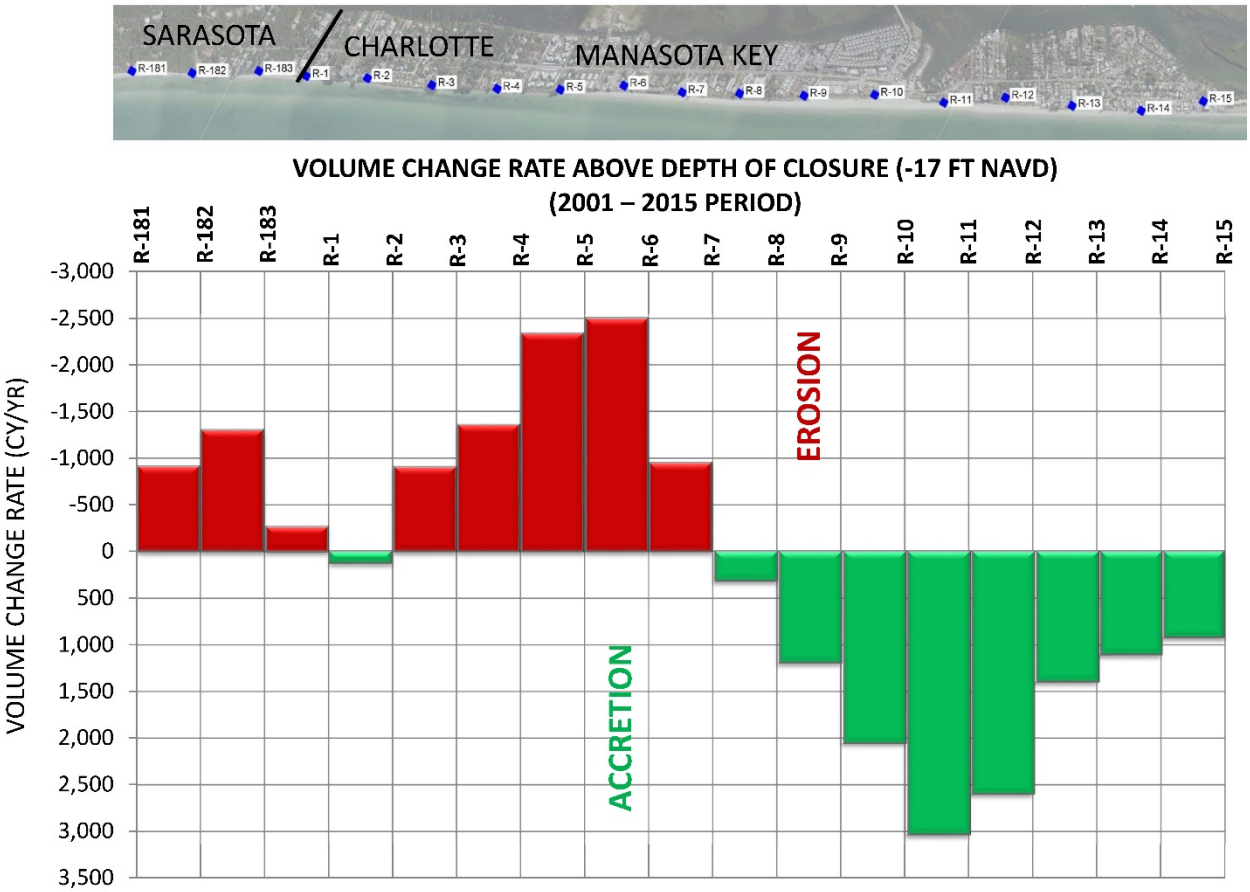

Figure 5. Volume Change Rates to Depth of Closure (2001 - 2015).

Northern Reach (R-181 to R183)
The reach experienced erosion of -34,870 cubic yards. The average erosion rate of -2,490 cubic yards per year equated to an average density of -12.8 cubic yards per foot per year which is an order of magnitude greater than the historical rate, evidence of the sediment deficit within the Study Area.

Rock Revetment Reach (R-1 to R-5)
The reach experienced erosion of -61,650 cubic yards. The average erosion rate of -4,400 cubic yards per year equated to an average density of -15.5 cubic yards per foot per year which was the highest erosion rate within the Study Area.

Downdrift Erosional Shadow (R-6 to R-11)
While this reach experienced significant shoreline recession along its entirety, the total volume change equal to 81,280 cubic yards was net accretion. The erosional shadow from a volumetric analysis extended to R-7. The average accretion rate of 5,810 cubic yards per year equated to an average density of 11.6 cubic yards per foot per year.

Southern Reach (R-12 to R-15)
The reach experienced accretion of 47,740 cubic yards. The average accretion rate of 3,410 cubic yards per year equated to an average density of 15.3 cubic yards per foot per year, which was the highest accretion rate within the Study Area.

5.3.2 Design Volume Change Rate

The original beach fill template density developed in the 2001-03 study equaled to 52 cubic yards per foot on average which included advanced nourishment. Examining the volume change rates, based upon professional judgment, the recommended density to be added to the rock revetment reach and upper portion of the downdrift erosional shadow reach (R-1 through R-7) for the conceptual restoration plans is 18 cubic yards per foot to account for the erosion that has occurred since 2001.

5.4 Sediment Budget Update

Figure 6 presents a comparison of the 1974 to 2001 sediment budget analysis presented in the 2001-03 study compared to the results presented above. The erosional trend along the northern portion of the Study Area extending to R-7 and the accretional trend along the southern portion of the Study Area extending to R-15 as identified in the shoreline and volume change analyses are evident in the figure.

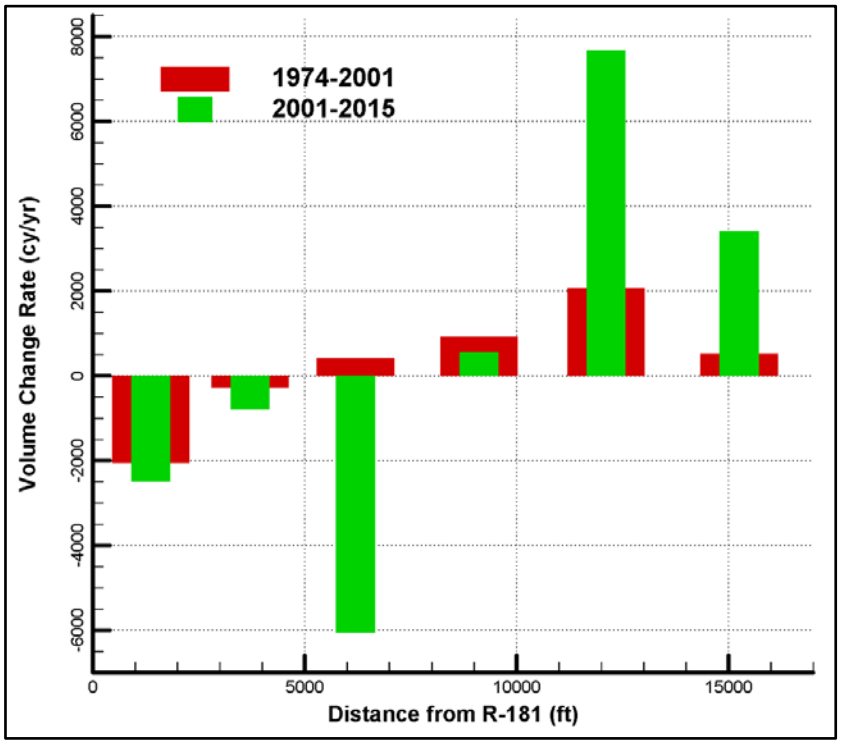

Figure 6. Manasota Key North Sediment Budget Update.

5.5 Storm Erosion Analysis

5.5.1 Introduction

An additional analysis was undertaken to examine the effects of a 25-year storm on the Study Area to provide additional design criteria for the conceptual restoration plans in terms of additional beach width to buffer the effects of such a storm during the anticipated life of the fill project.

5.5.2 Input Data

The input data used in the calibration simulations included bathymetric/topographic survey data, sediment characteristics, and time series of water level and wave forcing. The sources and characteristics of these data are presented below.

5.5.2.1 Bathymetry/Topography

The area for the SBEACH modeling study extended from FDEP monument R-181 (Sarasota) to R-15 (Charlotte). The source for bathymetry/topography data was the June 2015 survey conducted by CEC.

Tropical Storm Fay which occurred in August 2008 and affected the Project area was used for model calibration. Two surveys conducted in July 2008 and December 2008 were utilized to predict as accurately as possible the measured storm-induced erosion, through varying model parameters.

5.5.2.2 Sediment Characteristics

According to grain size analysis performed for the 2001-03 study, the Manasota Key composite grain size was 0.47 mm.

5.5.2.3 Water Levels

The water levels were used to impose boundary conditions for the model. The water level data were retrieved from the NOAA Naples Tide Station (ID 8725110) for the period between August 1, 2008 and November 30, 2008 and were available at 1-hour intervals.

5.5.2.4 Waves

The USACE Wave Information System (WIS) hindcast wave data were used as wave forcing in SBEACH. WIS (Hubertz, 1992) produces a high-quality online database of hindcast, nearshore wave conditions covering U.S. coastlines. The wave data covered the period from August 1, 2008 and November 30, 2008 and were available at 1-hour intervals at WIS Station 282 offshore of the Study Area.

5.5.3 Model Calibration

5.5.3.1 SBEACH Model

The Storm-induced BEAch CHange model (SBEACH) is a numerical simulation model of cross-shore beach, berm, and dune erosion produced by storm waves and water levels (Larson and Kraus, 1989). The model is applied in beach fill project design and evaluation and in other studies of beach profile change.

SBEACH includes the following features:

- meso-scale sediment transport model based on equilibrium profile concepts,
- sophisticated cross-shore breaking wave model of monochromatic and irregular waves,
- calculation of run-up, wave-induced setup, and dune overwash,
- representation of seawalls and non-erodible hard bottoms, and
- automated calculation of erosion parameters used in project applications.

5.5.3.2 Calibration Period

After reviewing the wave record, a 122-day period between August 2008 and November 2008 was utilized corresponding as close as possible to the dates of the two survey data sets. The goal of calibration was to reproduce as accurately as possible the measured changes in beach profiles.

5.5.3.3 Calibration Parameters

The initial profile elevations were based on the August 2008 survey. Two model parameters, Coefficient for Slope Dependent Term and Transport Rate Coefficient, were varied within their ranges for a total of nine (9) calibration simulations. The simulations were performed until the model predicted profile changes reasonably matching those based on the December 2008 survey. Table 4 presents a summary of the parameters used for each run.

Table 4. Summary of Calibrations Parameters.

		Transport Rate Coefficient		
		2.50E-07	**1.50E-06**	**2.50E-06**
Coefficient for Slope Dependent Term	**0.001**	Run 1	Run 2	Run3
	0.003	Run 4	Run 5	Run 6
	0.005	Run 7	Run 8	Run 9

Based on the calibration simulation results, Runs 9 and 3 most accurately predicted erosion caused by Tropical Storm Fay, thus those values were chosen for the simulations.

5.5.4 Simulation of 25-Year Storm Event

5.5.4.1 Waves

To generate the 25-year storm wave parameters, the WIS database was utilized to analyze wave conditions specific to the Project area. WIS (Hubertz, 1992) produces a high-quality online database of hindcast, nearshore wave conditions covering U.S. coastlines. The data cover a 33-year period from January 1, 1980 through December 31, 2012. The time interval of the data is one hour. WIS data used in the analysis were obtained at Station 282 located in approximately 23-foot water depth at (LAT=26.9N, LON=82.45W), approximately 6 miles offshore of the Project area. Figure 7 presents a graph of wave height analysis at this station for storm events of various return periods developed by the U.S. Army Engineer and Development Center (ERDC). Based on the graph, the 25-year storm wave height is equal to 9.1 feet (=2.8 m). The WIS-282 data series was analyzed to locate a storm event of similar wave height which would correspond to the 25-year storm.

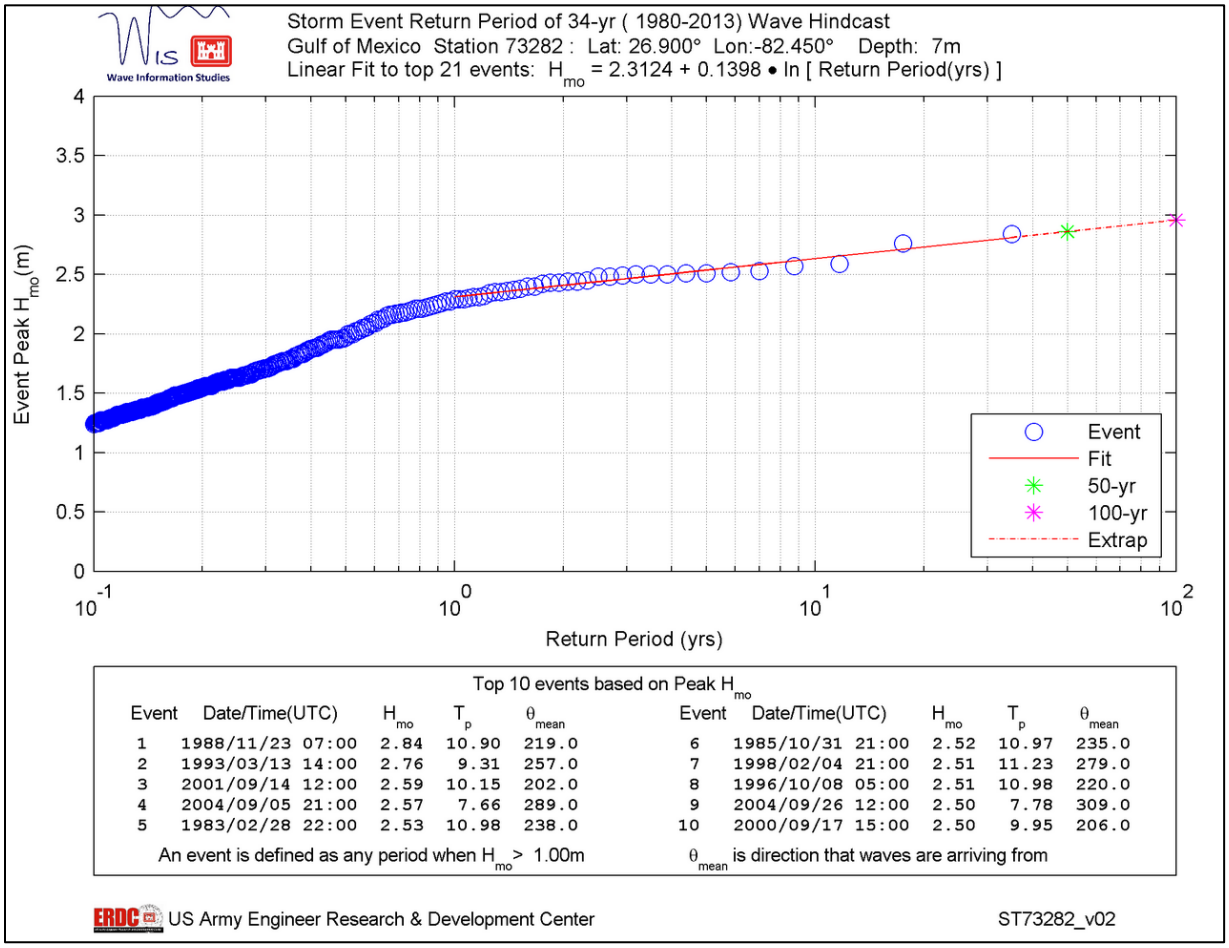

Figure 7. Wave Height Analysis of Storm Events at WIS-282 (source: ERDC).

5.5.4.2 Water Level

According to Dean and Chiu (1984) and Dean et al (1988), the 25-year peak storm height for Sarasota County and Charlotte County are 9.6 feet NGVD29 and 9.8 feet NGVD29, respectively. These values include contributions of wind stress, barometric pressure, wave setup, and tides. Water level time series were generated to match the peaks. Because SBEACH accounts for wave setup, the wave setup part of the 9.6-foot and 9.8-foot peak storm water levels was excluded from the SBEACH water level input.

5.5.5 SBEACH Results

Table 5 presents transect changes at Mean High Water (MHW) and +5 feet NAVD88 due to the simulated 25-year storm event for profiles R-1 through R-15.

Table 5. Summary of Transect due to 25-year Storm Calculated by SBEACH.

R-Mon	Changes at MHW (FT)	Changes at +5' NAVD88 (FT)
R-1	-20.2	-4.5
R-2	3.9	-16.0
R-3	4.2	-26.0
R-4	-10.6	-19.3
R-5	-10.9	-18.8
R-6	-27.8	-46.2
R-7	-28.2	-14.8
R-8	-29.5	-12.4
R-9	-32.7	-0.1
R-10	-36.6	2.5
R-11	-27.0	-3.0
R-12	-34.9	-6.1
R-13	-33.1	-3.8
R-14	-27.2	-11.9
R-15	-14.2	-43.2

The average storm induced change at MWH was 22 feet from R-1 to R-15. It is noted that the rock revetment affords some measure of storm damage reduction which may mute the profile changes when applying it to the beach fill plans. Therefore, the recommended beach fill width to be included in the conceptual restoration plans is 29 feet, the average of the profiles south of the revetment. This beach width multiplied by the assumed fill thickness of 9 feet, measured from the average beach berm (+4 feet NAVD88) to the trough (-6 feet NAVD88) on the 2015 profiles, equates to a design density of 11 cubic yards per foot.

6.0 CONCEPTUAL RESTORATION PLANS

6.1 Design Criteria

The upper beach berm elevation, beach berm slope, and toe of fill slope from the Charlotte County Erosion Control Project equal +5 feet NAVD88, 1H:100V, and 1H:15V, respectively, were recommended for the conceptual restoration plans. An 8-year renourishment interval is proposed for consistency with the Charlotte County Erosion Control Project. The recommended design shoreline erosion rate computed from the shoreline change analysis is -3.9 feet per year.

As described above, the average density developed in the 2001-03 study for the beach fill template including advanced nourishment equaled 52 cubic yards per foot. The recommended density to be added to the rock revetment reach and upper portion of the downdrift erosional shadow reach computed from the volume change analysis was 18 cubic yards per foot to account for the erosion that has occurred since 2001. The recommended density to be added to offset the impacts of the 25-year design storm event computed from the storm erosion analysis was 11 cubic yards per foot. Combined, the conceptual restoration template densities should fall within the target range of 63 cubic yards per foot to 81 cubic yards per foot.

The minimum design beach fill width to be maintained through the project life was set at 40 feet which provides sufficient dry beach width for environmental and recreational purposes. Factors for advanced nourishment, equal to 8 years times 3.9 feet per year, storm erosion equal to 11 cubic yards per foot, and additional nourishment along the rock revetments equal to 18 cubic yards per foot, were applied.

Beach fill templates were developed by applying the above design criteria on the 2015 profiles. End tapers were included to maximize fill placement while providing a smooth transition to the existing updrift beach (northern ends) or providing a smooth transition to the existing downdrift beach (southern ends) noting this segment receives benefits from the Charlotte County Erosion Control Project. The beach fill template widths were measured at MHW and densities were derived and compared to the target ranges. Minor adjustments were made to create a smooth uniform shoreline along the beach fill extents.

6.2 Development of Alternatives

6.2.1 Manasota Key North Conceptual Plan #1

The primary conceptual plan is a stand-alone restoration plan for Manasota Key North extending from R-1 to R-15. The total volume equaled 880,000 cubic yards along 14,100 feet of shoreline for an average fill density of 62.5 cubic yards per foot. The beach fill densities at each monument, exclusive of the tapers, ranged from 71.4 to 87.5 cubic yards per foot. The design beach fill width measured at MWH ranged from 40 feet to 75 feet along the rock

revetments. The total design template measured at MWH, exclusive of the tapers, ranged from 146 feet to 181 feet along the rock revetment (Table 6). The renourishment volume for the 8-year maintenance interval, computed by subtracting the design template volume from the total template volume, equaled 560,000 cubic yards.

Table 6. Manasota Key North Conceptual Plan #1 Design Characteristics.

R-Mon	Area (CY/FT)	Average Area (CY/FT)	Length (FT)	Volume (CY)	Design * Template (FT)	Total * Template (FT)
R-1	33.7 **				75	166
		52.5	957	50,267		
R-2	71.4				75	181
		76.2	1,016	77,440		
R-3	81.0				75	181
		82.3	1,021	84,043		
R-4	83.5				75	181
		84.6	987	83,500		
R-5	85.7				75	181
		86.6	987	85,466		
R-6	87.5				65	171
		86.3	918	79,243		
R-7	85.1				55	161
		83.9	898	75,304		
R-8	82.7				45	151
		82.0	1,009	82,710		
R-9	81.2				40	146
		80.6	1,102	88,795		
R-10	79.9				40	146
		78.5	1,094	85,824		
R-11	77.0				40	146
		54.6	978	53,364		
R-12	32.2 **				40	71
		17.9	1,046	20,484		
R-13	7.0 **				40	40
		7.0	1,083	7,581		
R-14	7.0 **				40	40
		6.0	984	5,901		
R-15	7.0 **				40	40
Totals (Rounded)			14,100	880,000		

* Width measured at MHW
** Located within beach fill taper

6.2.2 Sarasota-Charlotte Combined Conceptual Plan #2

The first alternative to the primary plan is a combined restoration plan extending the beach fill into Sarasota County to R-173 consistent with the original 2001-03 study. It is noted that the survey for the Study Area did not extend to R-173. To compute the restoration plan volume from R-181 to R-173, the average fill density from R-181 to R-1 was applied along the shoreline reach. The total volume equaled 1,540,000 cubic yards along 24,600 feet of shoreline for an average fill density of 62.6 cubic yards per foot. The beach fill densities at each monument, exclusive of the tapers, ranged from 57.3 (in the extension) to 87.5 cubic yards per foot. The design beach fill width measured at MWH ranged from 40 feet to 75 feet along the rock revetments. The total design template measured at MWH, exclusive of the tapers, ranged from 146 feet to 181 feet along the rock revetments (Table 7). The renourishment volume for the 8-year maintenance interval, computed by subtracting the design template volume from the total template volume, equaled 960,000 cubic yards.

6.2.3 Erosion Control Project Combination Conceptual Plan #3

The second alternative to the primary restoration plan is extending the beach fill to the Erosion Control Project's 2016 beach fill limit at R-18. The total volume equaled 1,070,000 cubic yards along 17,100 feet of shoreline for an average fill density of 62.6 cubic yards per foot. The beach fill densities at each monument, exclusive of the tapers, ranged from 40.0 (in the extension) to 87.5 cubic yards per foot. The design beach fill width measured at MWH ranged from 40 feet to 75 feet along the rock revetments. The total design template measured at MWH, exclusive of the tapers, ranged from 40 feet along the Erosion Control Project overlap to 181 feet along the rock revetments (Table 8). The extension fill density was reduced below the design criteria based on professional judgment recognizing the 180,000 cubic yards of sand will be placed from R-18 to R-21 along with installation of the terminal groin during the 2016 construction event for the Erosion Control Project that will stabilize the southern end of Manasota Key. The renourishment volume for the 8-year maintenance interval, computed by subtracting the design template volume from the total template volume, equaled 670,000 cubic yards.

6.2.4 Conceptual Design Plans and Typical Sections

Presented in Figures 8 through 10 are the conceptual plan view and typical sections for the Manasota Key North beach fill conceptual plans noting at this scale the various tapers and extensions are not shown. Appendix C presents the conceptual plan view and full set of sections from R-181 to R-15. The transition from the concept design for Manasota Key North to the permitted template for the Charlotte County Erosion Control Project between R-13 to R-15 is also depicted.

Table 7. Manasota Key North Conceptual Plan #2 Design Characteristics.

R-Mon	Area (CY/FT)	Average Area (CY/FT)	Length (FT)	Volume (CY)	Design * Template (FT)	Total * Template (FT)
R-173	END				75	146
		61.0	7,800	475,800		
R-181	60.4				75	146
		58.8	943	55,513		
R-182	57.3				75	146
		60.8	1,036	62,965		
R-183	64.3				75	156
		65.8	747	49,201		
R-1	67.4				75	166
		69.4	957	66,379		
R-2	71.4				75	181
		76.2	1,016	77,440		
R-3	81.0				75	181
		82.3	1,021	84,043		
R-4	83.5				75	181
		84.6	987	83,500		
R-5	85.7				75	181
		86.6	987	85,466		
R-6	87.5				65	171
		86.3	918	79,243		
R-7	85.1				55	161
		83.9	898	75,304		
R-8	82.7				45	151
		82.0	1,009	82,710		
R-9	81.2				40	146
		80.6	1,102	88,795		
R-10	79.9				40	146
		78.5	1,094	85,824		
R-11	77.0				40	146
		54.6	978	53,364		
R-12	32.2 **				40	71
		17.9	1,046	20,484		
R-13	7.0 **				40	40
		7.0	1,083	7,581		
R-14	7.0 **				40	40
		6.0	984	5,901		
R-15	7.0 **				40	40
Totals (Rounded)			24,600	1,540,000		

* Width measured at MHW
** Located within beach fill taper

Table 8. Manasota Key North Conceptual Plan #3 Design Characteristics.

R-Mon	Area (CY/FT)	Average Area (CY/FT)	Length (FT)	Volume (CY)	Design * Template (FT)	Total * Template (FT)
R-1	33.7 **				75	166
		52.5	957	50,267		
R-2	71.4				75	181
		76.2	1,016	77,440		
R-3	81.0				75	181
		82.3	1,021	84,043		
R-4	83.5				75	181
		84.6	987	83,500		
R-5	85.7				75	181
		86.6	987	85,466		
R-6	87.5				65	171
		86.3	918	79,243		
R-7	85.1				55	161
		83.9	898	75,304		
R-8	82.7				45	151
		82.0	1,009	82,710		
R-9	81.2				40	146
		80.6	1,102	88,795		
R-10	79.9				40	146
		66.7	1,094	72,990		
R-11	53.5				40	116
		46.8	978	45,722		
R-12	40.0				40	71
		40.0	1,046	41,840		
R-13	40.0				40	40
		40.0	1,083	43,320		
R-14	40.0				40	40
		40.0	984	39,340		
R-15	40.0				40	40
		40.0	3,000	120,000		
R-18	40.0				40	40
Totals (Rounded)			17,100	1,070,000		

* Width measured at MHW
** Located within beach fill taper

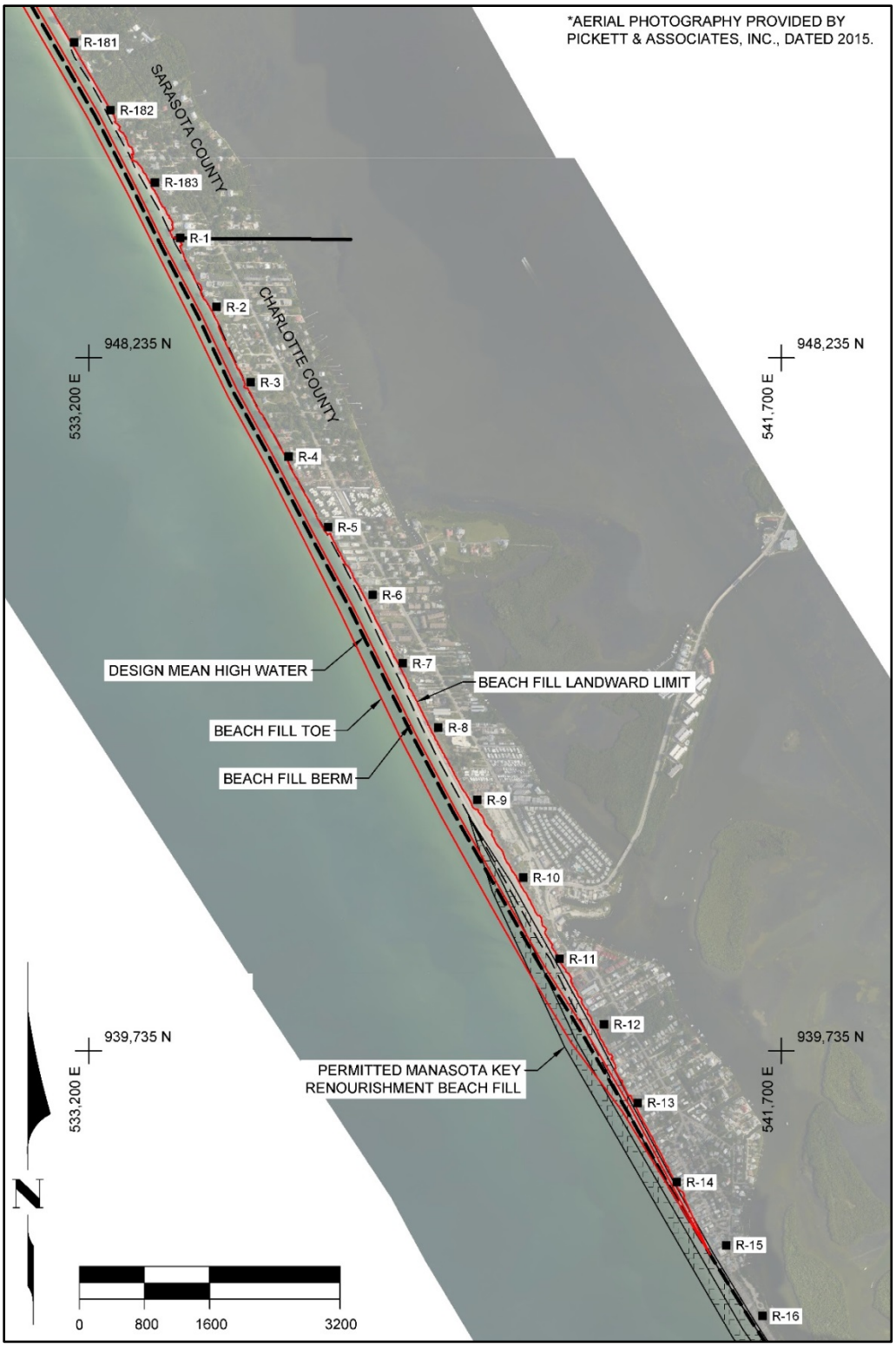

Figure 8. Manasota Key Conceptual Restoration Plan.

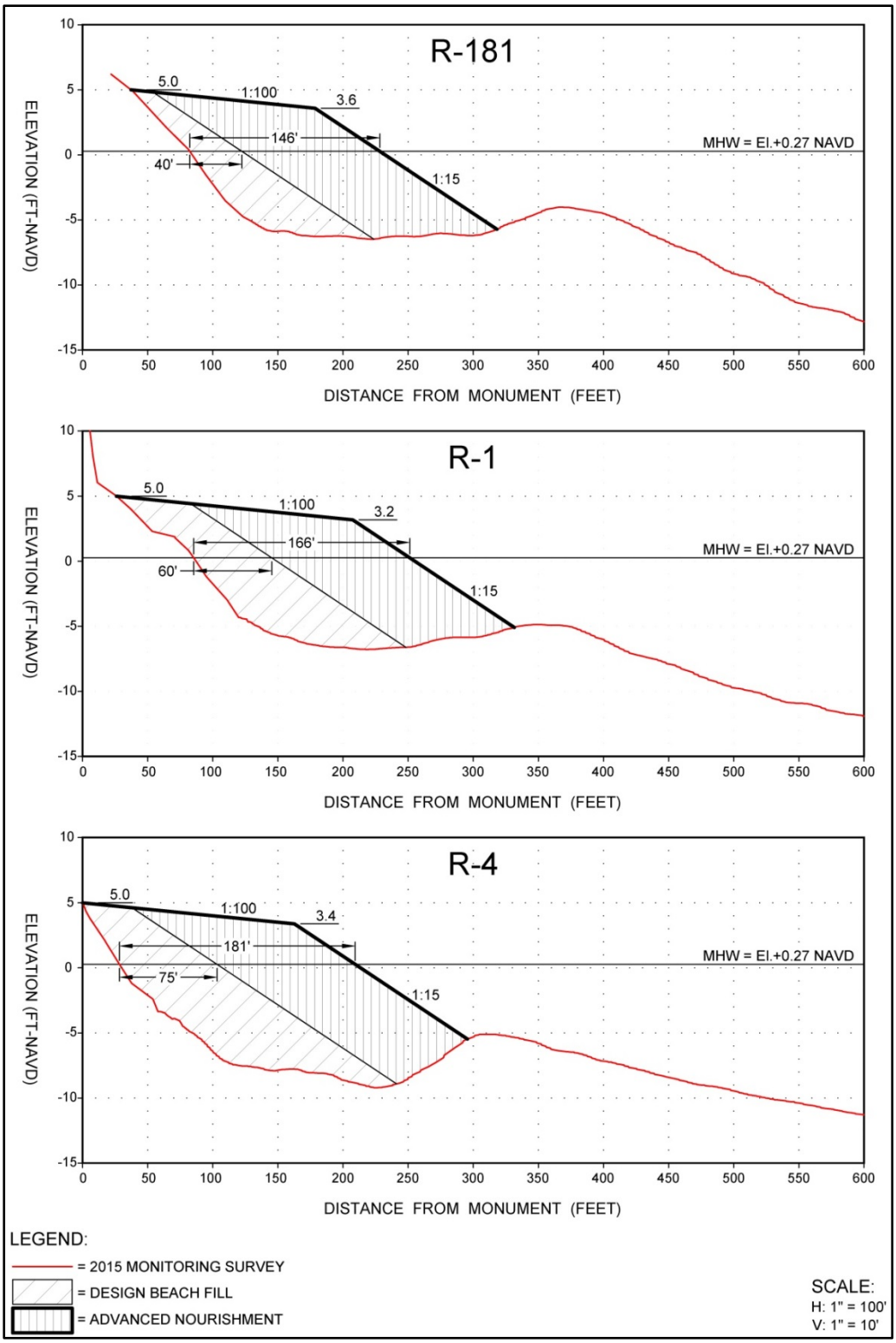

Figure 9. Manasota Key Conceptual Restoration Templates at R-181, R-1, and R-4.

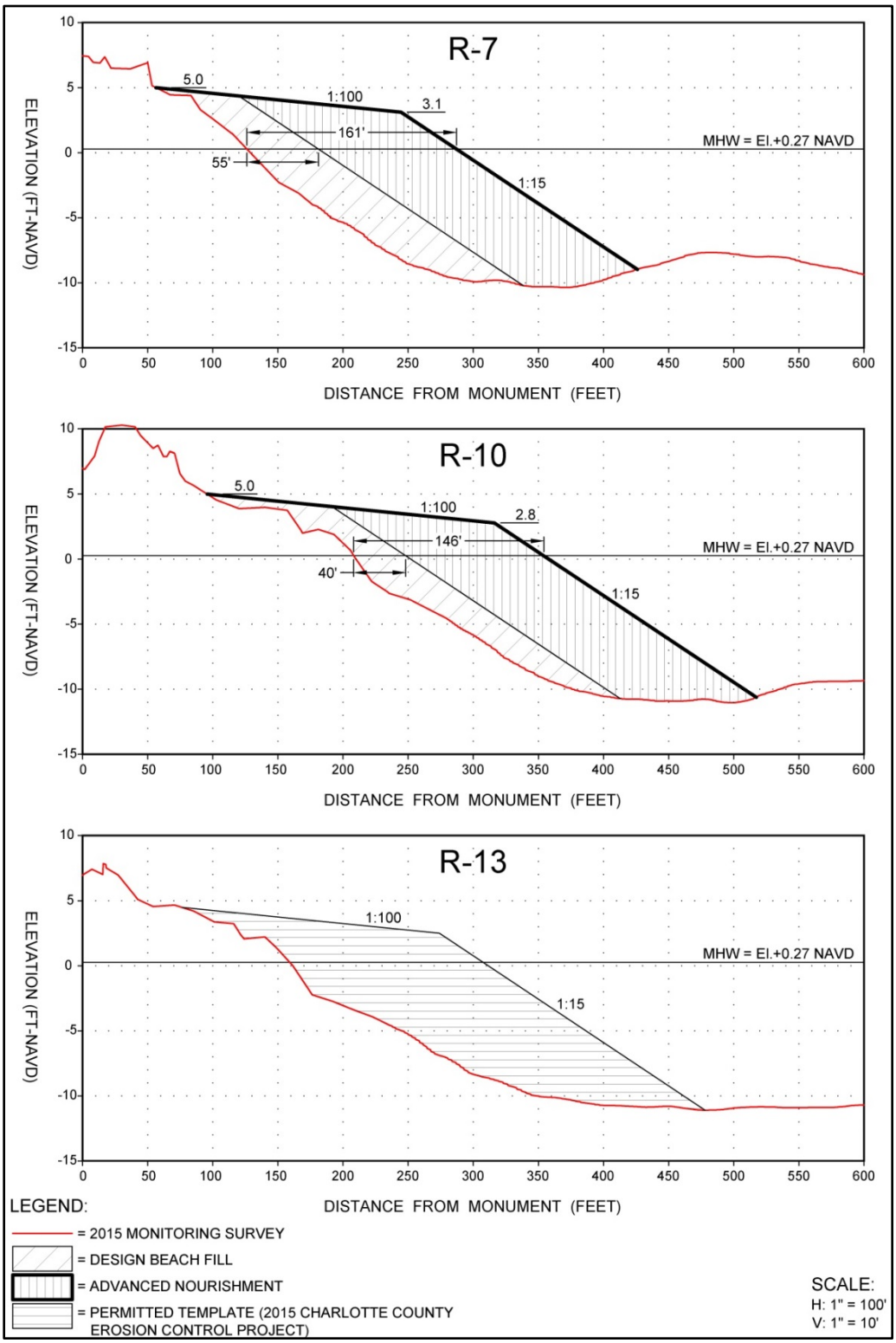

Figure 10. Manasota Key Conceptual Restoration Templates at R-7, R-10, and R-13.

7.0 POTENTIAL SAND SOURCES

7.1 Regional Sand Source Searches

7.1.1 Existing Studies

Multiple sand source searches have been completed in close proximity to the Study Area that have identified potential sand sources for consideration by the County for the future restoration and nourishment of Manasota Key North (Figure 11). It is noted this work was previously published by CEC and Coastal Technology Corporation (CTC) during the plan formulation of the Charlotte County Erosion Control Project (CEC and CTC, 2013).

7.1.2 CTC 1995

In May 1994, a total of seventy-two (72) jet probes were taken by CTC. An examination of the grain size, color, and thickness of the jet probe material was performed, and from these data sites were selected for additional analysis. In July 1994, CTC extracted forty-four (44) vibracores from the potential areas. A total of ninety-seven (97) samples and seven (7) composite samples were analyzed for sediment statistics. The mean grain size of the primary target area was 0.34 mm and designated as Borrow Area CT-C (Figure 11). This borrow area was one of two sand sources utilized for the 1995 Venice Beach Nourishment project (Walther, 1995). Approximately 1.0 MCY were mined from Borrow Area CT-C, and it was estimated to have approximately 900,000 cubic yards of beach quality sediment remaining.

7.1.3 CTC 2002

A 2002 CTC study reviewed previously identified sand resources offshore of Charlotte and Sarasota counties and estimated the quantities and qualities of previously undeveloped offshore borrow sources. The previously identified sites include thirteen (13) sites located generally within five miles of the shoreline of the two counties. According to the study, the offshore beach compatible sand resources of Sarasota and Charlotte Counties were approximately 32 MCY and 5.7 MCY, respectively. The 2002 CTC study also analyzed the available data regarding previously undeveloped borrow areas and estimated that there were five (5) new potential borrow areas offshore of Sarasota County containing up to 30.5 MCY of material and an estimated 37.5 MCY of material offshore of Charlotte County in three (3) potential borrow areas. The 2002 CTC study concluded three (3) potential borrow areas in Charlotte County identified as CT-5, CT-6 and CT-7 (Parkinson, 2002). The areas are located four to six miles offshore of Stump Pass (Figure 11). A 2004 geophysical transect was collected over this area by Coastal Planning & Engineering (CPE) and the results confirmed CT-5, CT-6 and CT-7 had sand in significant thicknesses (CPE, 2004).

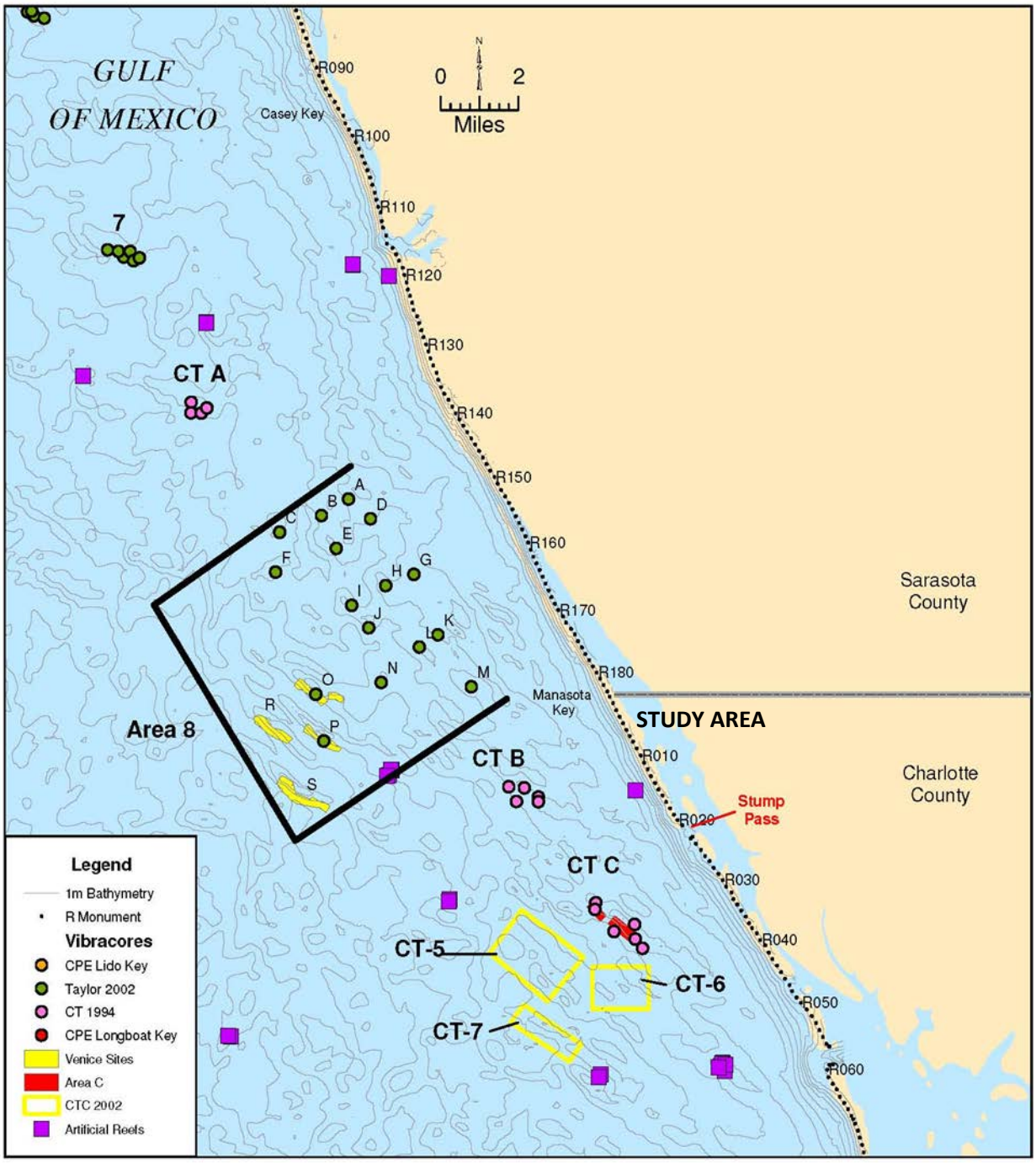

Figure 11. Study Area and Location of Previously Identified Borrow Areas (source: ross.urs-tally.com).

7.1.4 Taylor Engineering 2002

In 2002, Taylor Engineering collected fifty (50) twenty-foot vibracores offshore of Charlotte and Sarasota Counties (Taylor, 2002). The cores were collected for the City of Venice from seven potential borrow areas. Four of the areas were designated for the near term needs of the City of Venice, while areas 8O and 8P (Figure 11) were identified as areas in need of future exploration for the long term needs of the City. It was reported these sites may contain a combined total of 2.3 MCY with a mean grain size of 0.36 and 0.30, respectively, with less than 1% fines and color from gray to white. The Sarasota County – Venice, Florida Draft Limited Reevaluation Report (USACE, 2011) identified areas 8O and 8P, as well as additional areas 8R and 8S as the borrow sites for the next nourishment of Venice beaches.

Other subareas of Area 8 may also contain significant sand resources, but have not been developed into potential borrow sources. These include areas 8A, 8D, 8J and 8N. Sub-site 8A may contain up to 375,000 CY of sediment with a range of mean grain sizes from 0.23 mm to 0.29 mm with less than 1% fines. Sub-site 8D may contain up to 415,000 CY of beach quality sediment and mean grain size of 0.20 mm with less than 1% fines. Sub-site 8J may contain up to 225,000 CY of sediment with a coarser mean grain size of 0.40 mm. Sub-site 8N has both the largest potential volume size 550,000 CY and a mean grain size of 0.41 mm with less than 1% fines. Vibracores within the other sub-sites of Area 8 do not show significant thicknesses of clean sand and do not have defined geologic signatures (Taylor, 2002).

7.2 Charlotte County Erosion Control Project

A reconnaissance level sand source search was undertaken in 2012 to identify potential sand sources for construction of the Erosion Control Project. The search area included borrow areas CT-C, CT-5, CT-6 and CT-7 plus additional targets to the southeast. The investigation included geophysical (bathymetric, magnetometer, side-scan, and seismic) and geotechnical (vibracore) surveys. The results of the investigation identified two primary sand targets which encompassed the northwest portion of CT-C and CT-6 for the detailed sand source search (CEC, 2013).

The detailed level sand source search including combined geophysical and geotechnical surveys was undertaken in 2013 of the two primary sand targets denoted as Areas A and B (Figure 3-1). These two areas have been permitted for utilization to construct the initial and renourishment event of the Erosion Control Project. It is anticipated the significant majority of the identified sand resources within these two areas, totaling over 1.5 MCY, will be needed to address the sand needs for the permitted beach fills within the permit duration.

7.3 Upland Sand Sources

The Manasota Key North shoreline is accessible via upland access through the County's Beach Park and the Stump Pass Beach State Park providing the opportunity for utilization of upland sand to construct some or all of the conceptual restoration plans. Several communities in South

Florida have utilized upland sand sources to address their beach management needs either through renourishment or hot-spot maintenance in between renourishment events. Several quarries have been identified as having beach compatible sand and have been utilized successfully to construct beach fill projects within proximity to the Study Area including but not limited to E.R. Jahna in Ortona and Stewart Mining Industries in Immokalee. Local contractors have attended the Charlotte County Beaches and Shores Committee Meeting and expressed interest in participating in this work to provide upland sand for the future construction event.

7.4 Native Beach Sediment Specifications

7.4.1 Introduction

Pursuant to Florida Administrative Code 62B-41, to protect the environmental functions of Florida's beaches, only beach compatible fill shall be placed on the beach or in any associated dune system. Beach compatible fill is material that maintains the general character and functionality of the material occurring on the beach and in the adjacent dune and coastal system. One consideration for restoring and nourishing Manasota Key's beaches is to import beach compatible sand from upland sources. Summarized herein are the FDEP requirements for beach compatible sand specifications and the native beach characteristics for Manasota Key.

7.4.2 Florida Department of Environmental Protection

Municipalities undertaking beach restoration or nourishment must ensure that the sediment from any borrow area to be used in the project will meet the standard in Florida Administrative Code 62B-41.007(2)(j). The sediment from any proposed borrow source must be similar in Munsell color and grain size distribution to the material in the existing coastal system at the beach placement site.

In general, FDEP has developed the following sediment compliance specifications for borrow source compatibility (Table 9).

Table 9. FDEP Sediment Compliance Specifications.

Sediment Parameter	Parameter Definition	Compliance Value
Mean Grain Size	D50	Match Native Beach
Max. Silt Content	Passing #230 sieve	5%
Max. Shell Content*	Retained on #4 Sieve	5%
Munsell Color	Moist Value (Chroma = 1)	6 or Lighter
The beach fill material shall not contain construction debris, toxic material, other foreign matter, coarse gravel or rocks.		

*Shell Content is used as the indicator of fine gravel content for the implementation of quality control/quality assurance procedures.

It is noted these values may be adjusted subject to approval by the regulatory agencies through the Joint Coastal Permit process depending upon the variability in the native beach sediments.

7.4.3 Native Beach

In association with the County's design and permitting of their first Erosion Control Project, four (4) native beach samples taken from each of five (5) transects at R9, R12, R15, R18 and R21 on Manasota Key were analyzed (CTC, 2002). These samples were obtained from the following locations: (1) Backshore, (2) Mean High Water (MHW), (3) Mean Low Water (MLW), and (4) the -5-ft NAVD88 contour. The mean grain sizes for the Manasota Key samples ranged from 0.20 mm to 1.17 mm. The Manasota Key transects had a composite mean grain size of 0.47 mm. Percent fines ranged from 0% to <1% with an average of less than 1% fines. Percent gravel ranged from <1% to 18.1% with an average of 4.0% gravel. Percent carbonate material ranged from 5.8% to 62.3% with an average of 27.9% carbonate material by weight. A summary of these data are presented below in Table 10.

Table 10. Manasota Key Native Beach Characteristics.

Characteristic	Manasota Key Native
Mean Grain Size (Composite)	0.47 mm
% Fines (Avg)	<1%
% Gravel (Avg)	4.0%
%CaCO3 (Avg)	27.9%
Munsell Color	2.5Y 7/0 - 10YR 7/1 (dry) Light Gray

7.5 Sand Source Summary

Offshore sand targets in the Gulf of Mexico have been identified, surveyed, designed, permitted, and utilized for beach restoration and nourishment within proximity to the Study Area. Additional offshore sand targets have been identified that could be further investigated to serve as one option to provide beach compatible sand to address the erosion needs of Manasota Key North. The County could elect to utilize the Erosion Control Project's identified sources for Manasota Key North as another option; however, additional sources would then have to be surveyed, designed, and permitted to meet its future renourishment needs. Upland sand sources have been identified, tested, permitted, and utilized for beach restoration and nourishment within proximity to the Study Area. These sources should be investigated for potential use as a third option in future construction events which is outside the scope of this Study.

8.0 NEARSHORE HARDBOTTOM RESOURCES

8.1 Desktop Analysis

CEC analyzed aerial photography from 2006 through 2015 and beach profile data from 2001 and 2015 to identify potential nearshore hardbottom resources within the Study Area. While the photographs indicated exposed rock within close proximity to the shoreline, the profile data did not exhibit hardbottom relief. The mapping of the potential hardbottom overlain on the 2015 aerial photography is presented in Appendix A. These maps were utilized to develop a remote sensing plan to survey the nearshore zone of the Study Area to identify the presence or absence of nearshore hardbottom.

8.2 Remote Sensing

CEC employed a specialized subconsultant, Sonographics, to conduct a reconnaissance level side-scan sonar survey of the nearshore zone in July 2015. The survey extended from Manasota Key 1,000 feet north of the County line (R-183-Sarasota) to approximately one mile south of the County line (R-5-Charlotte). A Differential GPS (DGPS) was utilized during the survey to accurately record track-line position. The survey was performed using industry standards. The remote sensing survey consisted of collecting side-scan sonar imagery and analyzing it for surficial bottom features that can indicate the presence of hardbottom, debris, pipelines and other bottom features that may interfere with future beach restoration activities. The side-scan data was collected using an Edge Tech Model 4125 side-scan sonar system. The side-scan imagery was geo-encoded using a tow-fish position supplied by the Hypack Navigation Computer and stored in ta Edge Tech native – jstar (JSF) format on the side-scan system hard drive. Dual frequency data was collected for the entirety of the survey area. Stored electronic data was processed and an AutoCAD drawing of digitized bottom features was prepared including a mosaic of the identified hardbottom. The results of the survey confirmed nearshore hardbottom between R-2.5 and R-4. The side-scan sonar results correlates well to the 2015 aerial photography digitization.

8.3 Diver Verification

On September 16, 2015, CEC conducted a characterization of the identified nearshore hardbottom that extends from approximately R-2.5 to R-4 along Manasota Key North. The purpose of the hardbottom characterization was to approximate the limits of the hardbottom habitat, assess the physical features (relief, substratum type and sediment), and identify the biological hardbottom features. The characterization will be utilized to qualitatively define the impacts from a beach restoration project on the hardbottom resources, and inform the analysis of mitigation requirements to enable successful permitting of a future beach restoration project.

The dive team consisted of a senior scientist and two engineers. Five transects were established in the office as part of the desktop analysis. In the field, the endpoints of each transect were

located using a DGPS / Real-Time Kinematic unit. A float attached to a line with a weight was set at the seaward endpoint of each transect and a boat anchor was manually placed adjacent to the weight. An anchor was placed in the intertidal zone at the landward endpoint of each transect. A marked tape measure was tightly stretched between the two anchors.

The senior scientist performed the hardbottom characterization and identification of biological features. Beginning at the outer edge of each transect, the distance from the anchor to the edge of the hardbottom was recorded. Following the tape measure, the biologist stopped approximately every 12 meters and placed a one square meter quadrat on the left side of the tape measure with the top right-hand corner (as viewed by the biologist) at each interval mark. Observations on the relief, substratum type, sediment, and biological characteristics were assessed and recorded in situ. Other observations used to characterize the hardbottom area beyond the transects were also recorded. A summary of the observations is presented below.

Areal Extent
Utilizing the edge points measured in the field, CEC identified that the location and extents of hardbottom corresponded well to the 2015 aerial digitization. The approximate area of hardbottom was measured from the 2015 aerial photography equal to 4.25 acres. It is noted that the side-scan sonar data provided by Sonographics from their July 2015 survey may have picked up the shoreline armoring (existing revetment) and existing submerged groins and mapped them as hardbottom features. CEC will share their findings with Sonographics to improve their analysis.

Physical Features

Large-scale relief – Based on general observations of the combined five transects and areas beyond the transects, the large-scale relief (assessed in 100s of meters) of the hardbottom consists of large areas of flat rock having areas of low to medium relief (2 to 6 inches) interspersed with low ledges (4 to 12 inches) and breaks/cracks creating crevasses up to 12 inches deep.

Intermediate-scale relief –Based on general observations along each of the five transects, the intermediate-scale relief (assessed in 10s of meters), there are areas of flat to low relief rock with crevasses in areas where the rock is broken as described above.

Small-scale relief – Based on general observations of the individual one square meter quadrats, the small-scale relief, there are areas of flat to low relief rock where the relief ranged from 2 to 6 inches. When a crevasses or ledge was present, the relief ranged from 4 to approximately 12 inches.

Substratum Type
The entire area is exposed limestone rock and is within 200 m of the shoreline. Based on a review of historic aerial photos, the hardbottom has been exposed as a result of beach erosion and scour occurring within the trough between the shoreface and sand bar during the past decade.

Sedimentology
Where hardbottom is present, flat areas were covered with one inch or less of medium to coarse grain sand and shell. Areas of relief and the edges of the crevasses and ledges along with the flat areas have a dusting of fine silt that could be removed by "fanning" the areas by hand The thickness is estimated to be 3 mm or less.

Biological Hardbottom Features
Two community types were identified from the quadrat samples: turf algae community with limited amounts of fleshy algae that is the dominate community on the flat areas with areas of sponge community along the edges of ledges and crevasses. The biological species identified are listed in Table 11.

Table 11. Biological Species Observed on Nearshore Hardbottom.

Common Name	Scientific Name
Orange-encrusting sponge	*Diplastrella megastellata*
None (Brown algae)	*Padina vickersiae*
Branching Hydroid	*Sertularella speciosa*

9.0 PERMIT FEASIBILITY

9.1 General

Based upon a review of the FDEP permit and U.S. Fish and Wildlife Service (FWS) biological opinions for the County's Erosion Control Project, review of recently permitted beach projects in South Florida, and professional experience, the following species and habitats are the key environmental resources to be identified and protected, and measurable impacts thereto adequately mitigated for during the permitting, design and construction of the selected restoration plan.

9.2 Sea Turtles

The beach within the Study Area provides viable habitat for the loggerhead sea turtle, endangered leatherback sea turtle, endangered green sea turtle, endangered hawksbill sea turtle, and endangered Kemp's ridley sea turtle; and is designated loggerhead sea turtle critical habitat. Sea turtle nesting has been documented along Manasota Key North during the County's annual monitoring program. The conceptual restoration plans propose widening the beach with compatible sand providing the opportunity for sea turtle nesting. The regulatory agencies have developed Reasonable and Prudent Measures and Terms and Conditions including during construction to protect these species. The selected restoration plan will be subject to these requirements and environmental windows that preclude construction during sea turtle nesting season on Manasota Key.

9.3 Shorebirds and Migratory Birds

While the beach within the Study Area provides viable habitat for nesting shorebirds and foraging and resting habitat for migratory birds such as the threatened piping plover and threatened red knot, minimal usage by these species has been documented along Manasota Key North during the County's annual monitoring program. The conceptual restoration plans propose widening the beach with compatible sand providing the opportunity for shorebird nesting and for foraging and resting by migratory birds. The regulatory agencies have developed Reasonable and Prudent Measures and Terms and Conditions including during construction to protect these species. The selected restoration plan will be subject to these requirements and environmental windows that govern construction during shorebird nesting season.

9.4 Manatees

The nearshore zone along the Study Area as well as the pipeline corridors and borrow areas that will be utilized during construction include the geographic range of the manatee. The regulatory

agencies have developed Standard Conditions for In-Water Work to protect this specie. The selected restoration plan will be subject to these requirements during construction.

9.5 Smalltooth Sawfish

The nearshore zone along the Study Area as well as the pipeline corridors and borrow areas that will be utilized during construction include the geographic range of the smalltooth sawfish. The regulatory agencies have developed Standard Construction Conditions to protect this specie. The selected restoration plan will be subject to these requirements during construction.

9.6 Hardbottom Resources

As described above, significant hardbottom resources on the order of 4.25 acres have been identified within the nearshore zone along Manasota Key North that will be directly impacted by beach fill placement under the selected restoration plan. Impacts to these resources will have to be mitigated through creation of "like" resources, that is, hardbottom resources exhibiting similar characteristics of the hardbottom areas to be covered by the beach fill.

CEC reviewed other south Florida beach restoration projects that included nearshore hardbottom mitigation. The primary method employed to mitigate nearshore hardbottom impacts was to construct an artificial reef utilizing limestone boulders or prefabricated modules. The limestone boulders were locally available stone. The prefabricated modules were composed of poured concrete slabs with limestone cobbles and steel reinforcing.

In personal communication with FDEP regulatory staff, CEC presented a summary of the Study's goals, conceptual restoration plans, and nearshore hardbottom mapping and characterization results to assess the potential for mitigating the impacts from beach fill placement and successfully permit the selected restoration plan. FDEP staff opined that beach fill placement impacting 4.25 acres of nearshore hardbottom is a permittable activity provided a suitable mitigation plan was designed to offset the impacts. They shared the most common approach for other beach projects was to construct an artificial reef utilizing natural limestone of sufficient acreage in similar water depths and environment to mimic the characteristics of the resources impacted. Mitigation ratios for these other projects typically ranged from 1.0 to 1.5 depending upon the quality of hardbottom habitat to be impacted versus the quality of hardbottom habitat to be created and sustained.

9.7 Summary

Based upon a qualitative analysis of the key environmental resources and species identified for the Study Area, it is CEC's professional opinion that the selected restoration plan may be successfully permitted provided the County accepts all of the agency-developed protection and monitoring conditions for the critical species and habitats, and a mitigation plan is designed to

offset impacts to the nearshore hardbottom resources along Manasota Key North of sufficient acreage in similar water depths and environment to mimic the characteristics of these resources.

10.0 CONCEPTUAL OPINION OF PROBABLE PROJECT COSTS

10.1 Methodology

Based on the conceptual restoration plans and mitigation strategies to address project impacts to hardbottom resources, order of magnitude construction budgets were developed to include mobilization/demobilization, beach fill placement, and hardbottom mitigation. A 25% contingency was then applied to account for soft costs and uncertainties to formulate the conceptual opinion of probable project costs for the Study.

The Tri-Services Automated Cost Engineering System (TRACES MII Version 3.01) was utilized to develop the order of magnitude construction budgets. MII is the second generation of the TRACES software used as a costing tool by the USACE. The MII English Cost Book 2008, National Labor 2008 - Preliminary Draft, and the MII Equipment Region 3r 2007 libraries were linked to the project library in the development of this budget.

The dredge production rate, equipment daily cost, and sediment dredging and transport durations were developed utilizing a variation of the Cutter Suction Dredge Cost Estimating Program (CSDCEP) developed by the Center for Dredging Studies, Zachary Department of Civil Engineering, Texas A&M University (TAMU). The CSDCEP incorporates costing and production rate tools for cutterhead and mechanical dredges. The CSDCEP was customized for current inflation values, specific dredge parameters relating to fuel consumption, and sediment transport and offloading for the mechanical dredges. Shore-based construction and survey crews were eliminated from the derived daily cost equations because these are best estimated in the MII. The customized CSDCEP shall hereafter be referred to as the CEC-TAMU costing spreadsheets for hydraulic cutterhead dredging.

10.2 Basis

The basis for the order of magnitude construction budgets is comprised of the following items.

10.2.1 Mobilization/Demobilization

The mobilization/demobilization costs included the anticipated plant and equipment to be used in the excavation, transportation, and placement of fill materials. Separate mobilization/demobilization costs were developed for each major construction element such as cutterhead dredge and associated support equipment; construction personnel and equipment; and sediment pipeline delivery, installation, relocations, and removal. The derived budget was then compared to recent contract bids from projects of a similar nature. A summary of the individual mobilization/demobilization elements are listed below.

10.2.1.1 Dredge Mobilization/Demobilization

The cost associated with mobilization and demobilization of the cutterhead dredge, booster pump(s), plant, and support equipment and vessels was developed through analysis of recent construction contract bids and entered into the MII cost analysis as a lump-sum cost.

10.2.1.2 Mobilization/Demobilization of Shore Construction Personnel and Equipment

The cost associated with the mobilization of shore construction personnel and equipment was based on the required crews and equipment needed to work and shape the sediment within the fill template during construction and developed through analysis of recent restoration cost opinions.

10.2.1.3 Mobilization/Demobilization of Sediment Pipeline

The cost associated with mobilization and demobilization of the sediment pipeline was developed based on the required equipment and crews to handle the sediment pipeline from its home base to the job site.

The cost associated with the transport, installation, and removal of the shore segments of the sediment pipeline was developed based on the required equipment and crews needed to install/remove the shore segments of the sediment pipeline within the fill templates during fill placement.

The cost associated with the transportation, installation, relocation, and removal of the submerged sediment pipeline was developed based on the required equipment and crews needed to install the submerged sediment pipeline between the borrow area and the fill template; relocate the submerged sediment pipeline between borrow areas and the fill templates, and remove the submerged segments of the sediment pipeline.

10.2.2 Beach/Dune Fill

10.2.2.1 Dredging

The equipment cost was estimated by considering the daily rate for cutterhead dredge, booster pump(s), fuel, per foot sediment pipeline cost, and supporting equipment cost derived from the CEC-TAMU costing spreadsheets for cutterhead dredging. The estimated equipment daily cost was then multiplied by the sum of the fill placement duration and weather days. The unit cost per cubic yard of beach/dune fill was based on the required fill volume, anticipated cut-to-fill ratio losses, pumping distance, dredges pumping capacity, total dredging equipment daily cost, construction crews and shore equipment, and then divided by the required fill volume. The unit price was entered into the MII cost analysis as in-place cost for fill and multiplied by the

required volume to derive the cost for the sand only. Pay for sand as in-place for beach/dune construction has been utilized on prior restoration projects as a means to promote "best management practices" by the construction contractor.

10.2.2.2 Construction Crews and Equipment

The construction crews and equipment consist of a shore-based construction crew and equipment responsible for fill shaping and grading; an offshore sediment pipeline crew and equipment responsible for maintenance of the submerged sediment pipeline segments; and a shore sediment pipeline crew and equipment responsible for maintenance and relocation of the shore sediment pipeline as the fill advances within the fill template. The monthly cost for each crew and equipment set was developed within the MII cost analysis using the associated libraries and multiplied by the sum of the fill placement duration and weather days.

The cost associated with the shore-based construction personnel and equipment was developed based on the required crews and equipment needed to work and shape the sediment within the fill template during construction. The cost associated with the sediment pipeline crews personnel and equipment was developed based on the required crews and equipment needed to maintain the sediment pipeline. The equipment associated with shore segments of the sediment pipeline crew activities included bulldozers and sediment pipeline segment handlers commonly called skidders. The submerged sediment pipeline crews required additional personnel such as welders and crane operators. The submerged sediment pipeline crews utilize additional equipment such as barges, cranes, welding machines, and air compressors to maintain the submerged segments of the sediment pipeline.

10.3 Assumptions

The following assumptions were used in the development of production rates and equipment cost for cutterhead dredging for beach/dune and marsh fill construction which served as the basis for the development of the order of magnitude construction budgets.

10.3.1 Beach/Dune Fill

- Cutterhead suction dredge size / horsepower: 30" / 9,000 Hp (18 hours/day)
- 2 D-5 Dozers, 2 D-7 Dozers, and 1 Wheel Loader or equivalent (24 hours/day)
- Offshore borrow areas permitted for Erosion Control Project were basis for costing

10.3.2 Booster Pump

- Booster pump horsepower: 5,200 Hp

10.3.3 Fuel and Lubricants

- Bulk fuel cost per gallon: $1.92
- Lubricants: 10% of the fuel usage

10.3.4 Environmental Window

As described previously, the state and federal authorizations for Manasota Key will impose an environmental window precluding beach fill placement during sea turtle nesting season. The assumption for contract timing is construction can be completed in one mobilization effort within the authorized environmental window.

10.3.5 Summary

Applying these assumptions, production rates were calculated using the CEC-TAMU costing spreadsheets. Inputs for the production rate calculations for cutterhead suction dredge were average sediment pipeline length from the borrow area to restoration area, bank height, general sediment characteristics, and dredge size.

10.4 Dredge and Fill Construction Duration

The construction duration for dredging and fill placement is based mobilization of crews and equipment; sediment pipeline installation, relocation, and removal; sediment excavation and fill placement; and demobilization. A 25% downtime for weather was included. The total construction duration depends on the alternative plan / volume requirements.

10.5 Artificial Reef Mitigation Construction Budgets

Based upon personal communication with FDEP regulatory staff and knowledge of the Study Area's nearshore features, a limestone rock reef was chosen to serve as the mitigation strategy for the conceptual plans. Utilizing recent bid tabulations from south Florida beach restoration projects that performed hardbottom mitigation, unit costs for limestone rock reefs were developed and applied for the Study. For the purposes of developing the construction budget, a 1.5 multiplier was applied to the existing 4.25 acres yielding an estimated 6.4 acre artificial reef site. This multiplier accounts for near-term hardbottom exposure likely to occur between completion of the Study and actual construction, and the mitigation ratio to be developed once design of the mitigation site is completed and accepted by the regulatory agencies.

10.6 Conceptual Opinion of Probable Project Cost

The order of magnitude construction budgets were developed for each alternative and escalated from the estimate price year used in the MII and CEC-TAMU costing spreadsheets to the projected year of construction assumed to be 2019.

Table 12. Order of Magnitude Construction Budget: Conceptual Restoration Plan #1.

Manasota Key North Beach Erosion Study Update Manasota Key North Conceptual Plan #1 Conceptual Opinion of Probable Project Cost				
Item Description	**Unit**	**Estimated Quantity**	**Unit Price**	**Total***
Construction (Cost Year: 2019)				
1. Mobilization / Demobilization	L.S.	1	$2,674,000	$2,674,000
2. Beach/Dune Fill	C.Y.	880,000	$12.10	$10,648,000
3. Artificial Reef (Mitigation)	AC.	6.4	$949,000	$6,050,000
			Subtotal	**$19,372,000**
			25% Contingencies	**$4,843,000**
			TOTAL	**$24,215,000**

* Totals are rounded up to nearest $1,000
Cost Per Mile = $9,068,000 (2019 Dollars)
Unit Cost per Cubic Yard (without Mitigation) = $18.92 (2019 Dollars)
Unit Cost per Cubic Yard (with Mitigation) = $27.52 (2019 Dollars)

Table 13. Order of Magnitude Construction Budget: Conceptual Restoration Plan #2.

Manasota Key North Beach Erosion Study Update Sarasota-Charlotte Combined Conceptual Plan #2 Conceptual Opinion of Probable Project Cost				
Item Description	**Unit**	**Estimated Quantity**	**Unit Price**	**Total***
Construction (Cost Year: 2019)				
1. Mobilization / Demobilization	L.S.	1	$2,820,000	$2,820,000
2. Beach/Dune Fill	C.Y.	1,540,000	$14.40	$22,176,000
3. Artificial Reef (Mitigation)	AC.	6.4	$949,000	$6,050,000
			Subtotal	**$31,046,000**
			25% Contingencies	**$7,762,000**
			TOTAL	**$38,808,000**

* Totals are rounded up to nearest $1,000
Cost Per Mile = $8,488,000 (2019 Dollars)
Unit Cost per Cubic Yard (without Mitigation) = $20.29 (2019 Dollars)
Unit Cost per Cubic Yard (with Mitigation) = $25.20 (2019 Dollars)

Table 14. Order of Magnitude Construction Budget: Conceptual Restoration Plan #3.

Manasota Key North Beach Erosion Study Update Erosion Control Project Combination Conceptual Plan #3 Conceptual Opinion of Probable Project Cost				
Item Description	**Unit**	**Estimated Quantity**	**Unit Price**	**Total***
Construction (Cost Year: 2019)				
1. Mobilization / Demobilization	L.S.	1	$2,674,000	$2,674,000
2. Beach/Dune Fill	C.Y.	1,070,000	$11.90	$12,733,000
3. Artificial Reef (Mitigation)	AC.	6.4	$949,000	$6,050,000
			Subtotal	**$21,457,000**
			25% Contingencies	**$5,365,000**
			TOTAL	**$26,822,000**

* Totals are rounded up to nearest $1,000
Cost Per Mile = $8,282,000 (2019 Dollars)
Unit Cost per Cubic Yard (without Mitigation) = $18.00 (2019 Dollars)
Unit Cost per Cubic Yard (with Mitigation) = $25.07 (2019 Dollars)

11.0 FUNDING APPROACHES

As part of Study, potential federal, state, and local revenue sources were reviewed which might be used for to address the beach management needs for Manasota Key North.

11.1 Federal

11.1.1 Federal Shore Protection / Navigation Project

In the late 1990's – early 2000's when Charlotte County renewed their interest in the management of Stump Pass and its adjacent beaches including Manasota Key, they explored opportunities for Federal funding including a joint effort with Sarasota County through the West Coast Inland Navigation District. These efforts were unsuccessful and the County proceeded with funding at the local and state level.

In 2012, the County initiated a new request to the USACE to discuss federal funding of their Erosion Control Project. Within the request, Charlotte County committed to the USACE that if a project with a Federal interest is likely, the County would enter into a partnership agreement with the USACE to pay their local share of the required studies. Further, if it was found feasible to develop a Federal project at Stump Pass, the County would agree to provide the local cooperation elements and cost sharing prescribed by the Secretary of the Army. The USACE reviewed the County's request and reached the following determinations. With respect to shore protection, the updrift beach on Manasota Key within the Erosion Control Project limits has little infrastructure thus storm damage reduction benefits would be limited; and the downdrift beach, although developed and would realize benefits, was deemed to be cost-prohibitive to the general public due to the qualifier of access to the public on a just and equitable basis referencing the ferry cost for car access. With respect to navigation, the USACE determined that Stump Pass has limited commercial navigation and would not justify Federal participation in a project. The concluding paragraph stated it does not appear that there is Federal interest in moving forward with a Federal project at this time.

Based upon the USACE review of the Erosion Control Project and this negative determination, the likelihood of obtaining federal funding for Manasota Key North is very low attributed to the low benefit to cost ratio under the Federal standards as well as the lack of public access.

11.1.2 Federal Emergency Management Agency

The other opportunity to obtain federal funding for the Project is through the Federal Emergency Management Agency (FEMA). The Stafford Act, 42 U.S. C. 5121-5206, as amended, Sections 403 and 406; and 44 Code of Federal Regulations (CFR), Section 206.225, Emergency work, and Section 206.226, Restoration of damaged facilities, authorizes FEMA's Public Assistance Program to fund replacement of sand on damaged public beaches under

certain conditions. Eligibility is divided into two areas: emergency work and permanent work (restoration of damaged facilities). FEMA will review proposed beach restoration projects for compliance with the Endangered Species Act, Coastal Barrier Resources Act, and National Historic Preservation Act. Further, beach restoration funded as a post-storm recovery project is required to have all applicable Federal, State, Tribal, or local regulatory authorizations including, but not limited to, permits under Section 404 of the Clean Water Act and Coastal Zone Management Act.

FEMA provides funding for the restoration or replacement of a public facility (public beach) on the basis of its design to the conditions that existed immediately prior to the disaster. In accordance with 44 CFR Section 206.2260)(2), a beach may be considered an eligible facility when the beach was constructed by the placement of imported beach compatible sand to a designed elevation, width, and slope; the project has been maintained through periodic renourishment with imported beach compatible sand; and the maintenance program sustains the original design.

While the initial project for restoring the Manasota Key North beach will not be eligible for FEMA funding, provided the County implements a program for constructing and maintaining an engineered beach design on periodic basis, the program will be eligible for FEMA post-storm recovery funding in the future.

11.1.3 RESTORE Act

The RESTORE Act, signed into law in 2012, provides a vehicle for civil and administrative Clean Water Act penalties from the Deepwater Horizon disaster which occurred in 2010 in the Gulf of Mexico. The Act provides that 80% of the penalties collected will be allocated across the Gulf region. In Florida, the 23 Gulf coastal counties eligible for two categories, one that provides 35% directly to the counties; and one that provides 30% to a consortium of counties. A third category provides 30% to projects of regional significance across the Gulf region.

Projects may be proposed to FDEP who in consultation with FWC will evaluate the projects and submit the recommended ones to the Governor for submittal to the Gulf Coast Ecosystem Restoration Council for funding consideration. Florida has established the following priorities for proposed projects:

- Stormwater / Wastewater infrastructure projects
- Community resilience / Living shorelines,
- Water quality projects,
- Implementation of agriculture best management practices, or
- Fish and wildlife habitat and management.

The County is considering submitting the Erosion Control Project for a potential RESTORE Act funding. Future beach nourishment of the Manasota Key shoreline should also be considered especially if the regional approach with Sarasota County or if the combination with the Erosion Control Project is undertaken.

11.2 State

11.2.1 Introduction

The State of Florida's Beach Management Funding Assistance Program (BMFAP) is specifically intended to provide assistance to local governments for beach restoration activities such as the proposed Project. Since 2003, Charlotte County has applied for funding assistance under this program and to date has received over $4.3 million dollars in State cost sharing. The State has in their budget for fiscal year FY15-16 $2.5 million dollars for cost sharing of the Erosion Control Project.

11.2.2 BMFAP Analysis

Utilizing the guidelines developed by FDEP for the BMFAP, the ranking criteria for each alternative were determined (Table 15). For the Erosion Control Combination Project, the scores from this project's FY16-17 BMFAP were applied or improved based upon the expanded project parameters (e.g., project length, recreational and economic benefits).

Based upon the analysis, the Manasota Key North Conceptual Plan #1 scores the lowest in the funding matrix primarily due to the reduced project length and lack of public access. The Sarasota-Charlotte Combined Conceptual Plan #2 has the potential to score favorably within the BMFAP based upon the increased project length, recreational benefits, and public access; as well as the regionalization approach. The Erosion Control Project Combination Conceptual Plan #3 also has the potential to score favorably within the BMFAP based upon the increased project length, recreational benefits, and public access; as well as the proven performance and success of the past beach nourishment events.

Both options could be advanced for consideration by the stakeholders and Board of County Commissioners to assist with funding future beach projects on Manasota Key North. It is noted that the Erosion Control Project Combination will provide an additional benefit to the County and stakeholders within this project's limits from the increased scoring, thus improving the chances on receiving State cost sharing in the future.

It is also recommended that the County and Manasota Key North stakeholders examine opportunities to create public access along the Study Area including 5 foot wide public accesses extending from Gulf Boulevard to the beach, and parking for the public such as parallel parking within the right-of-way within one-quarter mile of the public access points. This strategy was implemented for the Erosion Control Project, which resulted in the County receiving over 44% state cost sharing for past projects.

Table 15. BMFAP Ranking Criteria for Conceptual Restoration Plans.

Criteria	Maximum	Plan #1	Plan #2	Plan #3
Severity of Erosion	10	1.2	0.9	6.0
Threat to Upland Structures	10	1.3	1.0	0.7
Recreational and Economic Benefits	10	2.4	2.7	2.5
Congressional Authorization of Project Phase	5	0	0	0
USACE Project Agreement	5	0	0	0
Availability of FEMA Funding	5	0	0	0
10-Year Comprehensive Financial Plan*	2	2	2	2
Designated Funding Source by Referendum*	2	2	2	2
Third Party Funding	2	0	0	0
Quarterly Reporting Requirements	2	0	0	2
Active Permits	1	0	0	1
Secured Local Funds	1	0	0	1
Previous Cost Sharing in Feasibility or Design	1	1	1	1
Enhanced Longevity	3	0	0	3
Previously Restored Shoreline	5	0	0	5
Release of Appropriation	1	0	0	0
Project Performance: Nourishment Interval	8	6	6	6
Project Performance: Cost Per Mile Per Year **	2	TBD	TBD	TBD
Mitigating Inlet Effects	10	0	0	0
Innovative Technologies	3	0	0	0
Technologies New to Florida	2	0	0	0
Enhancing Nesting Sea Turtle Refuges	5	0	0	0
Regionalization	5	0	5	0
Significance: Project Length	10	2.7	4.7	5.2
Significance: Construction Phase Projects	1	0	0	1
Significance: Economic Impact	2	1	1	1
Significance: Advanced Placement Loss	5	0	0	0
Significance: Erosion into Design Profile	1	0	0	1
Significance: Placement Volumes **	1	TBD	TBD	TBD
Total		**19.6**	**26.3**	**40.4**

* Assumed Funding Plan would be instituted for all three conceptual plans
** To Be Determined (TBD): Scoring function of state wide project costs and volumes

11.3 Local

11.3.1 Potential Sources

As part of the long-term plan for beach restoration and inlet maintenance, in May 2003, Charlotte County established two dedicated funding sources. Ordinance 2003-25 states pursuant to the provisions of Section 125.01, Florida Statutes, the County has the power to establish a municipal service benefit unit (MSBU) and levy ad valorem taxes within the MSBU boundary; and the County has determined that is in the best interest of the property owners and residents

in the Project area to create a MSBU to provide funding for beach management. The primary purpose of the MSBU is to provide for the nourishment, renourishment and prevention of erosion of the beaches located within the MSBU boundary from funds derived from assessments within the MSBU boundary. Funding derived from the MSBU may be used in conjunction with funding derived from the second funding source, the Stump Pass/Beach Renourishment Taxing Unit described below.

Ordinance 2003-26 states pursuant to the provisions of Section 125.01, Florida Statutes, the County has the power to establish a municipal service taxing unit (MSTU) and levy ad valorem taxes within the MSTU boundary; and the County has determined that is in the best interest of the property owners and residents in the Project area to create a MSTU to provide funding for Stump Pass dredging. The primary purpose of the MSTU is to provide funding for the costs associated with the Stump Pass dredging project including permit requirements, annual monitoring; maintenance dredge projects; improvements to the Stump Pass Beach State Park; and mitigation for loss of sea bird habitat due to the dredging of the new channel. Funding derived from the MSTU may be used in conjunction with funding derived from the first funding source, the Stump Pass/Beach Renourishment Benefit Unit described above.

In addition to these two dedicated funding sources, the County has applied funds from their Tourist Development Council bed taxes, WCIND funds, and boater improvement funds.

Due to the challenges associated with obtaining State and Federal funding, and recognizing that both State and Federal funding programs require local matching dollars, the County and stakeholders should work together to develop the program to provide local funding sources for the beach management program on Manasota Key North. Next, the Tourist Development Council bed taxes should be reviewed for inclusion in the local funding program. Further, because the existing MSTU encompasses the Study Area, the County should analyze the MSTU for opportunities to provide funding for future beach nourishment on Manasota Key North.

The WCIND and boater improvement funds are tied to the benefits for navigation at Stump Pass which is outside the Study Area, thus it is anticipated that neither of these sources could be utilized for the local funding program.

11.3.2 Approaches

There are several key parameters with respect to establishing a MSBU or MSTU to fund the selected restoration plan. An MSBU requires the special assessment be related to the benefit that accrues to the property from the project constructed, the special assessment need not be uniform within the MSBU boundary but must be fairly and reasonably apportioned, and the County has broad discretion in identifying the benefits of a project and developing a methodology to apportion the benefits and the costs.

The primary benefits to the properties within the beach fill limits is the storm damage reduction benefits provided by the increased beach width. These benefits reduce as the distance to the

upland infrastructure increases. The secondary benefits from beach restoration may include enhanced recreation, improved environmental conditions, increased property values, and increased tourism / economic activity.

Examples of beach projects that have been funded through a zoned MSBU include the following. The 1994 Palm Island Restoration Project was paid for by the residents of the Palm Island Resort through a County established MSBU. The storm damage reduction benefits were determined to account for 60% of the project benefits and enhanced recreation benefits were determined to account for 40% of the project benefits. Only the beach-front property owners paid for the storm damage reduction benefits; their share was divided equally among the properties. All the property owners paid equally for the recreational benefits. A second example includes the Town of Longboat Key. To pay for their beach restoration projects, the Town established a two zoned MSBU for the beach-front and off-beach properties. The spilt between storm damage reduction and recreational benefits is 80/20 noting all commercial and rental property owners pay the 80% apportionment regardless of which zone they are in.

Another example of a tiered system is the Charlotte County Erosion Control Project. As described above, the County is the local sponsor and established both a MSBU that includes all beach-front properties that receive direct beach fill placement to pay for the storm damage reduction benefits, and a MSTU that includes all the properties within West County to pay for the enhanced recreational and environmental benefits.

As part of establishing a recommendation for funding the beach management needs for Manasota Key North, CEC recommends soliciting stakeholder input as to the delineation of the beach-front and off-beach zones, and apportionments thereto for the storm damage reduction and recreational benefits.

12.0 STAKEHOLDER MEETINGS

Two formal presentations have been given to the Manasota Key North stakeholders including the Beaches and Shores Advisory Committee meeting in October 2015 and the South Sandpiper Key Association meeting in January 2016. Further, updates have been provided to the stakeholders at the November 2015 through March 2016 meetings of the Beaches and Shores Advisory Committee. A formal presentation was also given to the Board of County Commissioners for both Sarasota and Charlotte Counties at their Joint Meeting in November 2015.

The presentations to the stakeholders included the Study overview, historical perspective of the beach and inlet management activities, summary of the prior study, erosion analysis, and results of the hardbottom mapping to describe the current conditions on Manasota Key North. The conceptual plans, potential sand sources, construction budgets, and funding approaches were presented in detail. The stakeholders were requested to provide input on whether they support beach nourishment to address the erosion issues, their willingness to execute a construction easement to provide access to the County and contractor to conduct the work, a preference on a restoration plan, and an expression of their willingness to pay they fair share of the costs. They were also asked to consider addition public parking and access points to improve the chances of receiving State cost sharing and at a higher percentage. The presentation at the Joint Meeting was a synthesis of the stakeholder presentations noting it was for information purposes only; and no stakeholder input was requested.

The issues, concerns, and questions expressed by the stakeholders included the following topics:

<u>Severity of Erosion</u>

- Current conditions are so severe the existing shoreline armoring will fail sometime during the three years it takes to complete the design, permits, and construction.
- What temporary means are available to address the critical erosion until beach project can be constructed?
- What is the County's policy on armoring?
- Would DEP make the property owners remove any armoring structure installed now to address the severe erosion at the time of constructing the beach project?

<u>Construction Easements</u>

- Concern expressed over having to execute a construction easement for a yet to be determined beach management program.
- What is the percentage of the property owners that have to sign the construction easements for the County to construct the beach project?
- Some beachfront owners are holding the rest of the beachfront owners hostage by refusing to sign their easements.

Costs

- What will the beach management program cost each property owner?
- What is the percentage of the property owners that are needed to support the MSBU to have it established?
- What fiscal contribution will the County make to the beach management program?
- How does the State funding program work?
- Is the beach management program eligible for Federal dollars?

Erosion Control Line

- How does setting an Erosion Control Line affect the privacy of the beachfront owners?
- How does setting an Erosion Control Line affect the property rights of the beachfront owners?
- What new laws will go into effect after the Erosion Control Line is set?
- Can the Erosion Control Line be set seaward of MHW along the revetments, e.g., at the seaward toe of the rock?

Dunes

- Must a dune be constructed as part of the beach project?

Property Rights

- What happens when the beach project is constructed and now the perception is the County has increased public access to the beach? Non-beachfront owners / non-residents will feel they are entitled to use the beach and adversely affect the beachfront owners who want to remain private.
- There should be an ongoing responsibility for the County to make sure there is a level of enforcement after the beach project is built and public access has been provided / improved, including increasing law enforcement.
- Where will the public park after the beach project is constructed noting the new beach will attract more visitors to Manasota Key North?
- Would the County relax rules for the beachfront owners who give up their private beach?

13.0 RECOMMENDATIONS

13.1 Restoration Strategy

The recommended strategy to address the critically eroding beaches of Manasota Key North is to implement a beach management program consisting of initial restoration and periodic beach nourishment. Based upon the updated erosion analysis, professional experience and judgment of CEC, and input received from the residents who attended and provided input during the stakeholder meetings, the recommended restoration plan for Manasota Key North should focus on the beach segment from R-1 to R-10.5, that is, from the County line to the southern end of Chadwick Park. These limits correspond to the critically eroded beach segment adjacent to and along the existing rock revetments, and align with the majority of the residents who support beach nourishment to address the erosion problem along Manasota Key North. Offshore sand sources including targets previously identified as well as additional targets further offshore should be explored and identified for future beach nourishment. Upland sand sources should also be explored and identified for future beach nourishment. Continued communication with Sarasota County to seek their interest in a future regional strategy is warranted as extending the beach fill limits will enhance project performance and create opportunities for cost sharing and garnering additional funding from non-local sources.

13.2 Permitting Recommendations

The County's permits for the Erosion Control Project include future beach nourishment on Manasota Key extending to the northern end of Chadwick Park at R-9. The permitting recommendation is to take advantage of the existing permits and pursue a major modification to extend the permitted beach fill limits along Manasota Key North. The focus of the permitting process will be designing an appropriate mitigation plan to offset impacts to the nearshore hardbottom resources along Manasota Key North of sufficient acreage in similar water depths and environment to mimic the characteristics of these resources.

13.3 Funding Recommendations

Specific to federal funding, the County could evaluate the opportunity to qualify the program for RESTORE Act funding. Further, implementing a program for constructing and maintaining an engineered beach design on a periodic basis will qualify the program for FEMA post-storm recovery funding for future nourishment events.

The proposed beach management program may be eligible for State cost sharing under the BMFAP and an annual application for funding should be made beginning with FY17-18 due to the state in summer 2016. The recommended approach for modifying the Erosion Control Project permits to include Manasota Key North will garner higher scores than as a stand-alone project in the BMFAP. To improve funding potential, it is recommended that the County and

Manasota Key North stakeholders examine opportunities to create public access along the beach including 5 foot wide public accesses extending from Gulf Boulevard to the beach, and parking for the public such as parallel parking within the right-of-way within one-quarter mile of the public access points.

Continue to explore partnering with Sarasota is recommended to increase the program's scope and magnitude and provide a funding partner to offset the significant fixed costs such as mobilization and demobilization. Further, this will garner additional points in the State's ranking criteria thus improving chances for State funding.

Local sources are required to help fund the recommended program, thus the County and Manasota Key North stakeholders should work together to provide the local share of the total project costs. The County could evaluate local sources including Tourist Development Council bed taxes and other County sources recognizing the benefits a beach management program affords the County and residents. The County could pursue an economic study to define these benefits and assist with the allocation of costs among the beneficiaries.

13.4 Restoration Plan Details

The recommended plan for the initial restoration of Manasota Key North is a component of Conceptual Plan No. 1 with the following modifications.

- Extend the beach fill limits 1000 ft. on the north end into Sarasota County to provide a taper to the beach fill to enhance project performance.
- Reduce the beach fill over 3,500 ft. on the south end to correspond to the limits of Chadwick Park at R-10.5.
- Provide a taper on the south end from R-10 to R-10.5 to provide a smooth transition to natural grade.
- Redesign the beach fill width for a 5 year design life to align with the first nourishment cycle of the County's Erosion Control Project projected to be in 2024.

For the initial restoration, the total volume equals 654,000 cubic yards along 10,540 feet of shoreline for an average fill density of 62 cubic yards per foot. The beach fill densities at each monument, exclusive of the tapers, range from 59 to 74 cubic yards per foot. The design beach fill width measured at MWH ranges from 40 feet to 75 feet along the rock revetments. The total design template measured at MWH, exclusive of the tapers, ranges from 114 feet to 149 feet along the rock revetment.

Applying the same unit costs from Conceptual Restoration Plan 1, the order of magnitude construction budget for recommended plan for the initial restoration is $20,800,000. The average cost per mile equates to $10,418,000. The average unit cost per cubic yard with and without mitigation equates to $31.80 and $20.24, respectively. These costs are presented in 2019 dollars.

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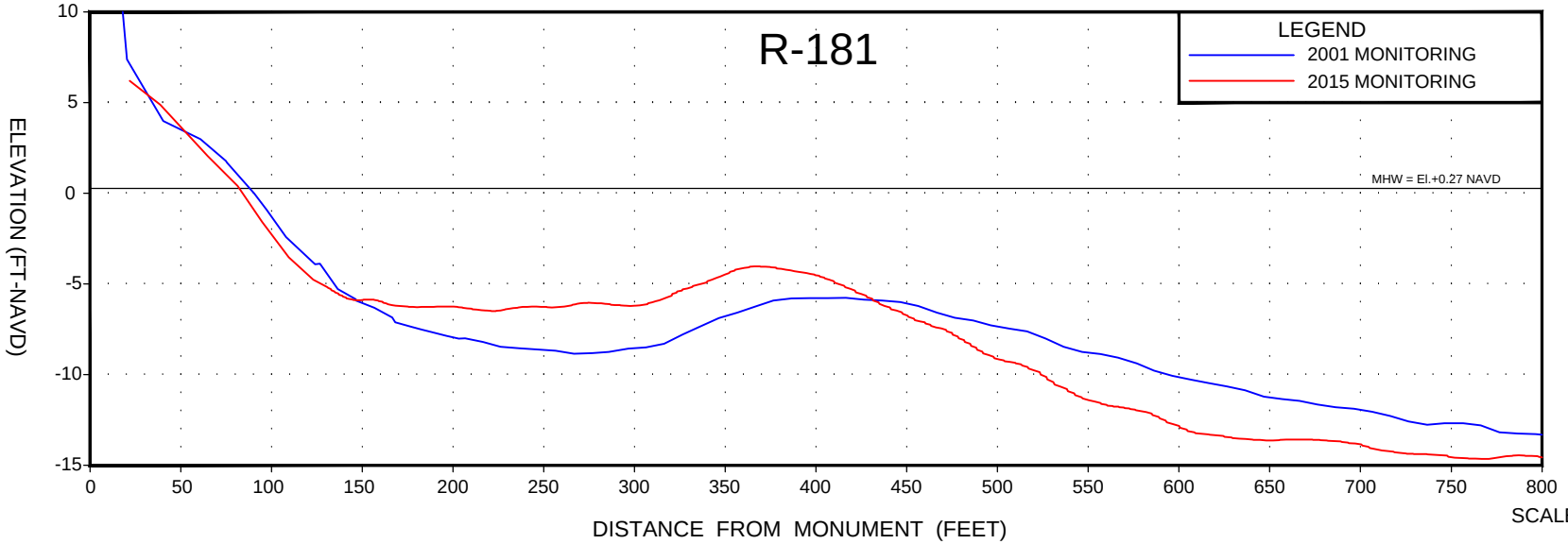
APPENDIX A: MANASOTA KEY NORTH BEACH PROFILES



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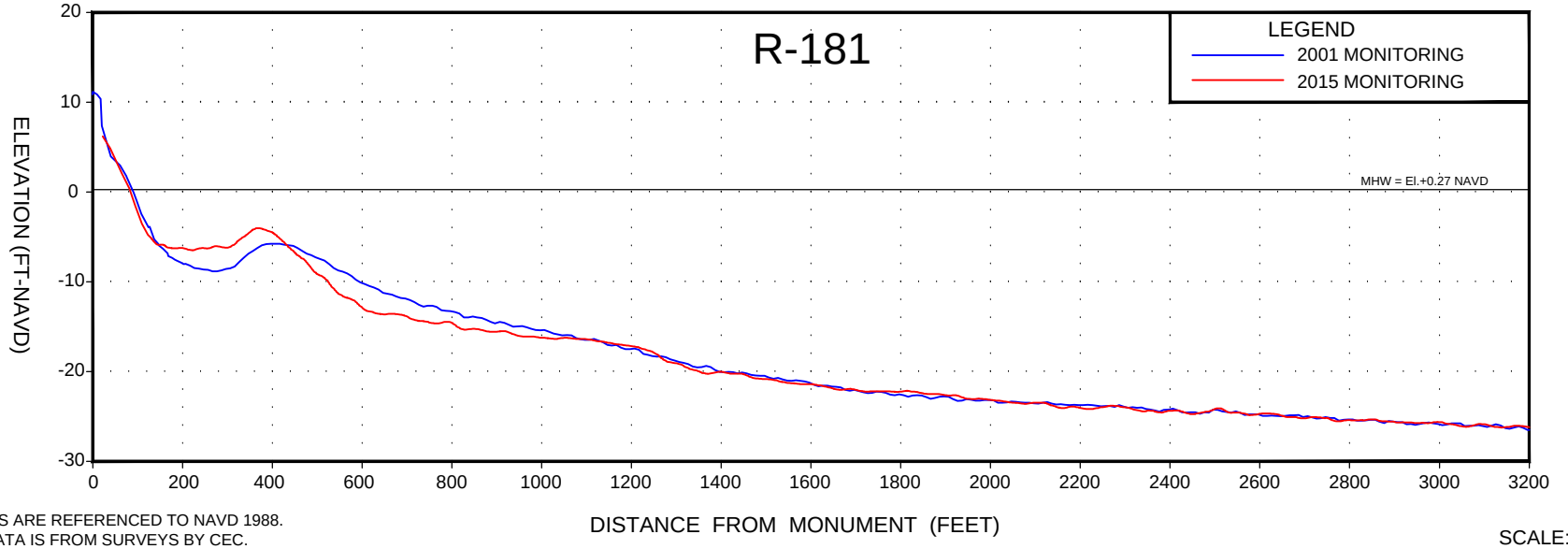

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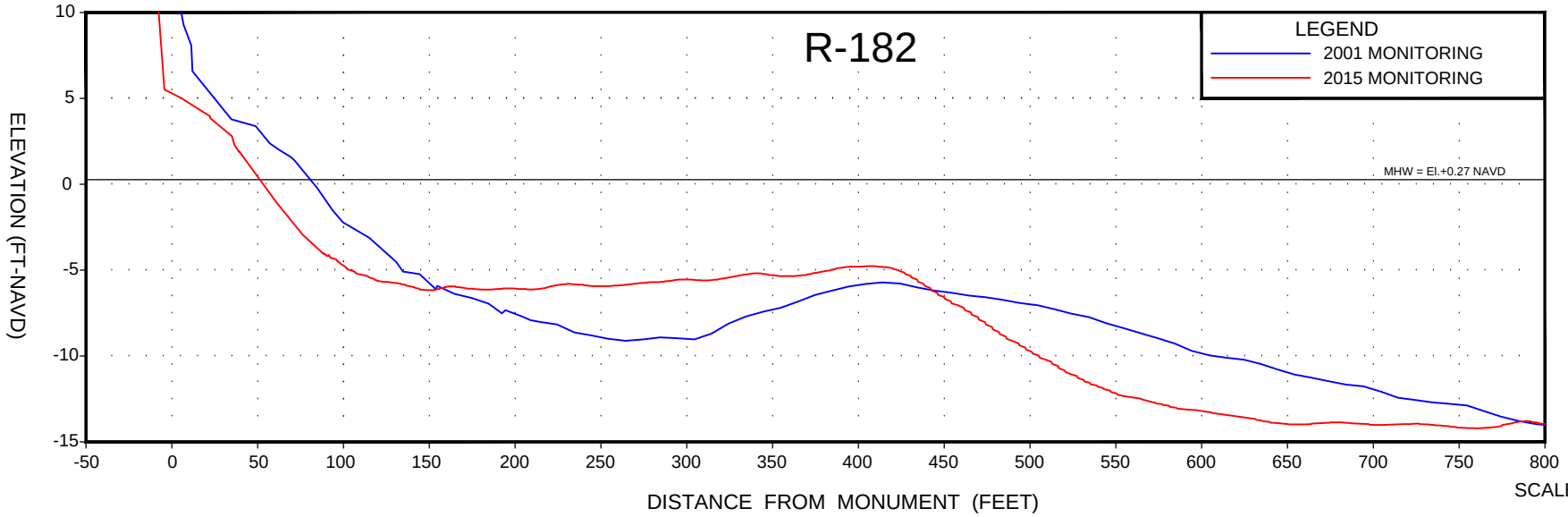

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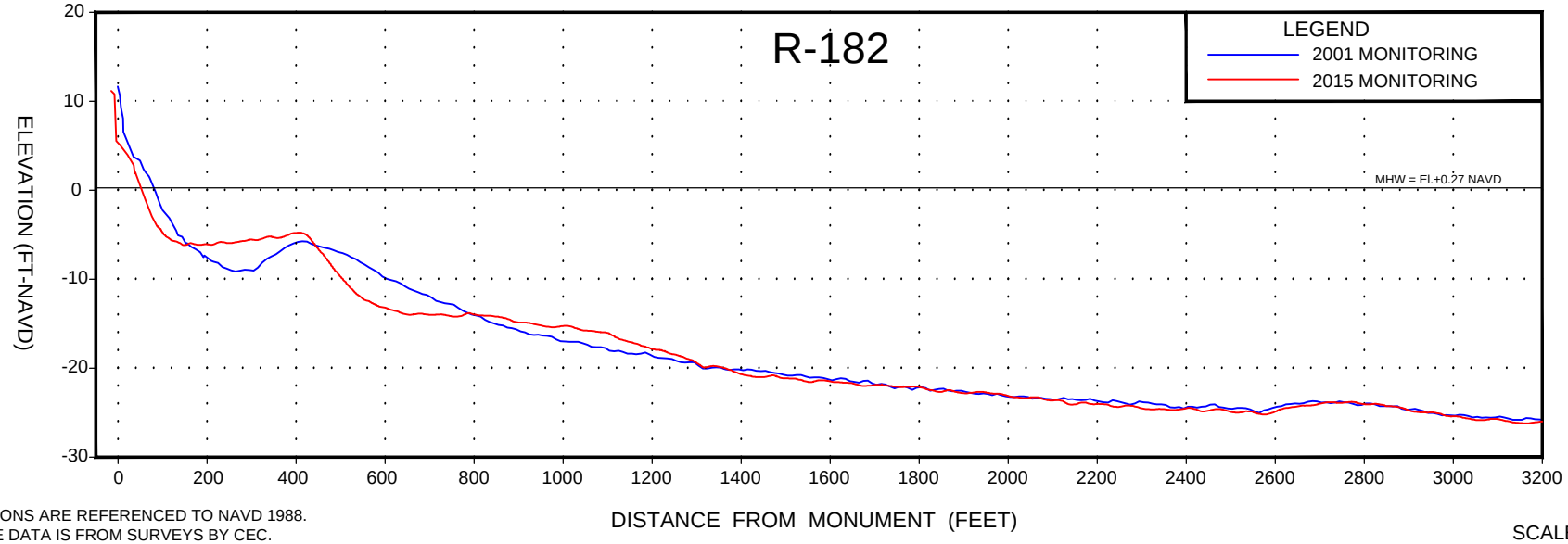

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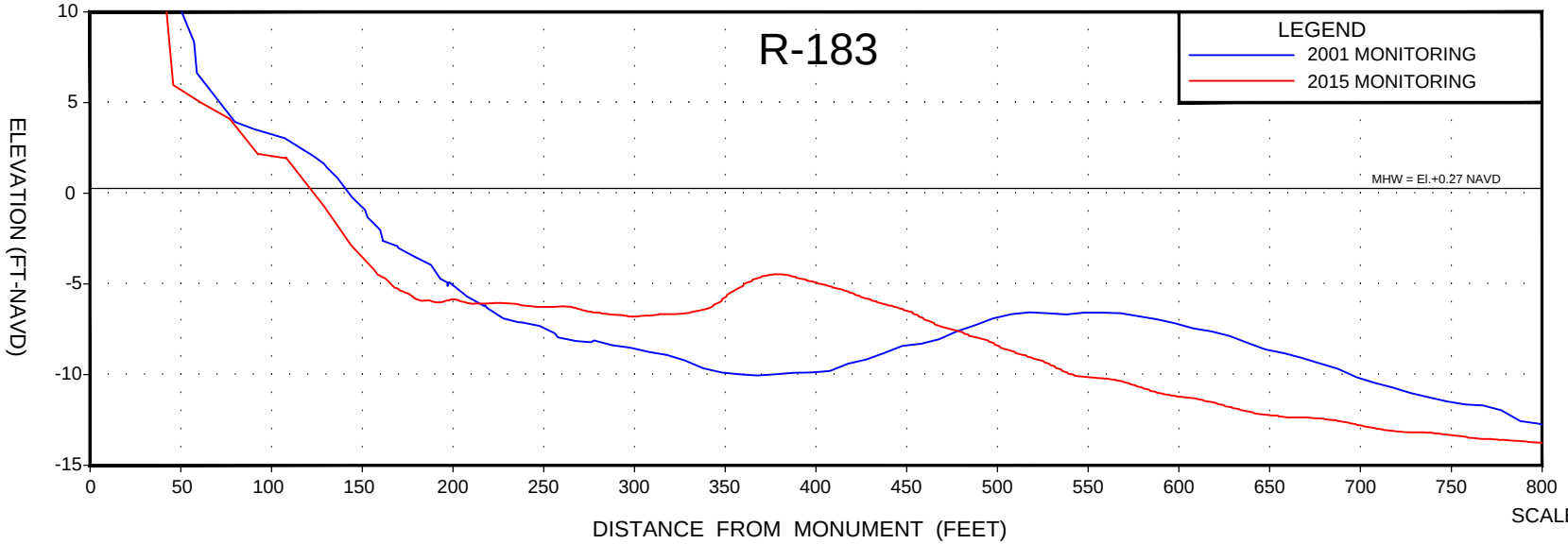

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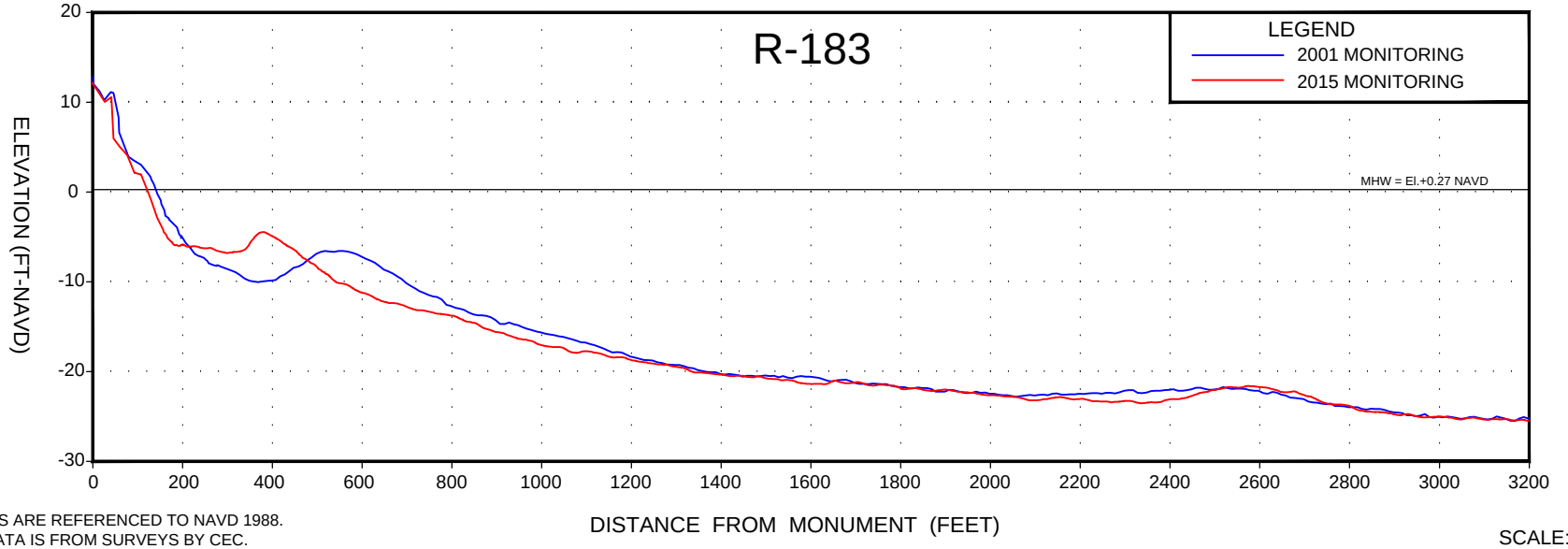

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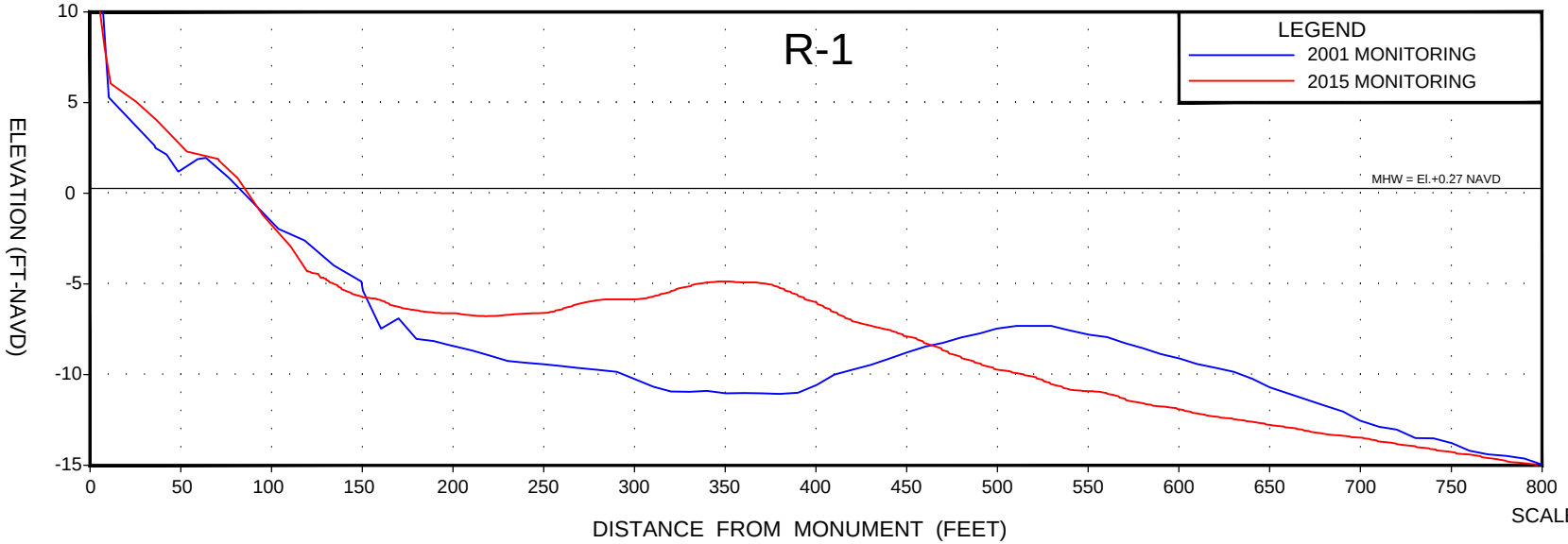

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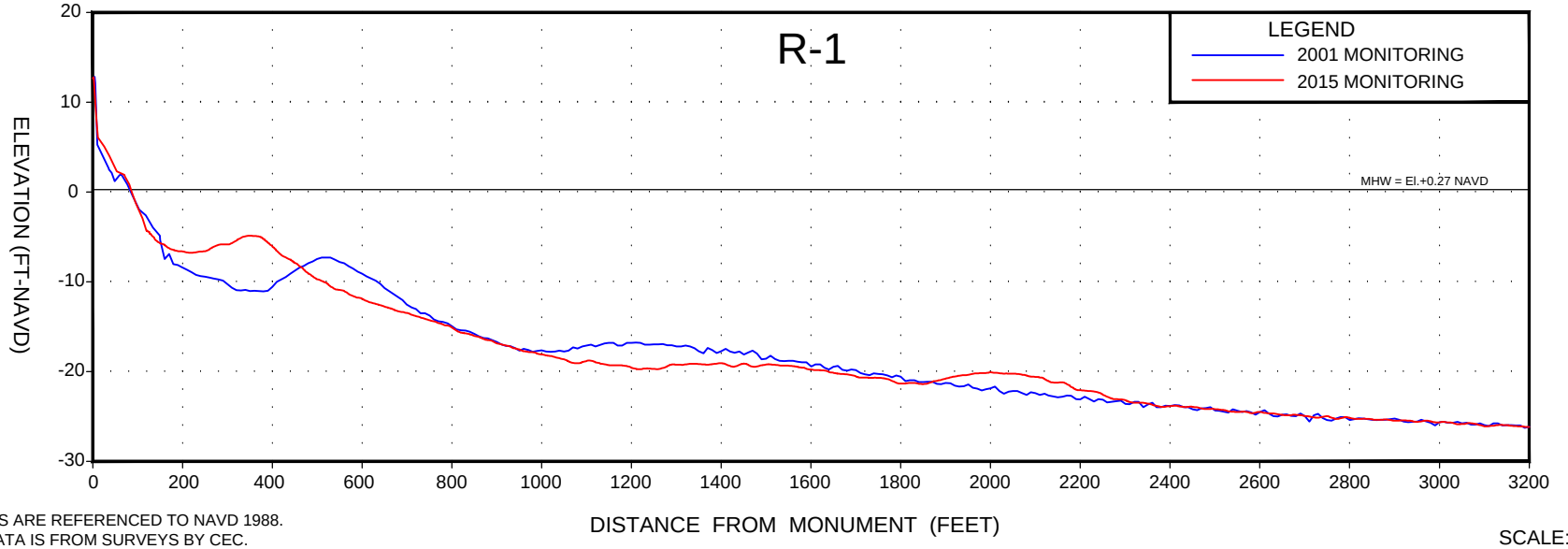

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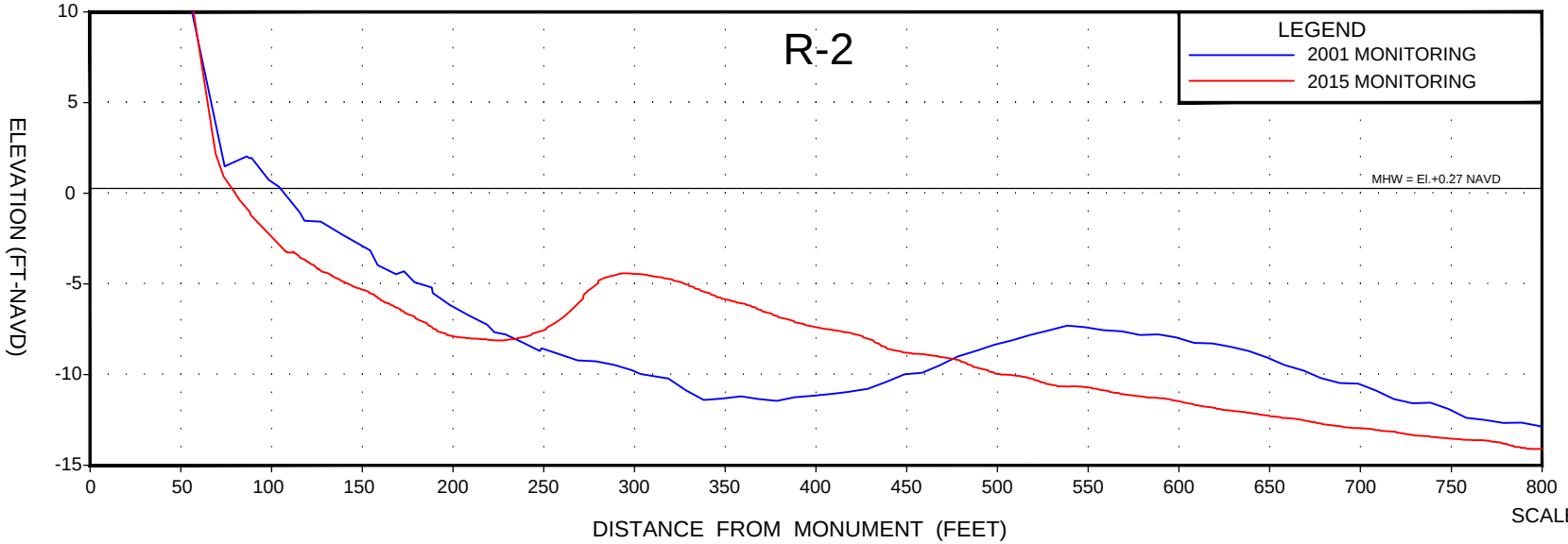

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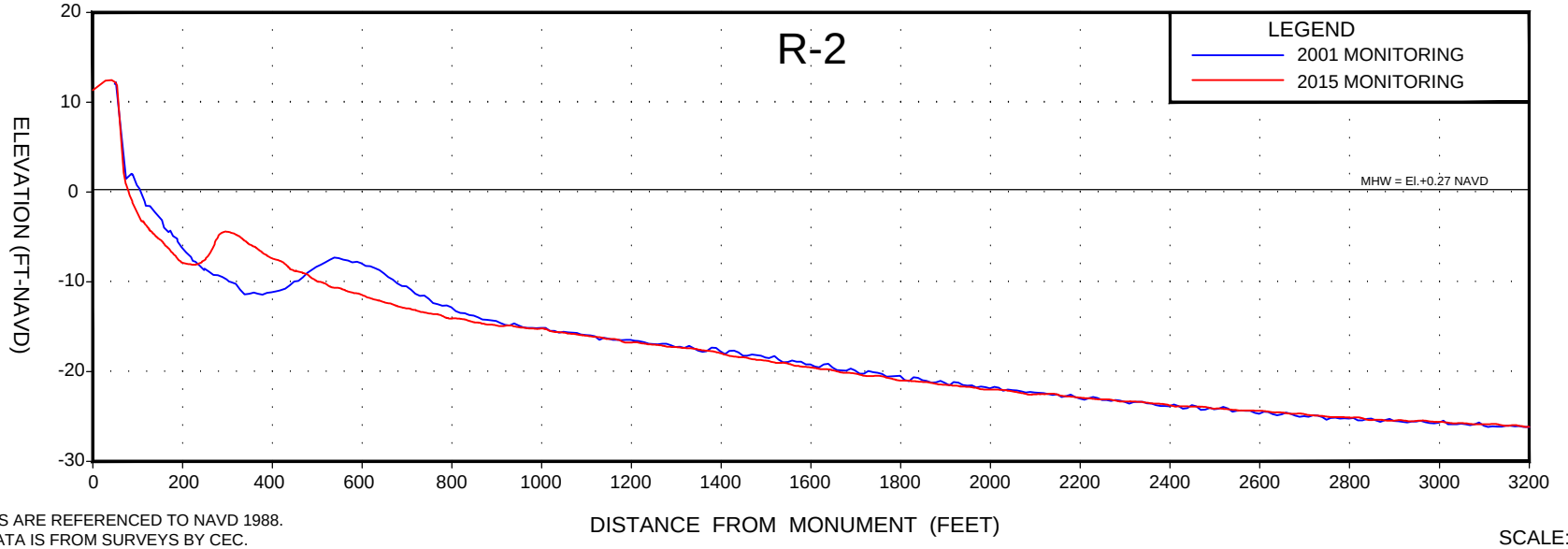

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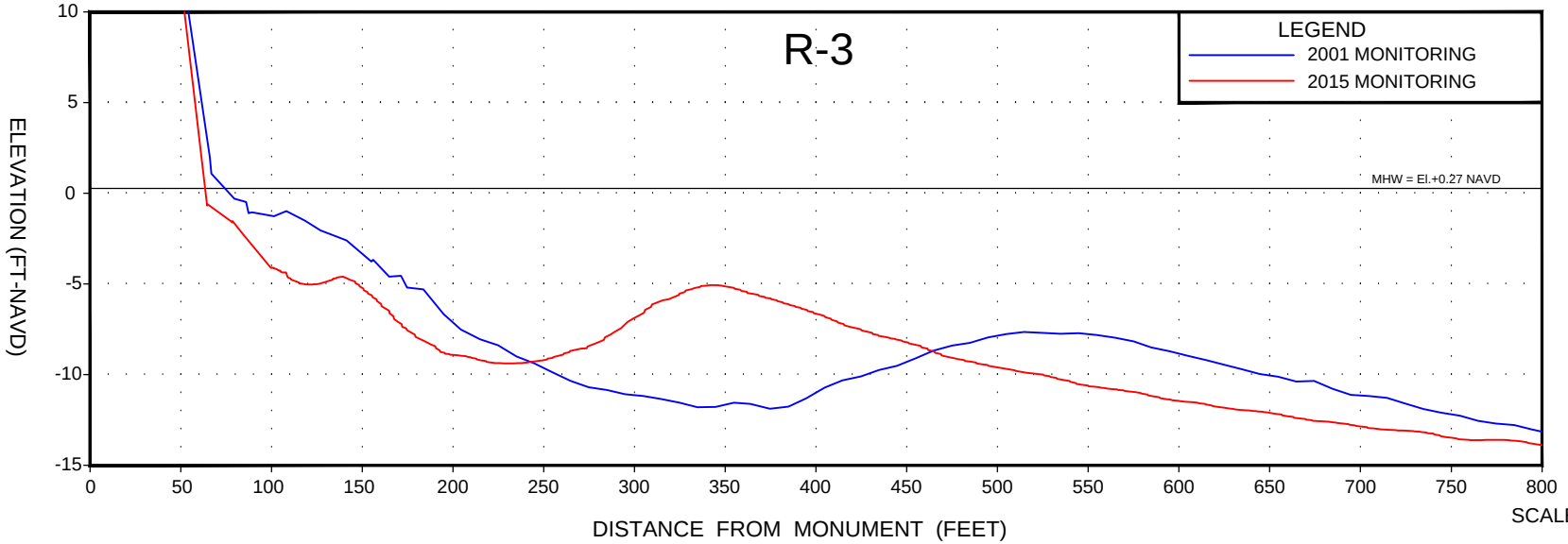

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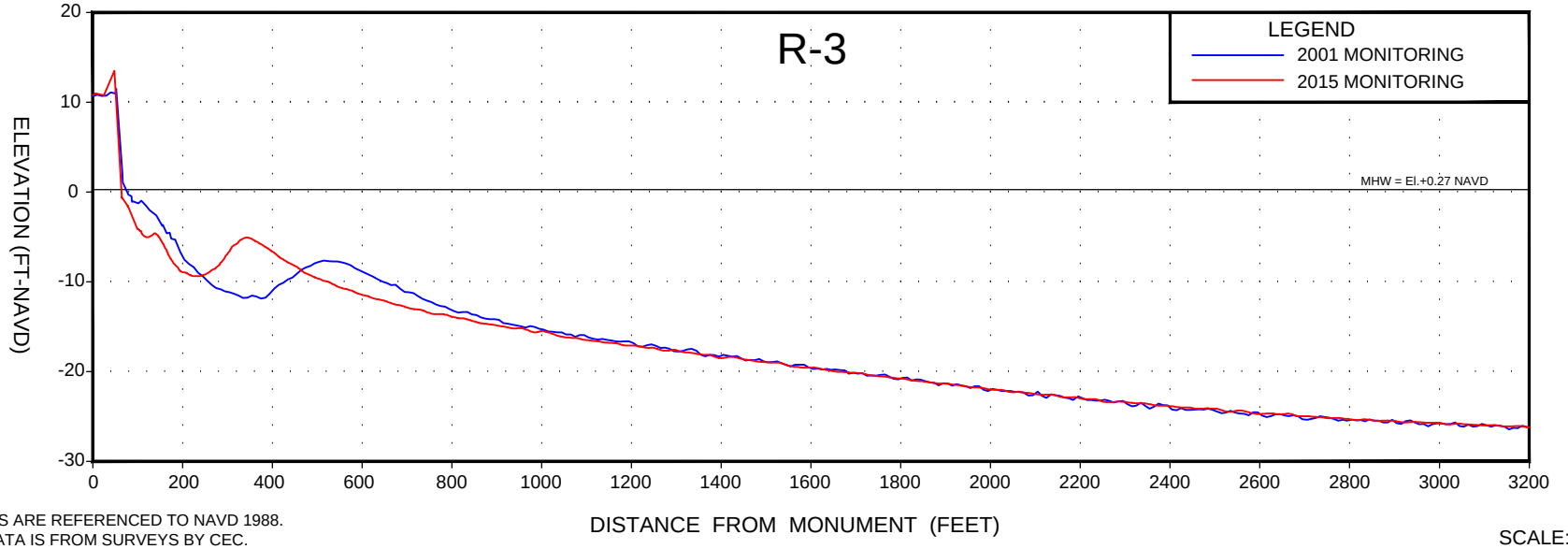

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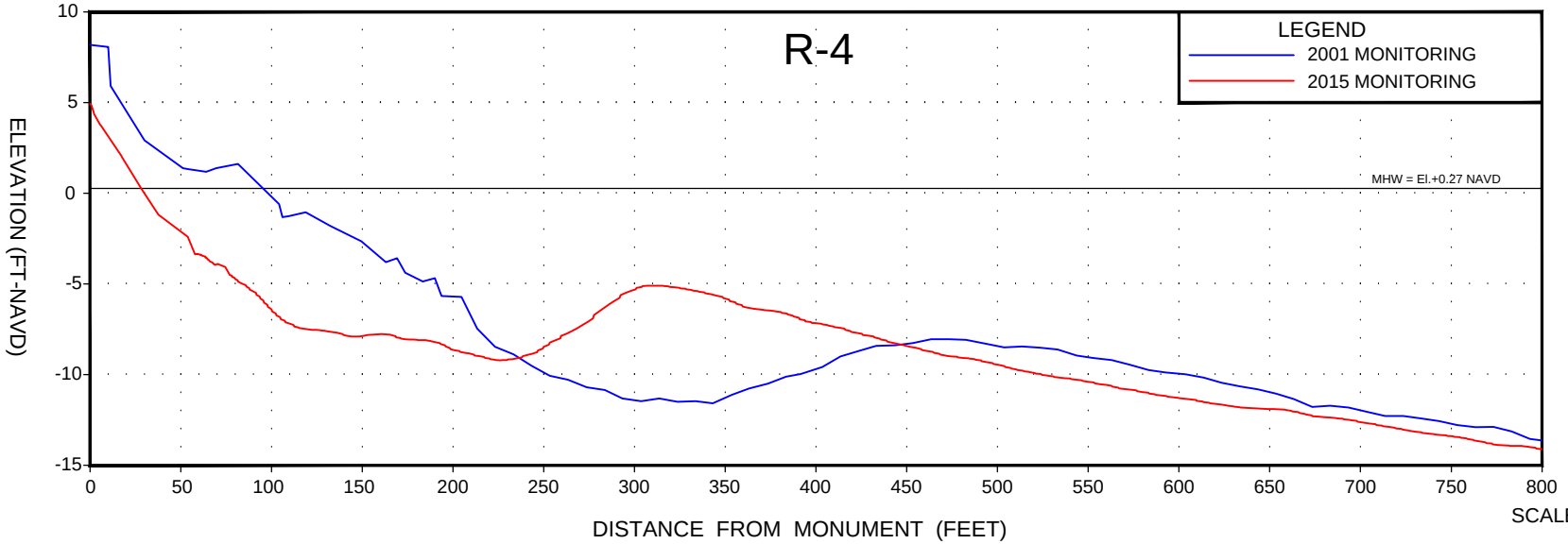

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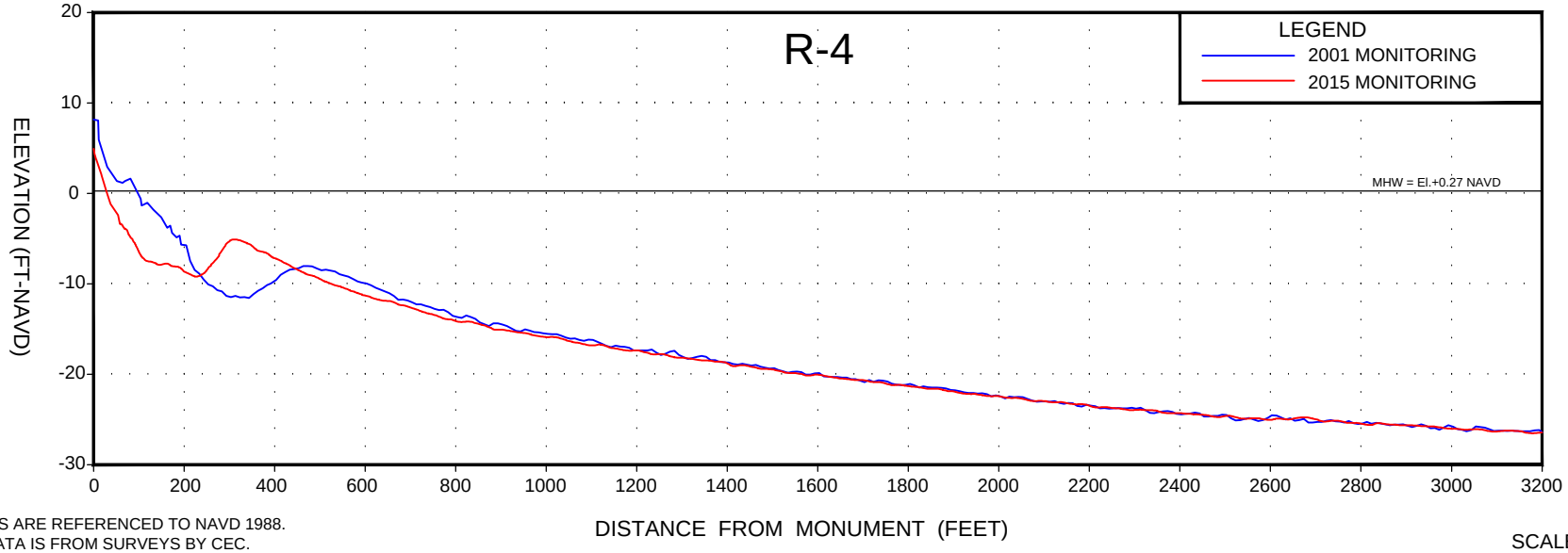

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E-Mail: engcollier@cecifl.com

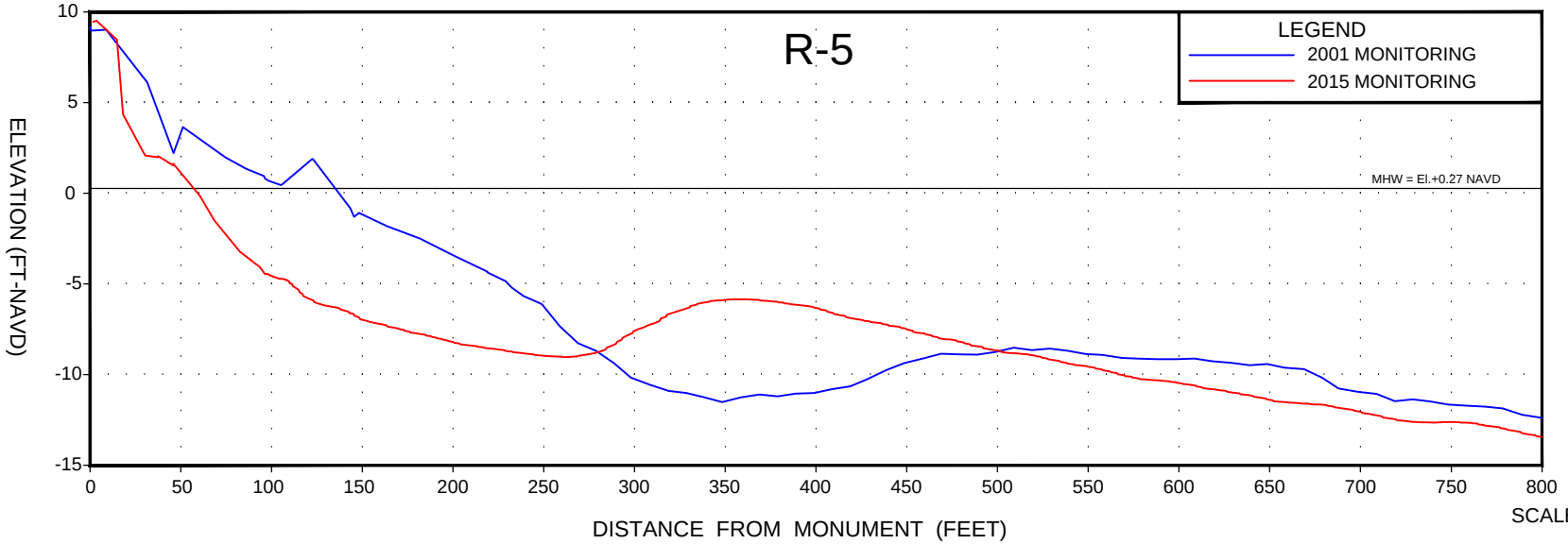
SHEET OF
FILE NO.: 15082-M-4

CLIENT: CHARLOTTE COUNTY

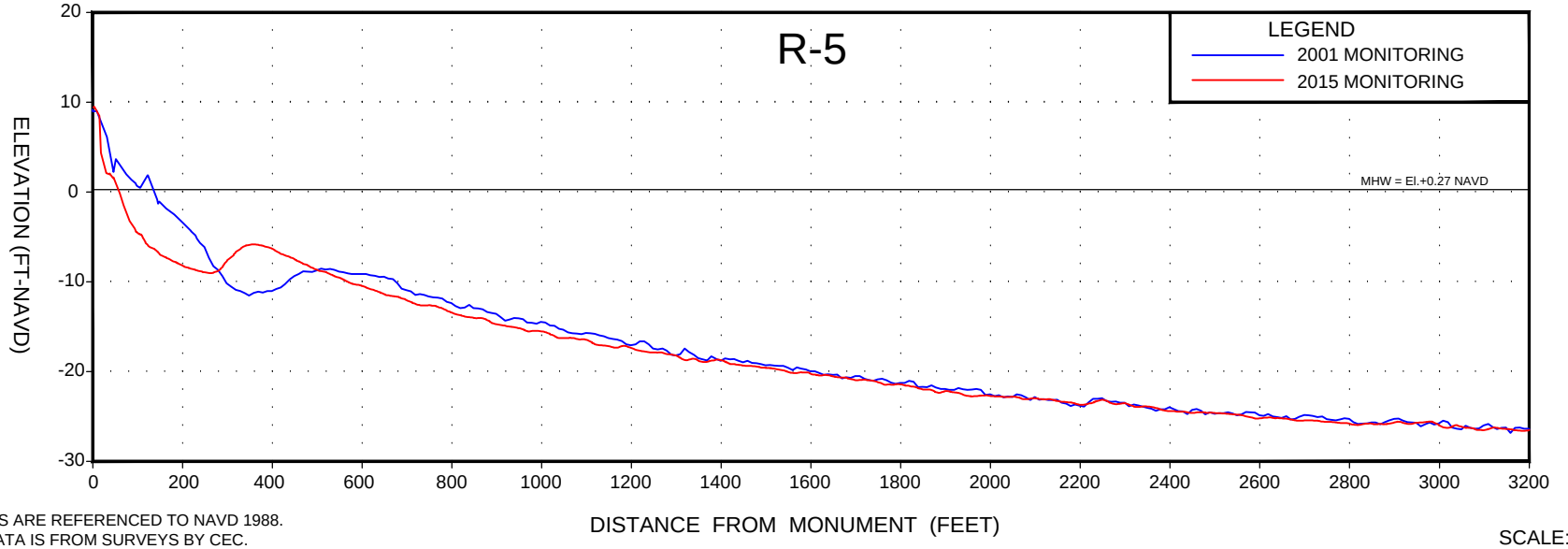
TITLE: R-4 MONITORING SURVEY

DATE: JUNE 2015		SCALE: AS SHOWN	
DRAWN: SDB		F.B.	
CHECKED: MTP		PG.	
SEC.	TWP.	RNG.	
ACAD NO. 15082 2001-2015 PROFILES adjusted.dwg			
REF. NO. 15.082			

NO.	DATE	BY	REVISION DESCRIPTION



SCALE: Horiz: 1" = 100'
Vert: 1" = 10'



SCALE: Horiz: 1" = 400'
Vert: 1" = 20'

NOTES:

1. ELEVATIONS ARE REFERENCED TO NAVD 1988.
2. PROFILE DATA IS FROM SURVEYS BY CEC.
CEC JOB NO. 15.082.

FILE NO.: 15082-M-5
SHEET OF

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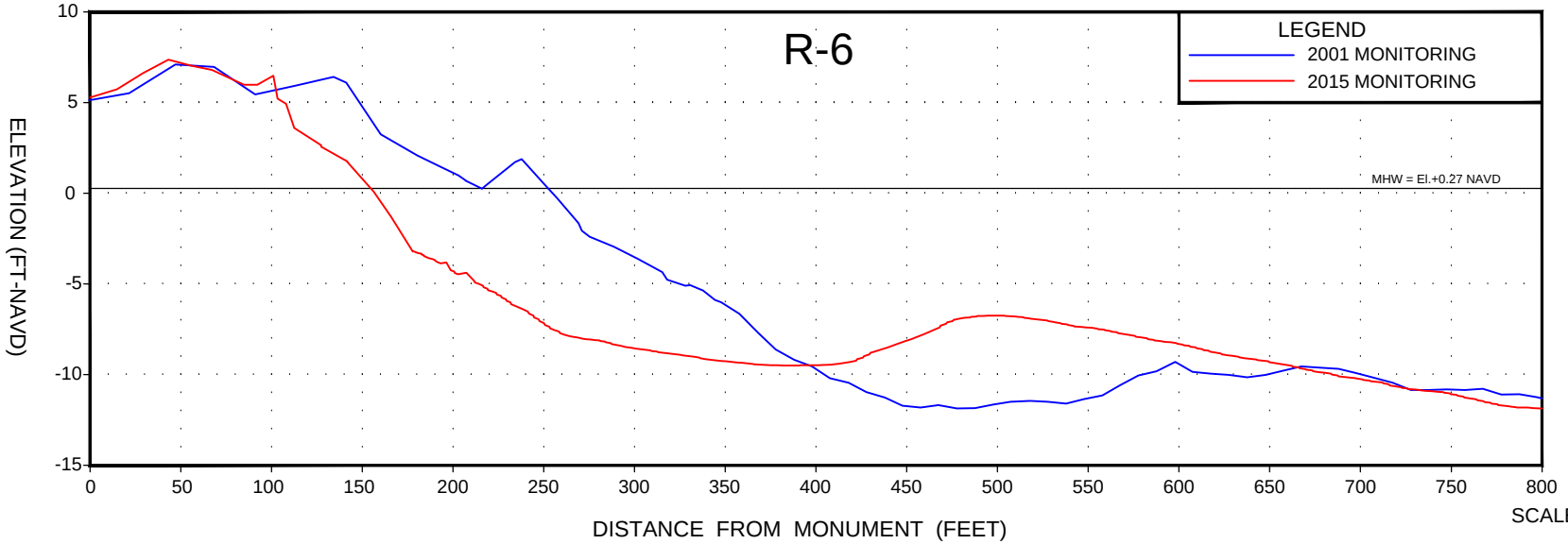
CLIENT: CHARLOTTE COUNTY

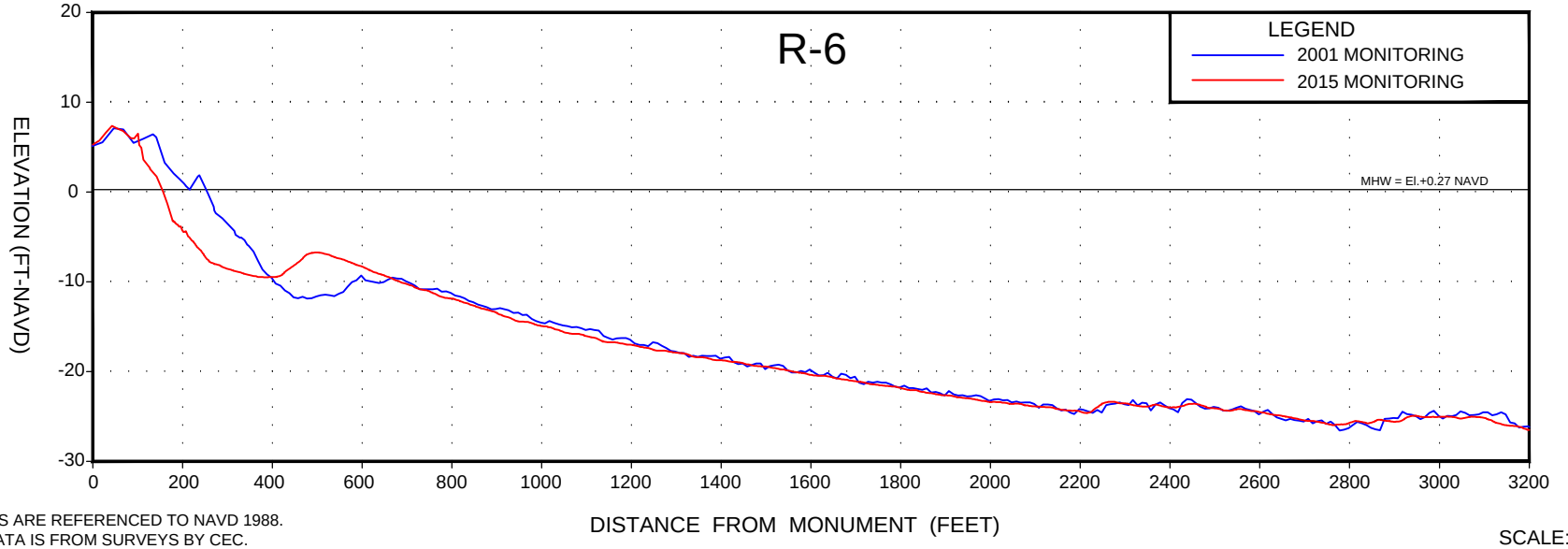
TITLE: R-5 MONITORING SURVEY

DATE: JUNE 2015	SCALE: AS SHOWN		
DRAWN: SDB	F.B.		
CHECKED: MTP	PG.		
SEC.	TWP.	RNG.	
ACAD NO. 15082 2001-2015 PROFILES adjusted.dwg			
REF. NO. 15.082			

NO.	DATE	BY	REVISION DESCRIPTION



SCALE: Horiz: 1" = 100'
Vert: 1" = 10'



SCALE: Horiz: 1" = 400'
Vert: 1" = 20'

NOTES:

1. ELEVATIONS ARE REFERENCED TO NAVD 1988.
2. PROFILE DATA IS FROM SURVEYS BY CEC.
CEC JOB NO. 15.082.

FILE NO.: 15082-M-6
SHEET OF

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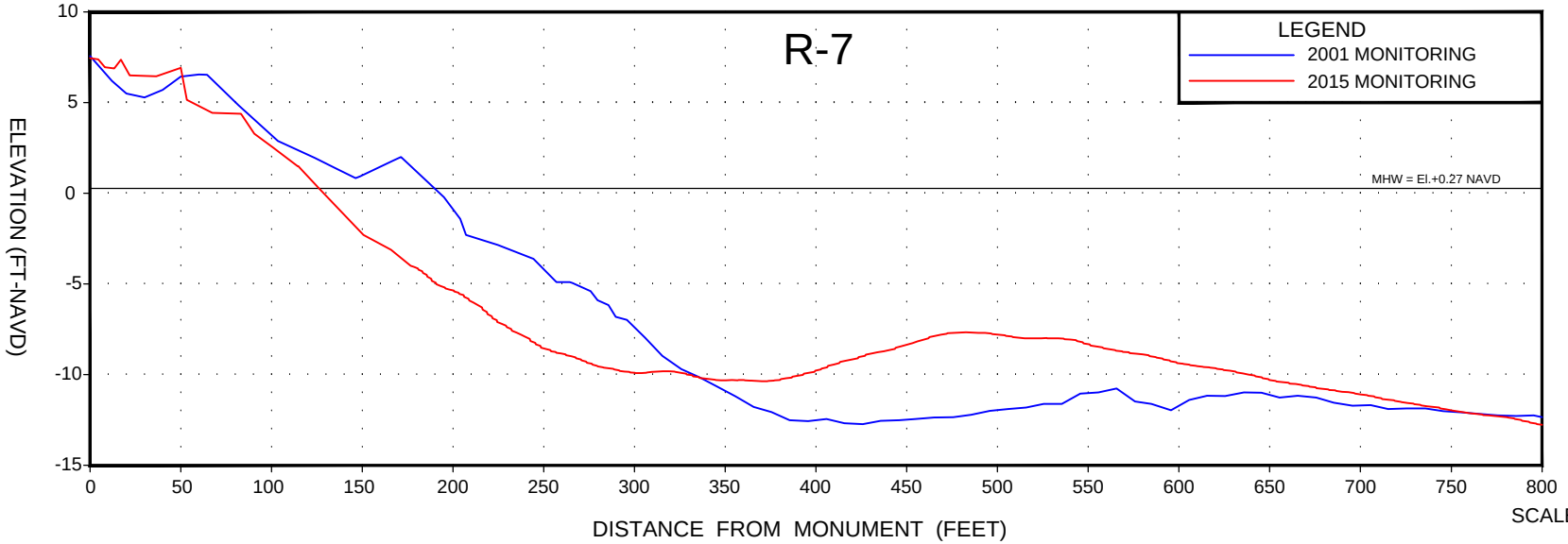
CLIENT: CHARLOTTE COUNTY

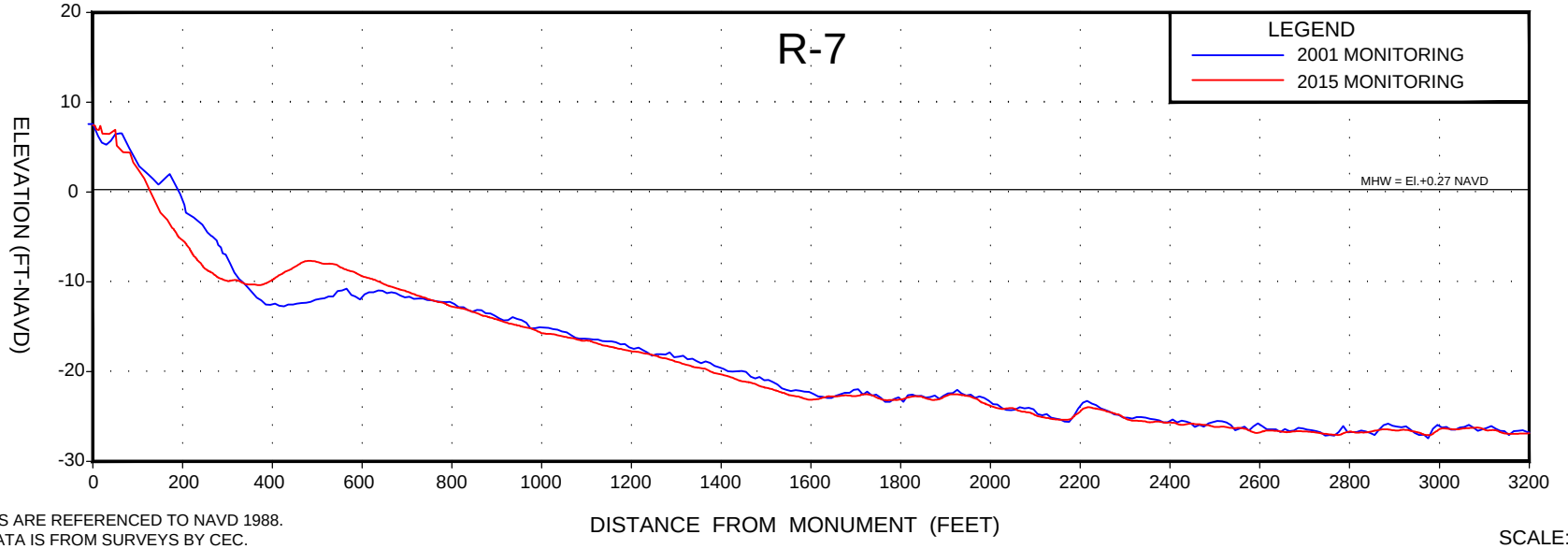
TITLE: R-6 MONITORING SURVEY

DATE: JUNE 2015	SCALE: AS SHOWN		
DRAWN: SDB	F.B.		
CHECKED: MTP	PG.		
SEC.	TWP.	RNG.	
ACAD NO. 15082 2001-2015 PROFILES adjusted.dwg			
REF. NO. 15.082			

NO.	DATE	BY	REVISION DESCRIPTION



SCALE: Horiz: 1" = 100'
Vert: 1" = 10'



SCALE: Horiz: 1" = 400'
Vert: 1" = 20'

NOTES:

1. ELEVATIONS ARE REFERENCED TO NAVD 1988.
2. PROFILE DATA IS FROM SURVEYS BY CEC.
CEC JOB NO. 15.082.

FILE NO.: 15082-M-7
SHEET OF

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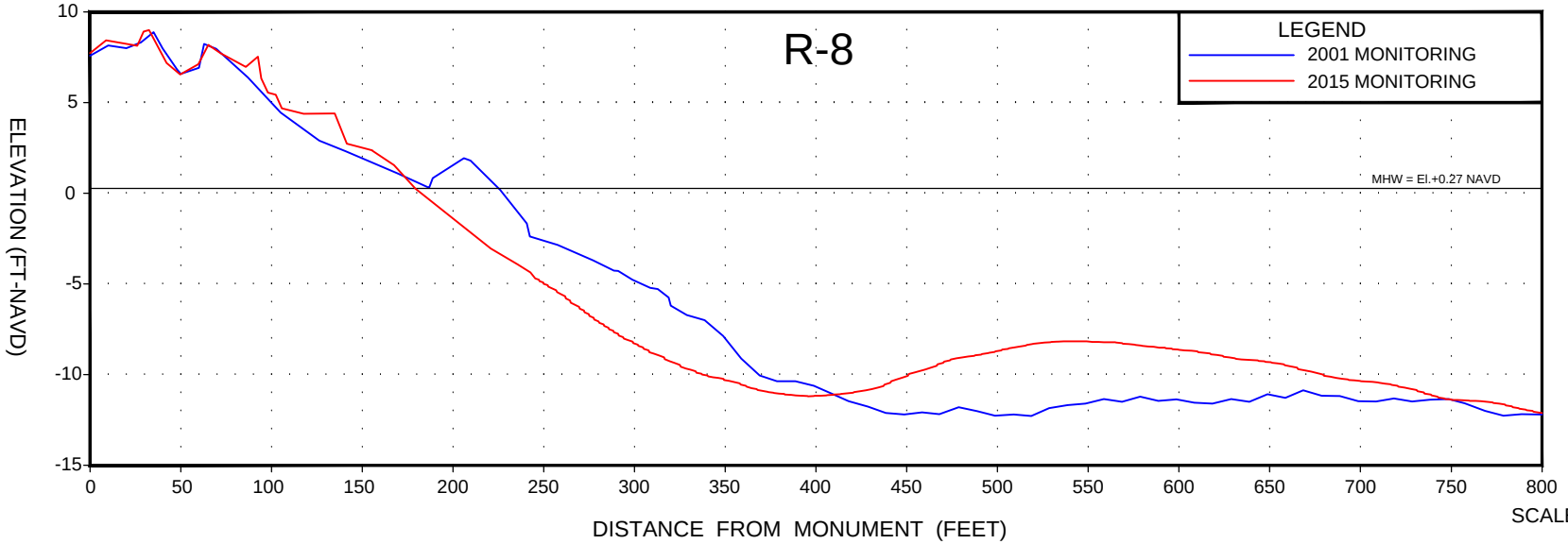
CLIENT: CHARLOTTE COUNTY

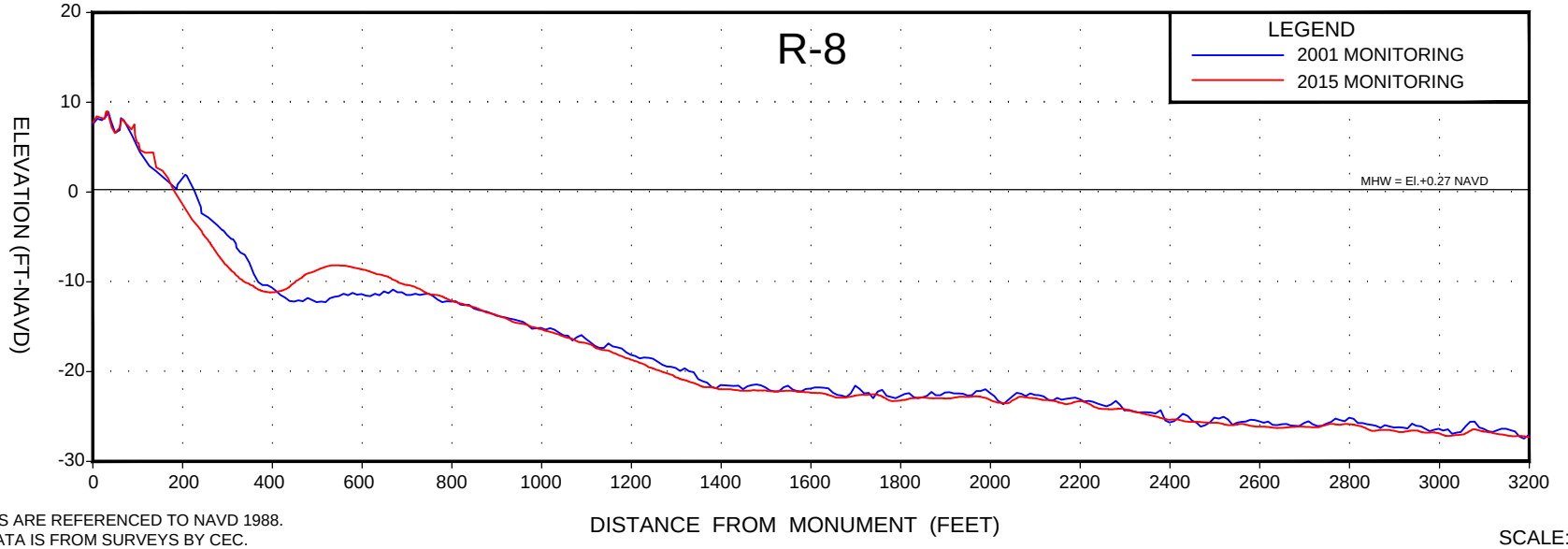
TITLE: R-7 MONITORING SURVEY

DATE: JUNE 2015	SCALE: AS SHOWN		
DRAWN: SDB	F.B.		
CHECKED: MTP	PG.		
SEC.	TWP.	RNG.	
ACAD NO. 15082 2001-2015 PROFILES adjusted.dwg			
REF. NO. 15.082			

NO.	DATE	BY	REVISION DESCRIPTION



SCALE: Horiz: 1" = 100'
Vert: 1" = 10'



SCALE: Horiz: 1" = 400'
Vert: 1" = 20'

NOTES:

1. ELEVATIONS ARE REFERENCED TO NAVD 1988.
2. PROFILE DATA IS FROM SURVEYS BY CEC.
CEC JOB NO. 15.082.

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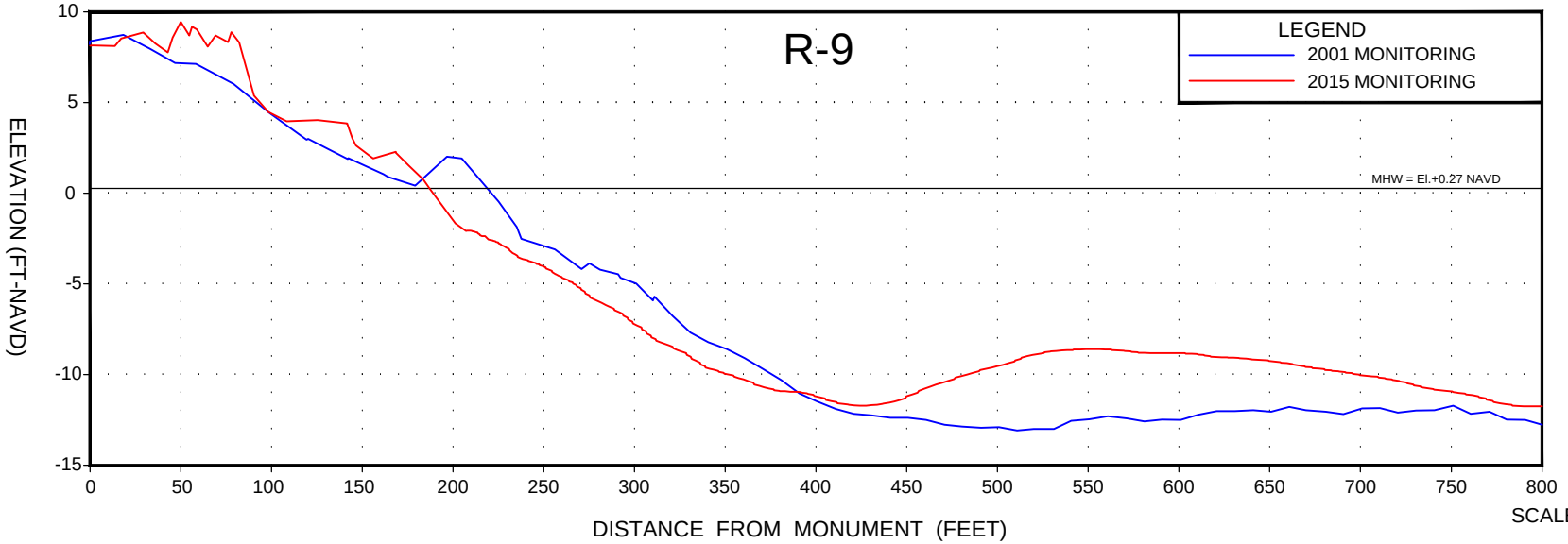
SHEET OF
FILE NO.: 15082-M-8

CLIENT: CHARLOTTE COUNTY

TITLE: R-8 MONITORING SURVEY

DATE: JUNE 2015		SCALE: AS SHOWN	
DRAWN: SDB		F.B.	
CHECKED: MTP		PG.	
SEC.	TWP.	RNG.	
ACAD NO. 15082 2001-2015 PROFILES adjusted.dwg			
REF. NO. 15.082			

NO.	DATE	BY	REVISION DESCRIPTION



SCALE: Horiz: 1" = 100'
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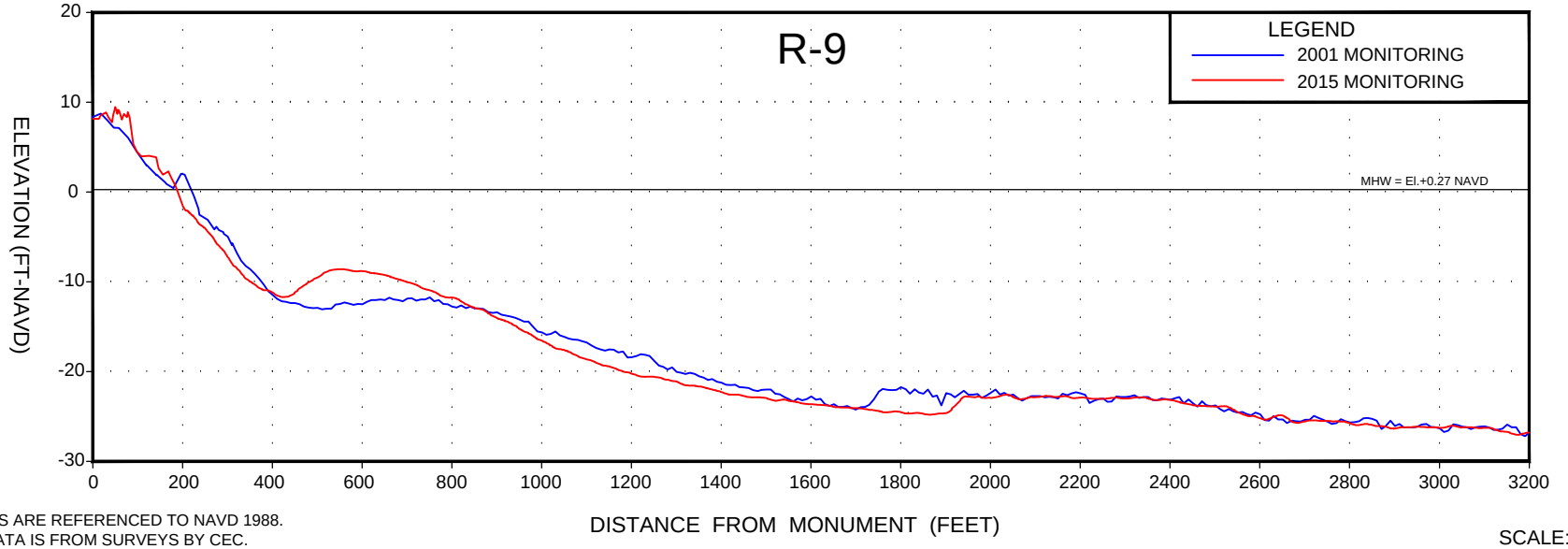

SCALE: Horiz: 1" = 400'
Vert: 1" = 20'

NOTES:

1. ELEVATIONS ARE REFERENCED TO NAVD 1988.
2. PROFILE DATA IS FROM SURVEYS BY CEC.
CEC JOB NO. 15.082.

FILE NO.: 15082-M-9
SHEET OF

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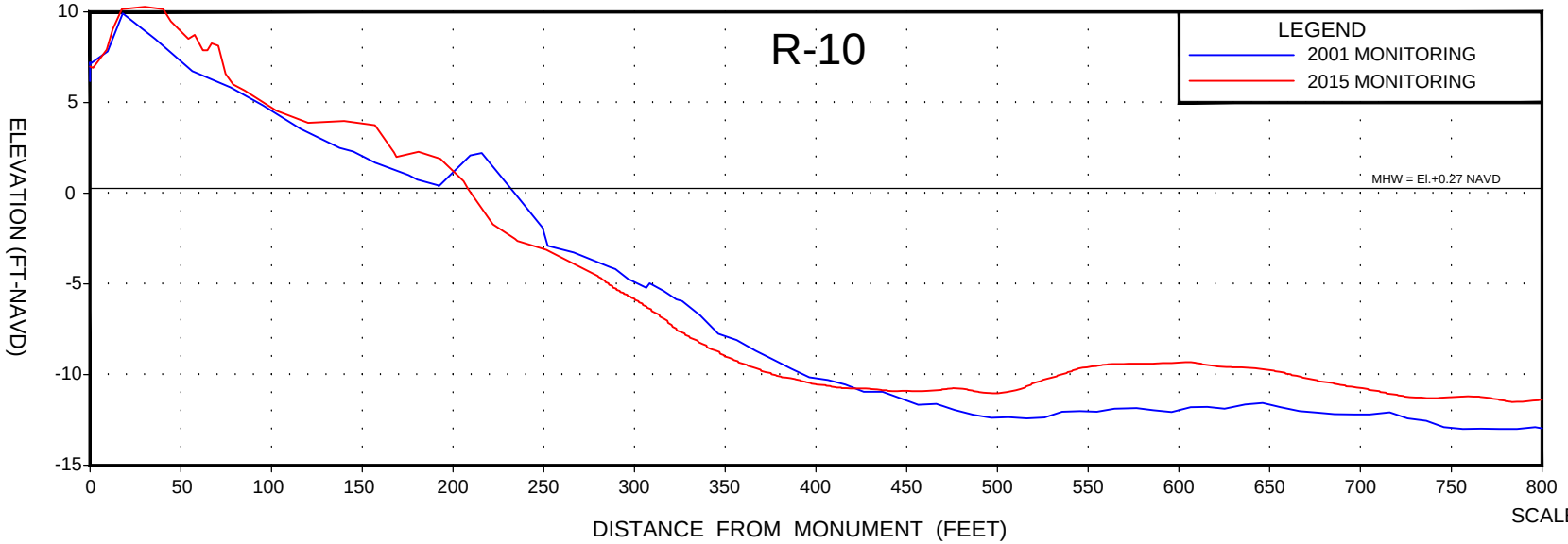
CLIENT: CHARLOTTE COUNTY

TITLE: R-9 MONITORING SURVEY

DATE: JUNE 2015	SCALE: AS SHOWN		
DRAWN: SDB	F.B.		
CHECKED: MTP	PG.		
SEC.	TWP.	RNG.	
ACAD NO. 15082_2001-2015 PROFILES_adjusted.dwg			
REF. NO. 15.082			

NO.	DATE	BY	REVISION DESCRIPTION



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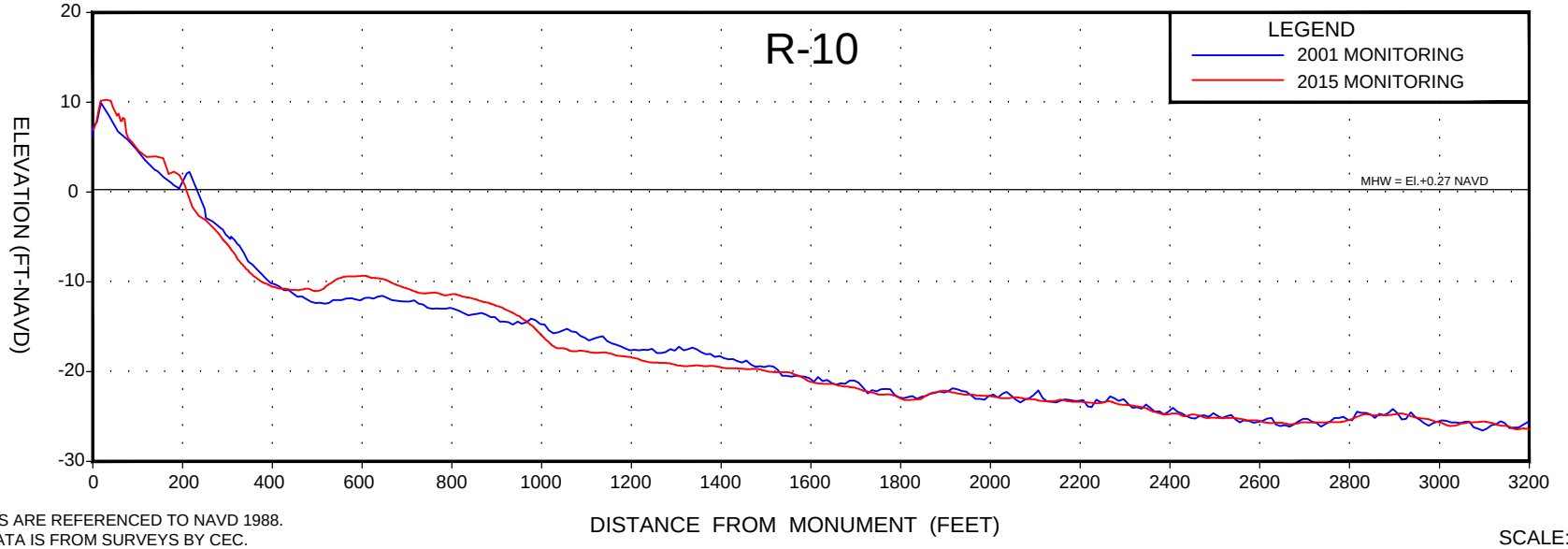
Vert: 1" = 10'



SCALE: Horiz: 1" = 400'
Vert: 1" = 20'

NOTES:

1. ELEVATIONS ARE REFERENCED TO NAVD 1988.
2. PROFILE DATA IS FROM SURVEYS BY CEC.
CEC JOB NO. 15.082.

FILE NO.: 15082-M-10 SHEET OF

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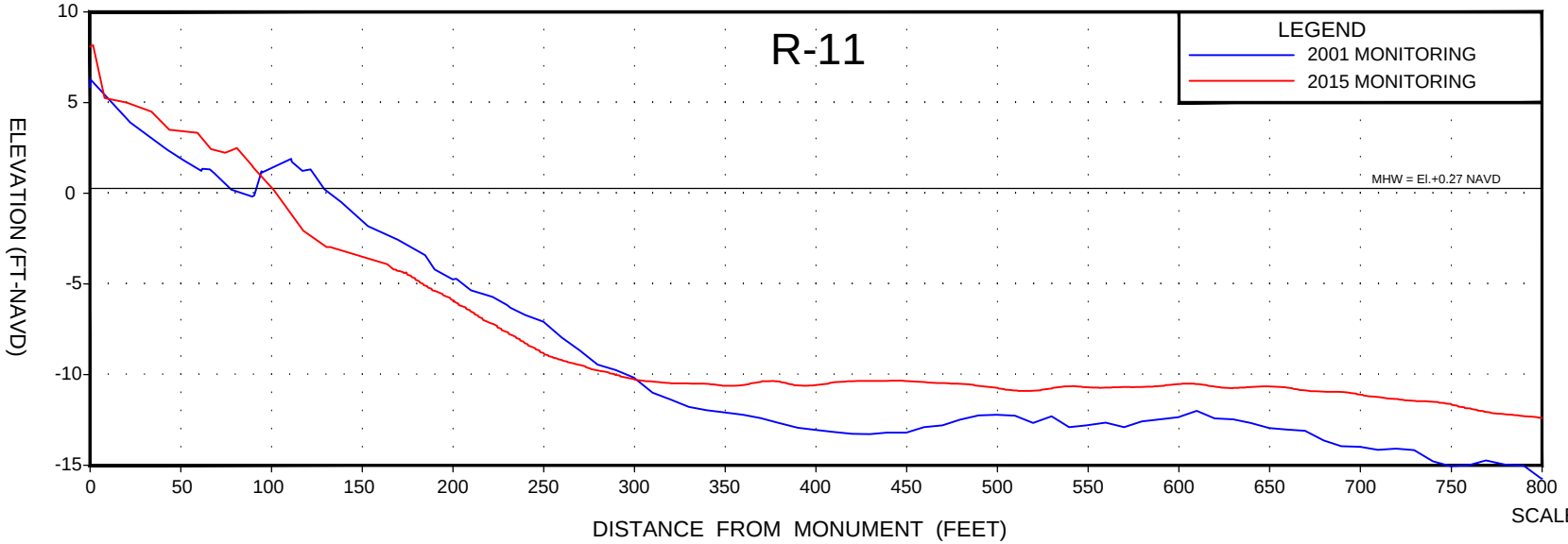
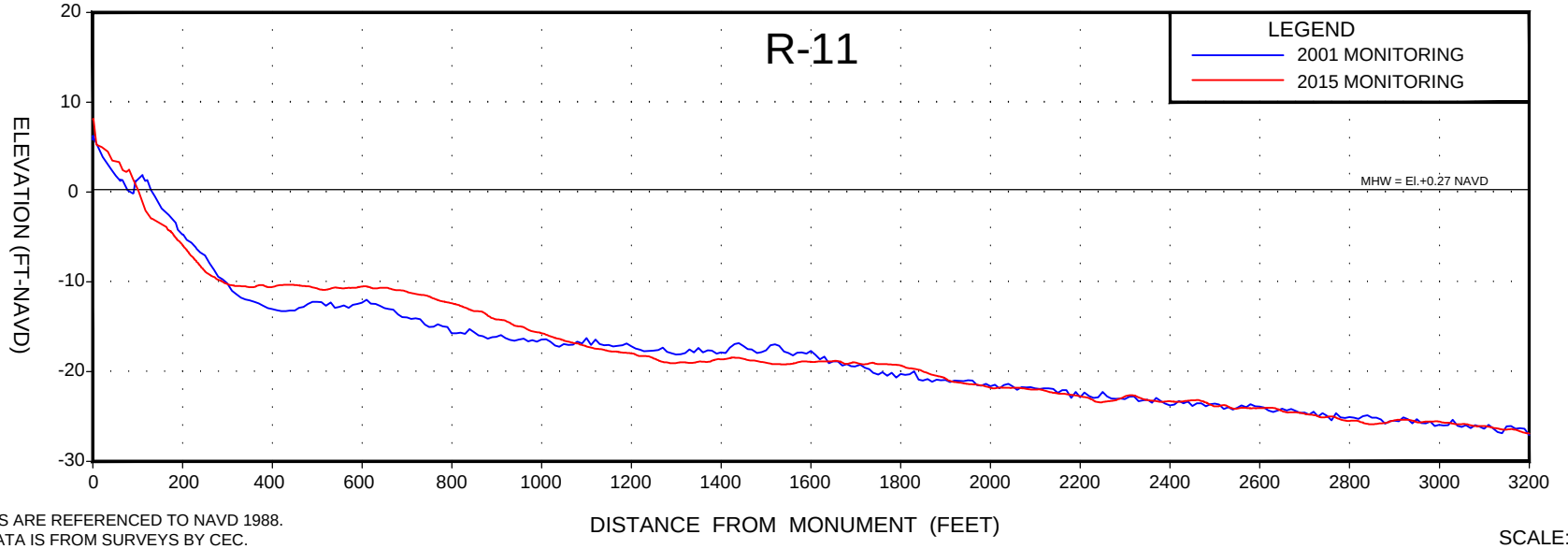
TITLE: R-10 MONITORING SURVEY

DATE: JUNE 2015	SCALE: AS SHOWN		
DRAWN: SDB	F.B.		
CHECKED: MTP	PG.		
SEC.	TWP.	RNG.	
ACAD NO. 15082_2001-2015 PROFILES_adjusted.dwg			
REF. NO. 15.082			

NO.	DATE	BY	REVISION DESCRIPTION



SCALE: Horiz: 1" = 100'
Vert: 1" = 10'



SCALE: Horiz: 1" = 400'
Vert: 1" = 20'

NOTES:

1. ELEVATIONS ARE REFERENCED TO NAVD 1988.
2. PROFILE DATA IS FROM SURVEYS BY CEC.
CEC JOB NO. 15.082.

FILE NO.: 15082-M-11 SHEET OF

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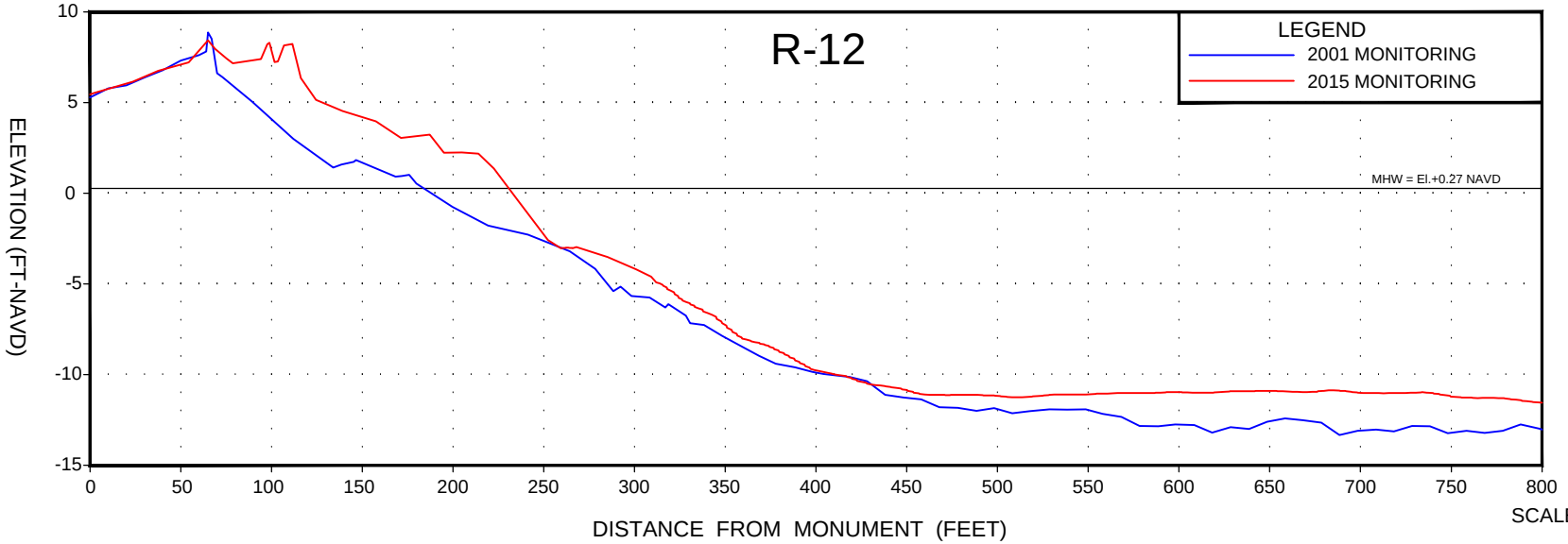
CLIENT: CHARLOTTE COUNTY

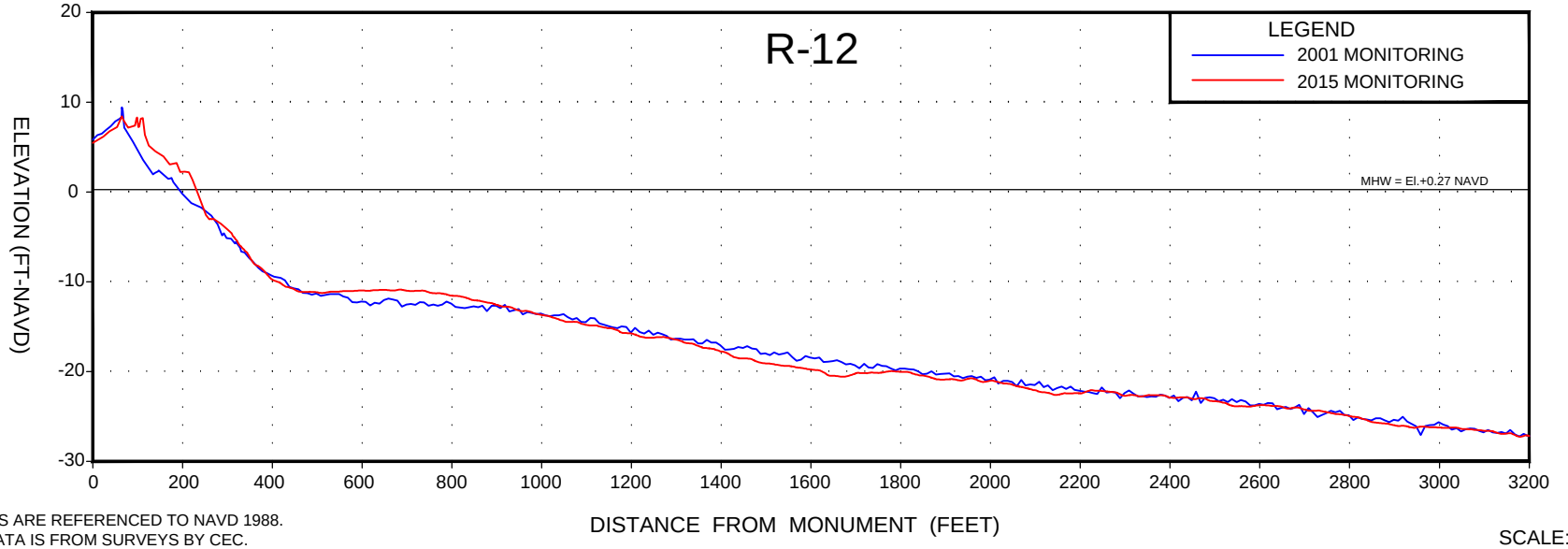
TITLE: R-11 MONITORING SURVEY

DATE: JUNE 2015	SCALE: AS SHOWN		
DRAWN: SDB	F.B.		
CHECKED: MTP	PG.		
SEC.	TWP.	RNG.	
ACAD NO. 15082_2001-2015 PROFILES_adjusted.dwg			
REF. NO. 15.082			

NO.	DATE	BY	REVISION DESCRIPTION



SCALE: Horiz: 1" = 100'
Vert: 1" = 10'



SCALE: Horiz: 1" = 400'
Vert: 1" = 20'

NOTES:

1. ELEVATIONS ARE REFERENCED TO NAVD 1988.
2. PROFILE DATA IS FROM SURVEYS BY CEC.
CEC JOB NO. 15.082.

FILE NO.: 15082-M-12 SHEET OF

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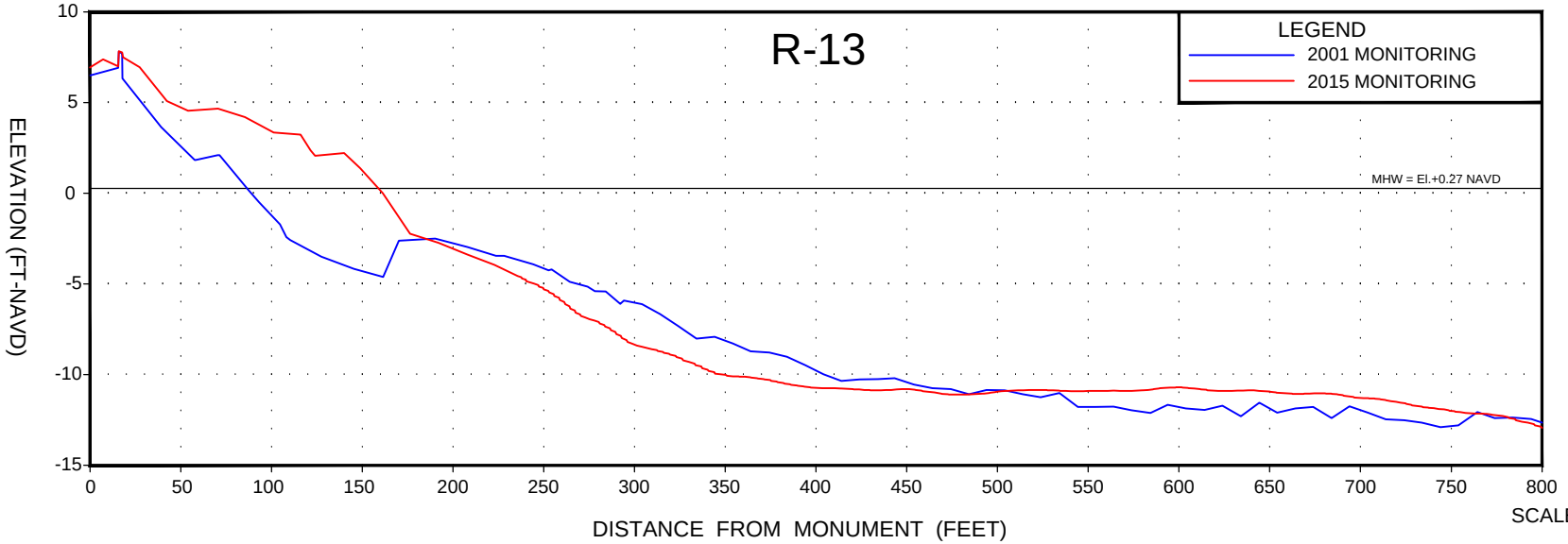
CLIENT: CHARLOTTE COUNTY

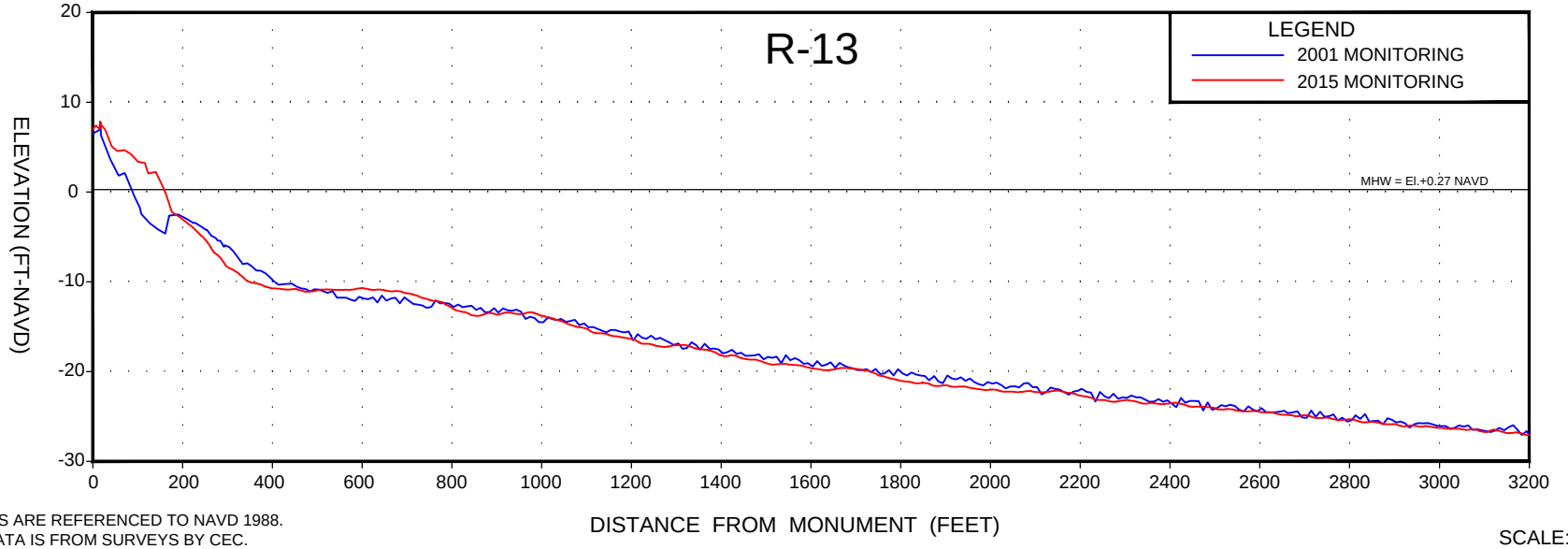
TITLE: R-12 MONITORING SURVEY

DATE: JUNE 2015		SCALE: AS SHOWN	
DRAWN: SDB		F.B.	
CHECKED: MTP		PG.	
SEC.	TWP.	RNG.	
ACAD NO. 15082 2001-2015 PROFILES adjusted.dwg			
REF. NO. 15.082			

NO.	DATE	BY	REVISION DESCRIPTION



SCALE: Horiz: 1" = 100'
Vert: 1" = 10'



SCALE: Horiz: 1" = 400'
Vert: 1" = 20'

NOTES:

1. ELEVATIONS ARE REFERENCED TO NAVD 1988.
2. PROFILE DATA IS FROM SURVEYS BY CEC.
CEC JOB NO. 15.082.

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CLIENT: CHARLOTTE COUNTY

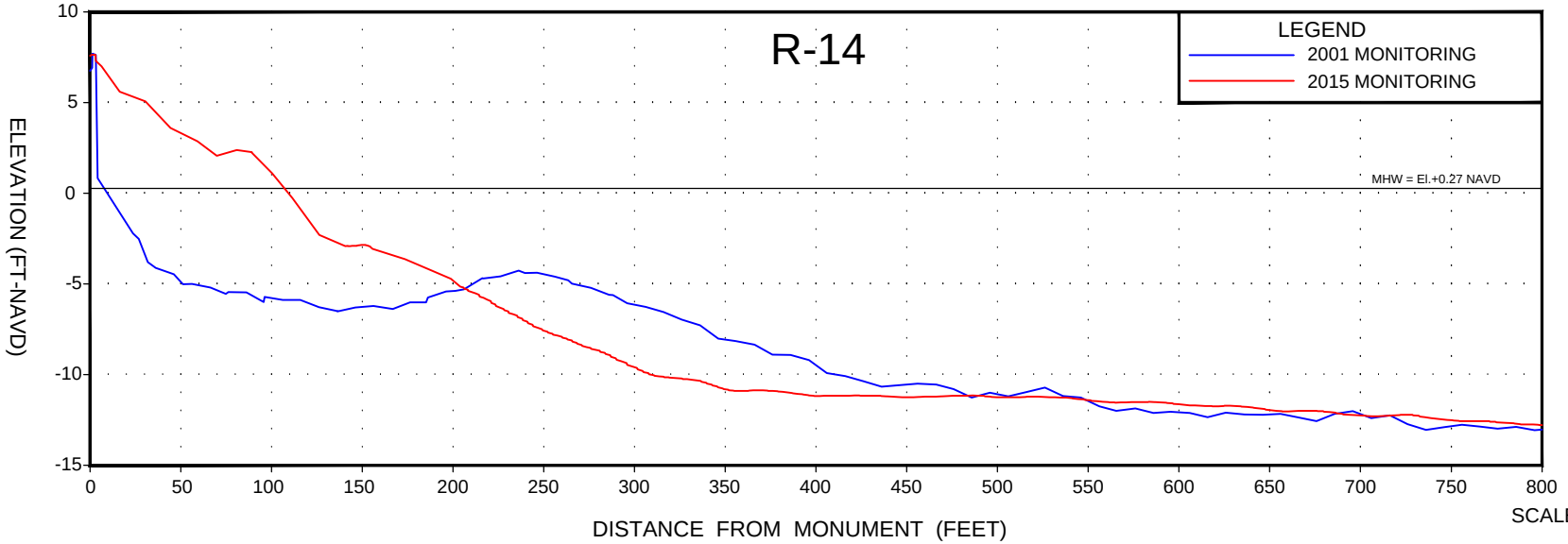
TITLE: R-13 MONITORING SURVEY

DATE: JUNE 2015	SCALE: AS SHOWN		
DRAWN: SDB	F.B.		
CHECKED: MTP	PG.		
SEC.	TWP.	RNG.	
ACAD NO. 15082 2001-2015 PROFILES adjusted.dwg			
REF. NO. 15.082			

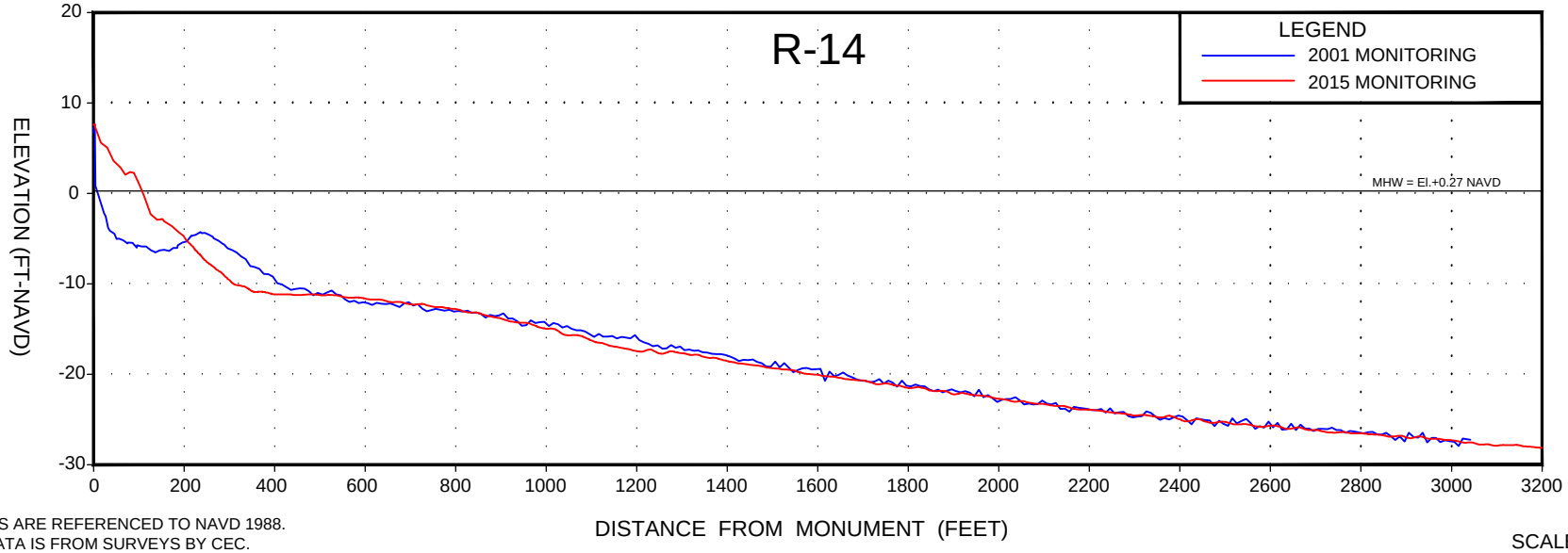
NO.	DATE	BY	REVISION DESCRIPTION

FILE NO.: 15082-M-13

SHEET OF



SCALE: Horiz: 1" = 100'
Vert: 1" = 10'



SCALE: Horiz: 1" = 400'
Vert: 1" = 20'

NOTES:

1. ELEVATIONS ARE REFERENCED TO NAVD 1988.
2. PROFILE DATA IS FROM SURVEYS BY CEC.
CEC JOB NO. 15.082.

FILE NO.: 15082-M-14
SHEET OF

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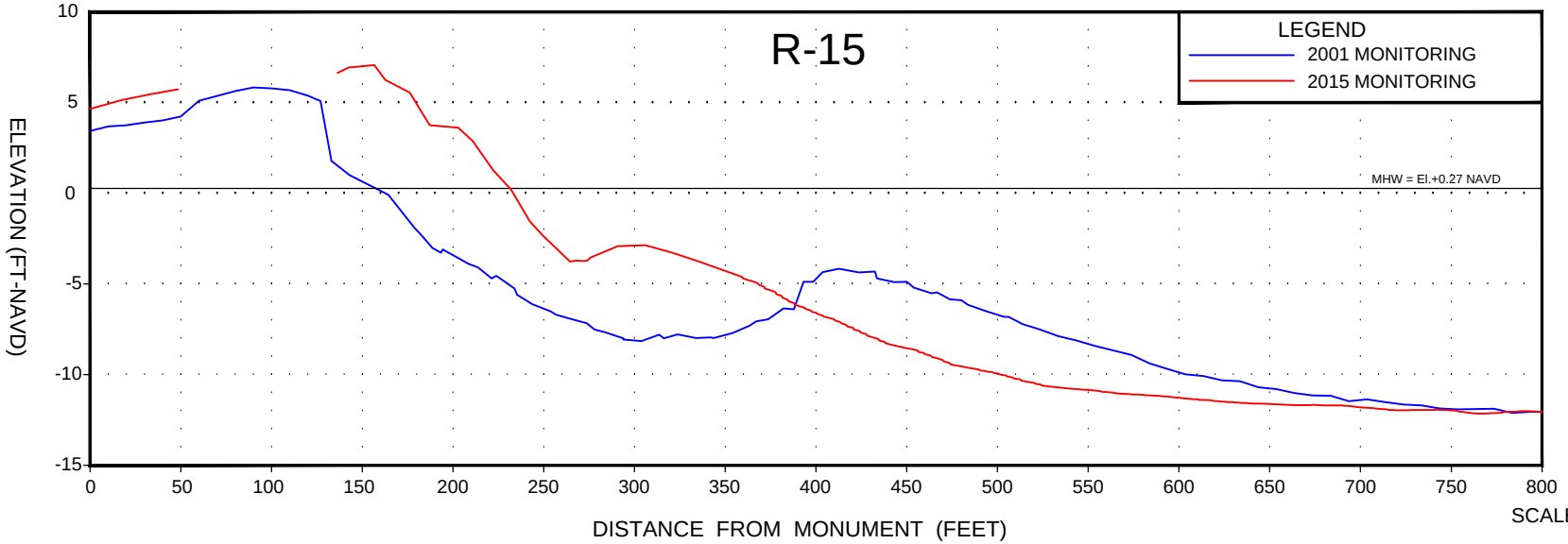
CLIENT: CHARLOTTE COUNTY

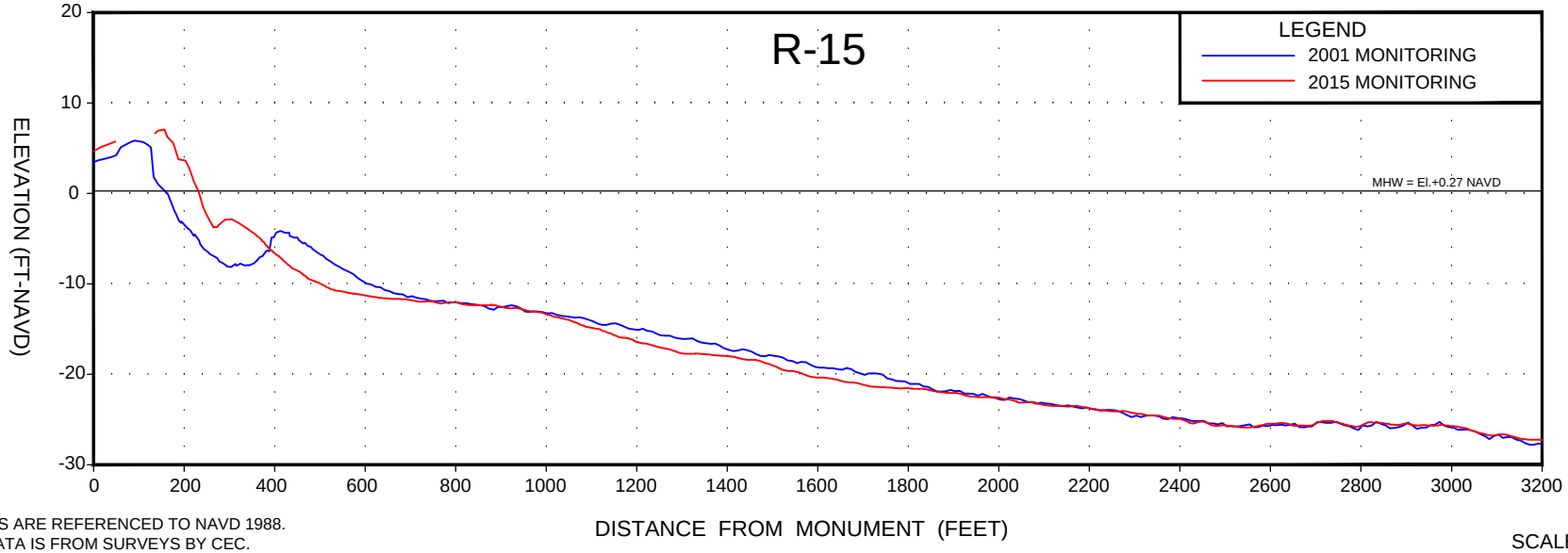
TITLE: R-14 MONITORING SURVEY

DATE: JUNE 2015	SCALE: AS SHOWN		
DRAWN: SDB	F.B.		
CHECKED: MTP	PG.		
SEC.	TWP.	RNG.	
ACAD NO. 15082 2001-2015 PROFILES adjusted.dwg			
REF. NO. 15.082			

NO.	DATE	BY	REVISION DESCRIPTION



SCALE: Horiz: 1" = 100'
Vert: 1" = 10'



SCALE: Horiz: 1" = 400'
Vert: 1" = 20'

NOTES:

1. ELEVATIONS ARE REFERENCED TO NAVD 1988.
2. PROFILE DATA IS FROM SURVEYS BY CEC.
CEC JOB NO. 15.082.

FILE NO.: 15082-M-15
SHEET OF

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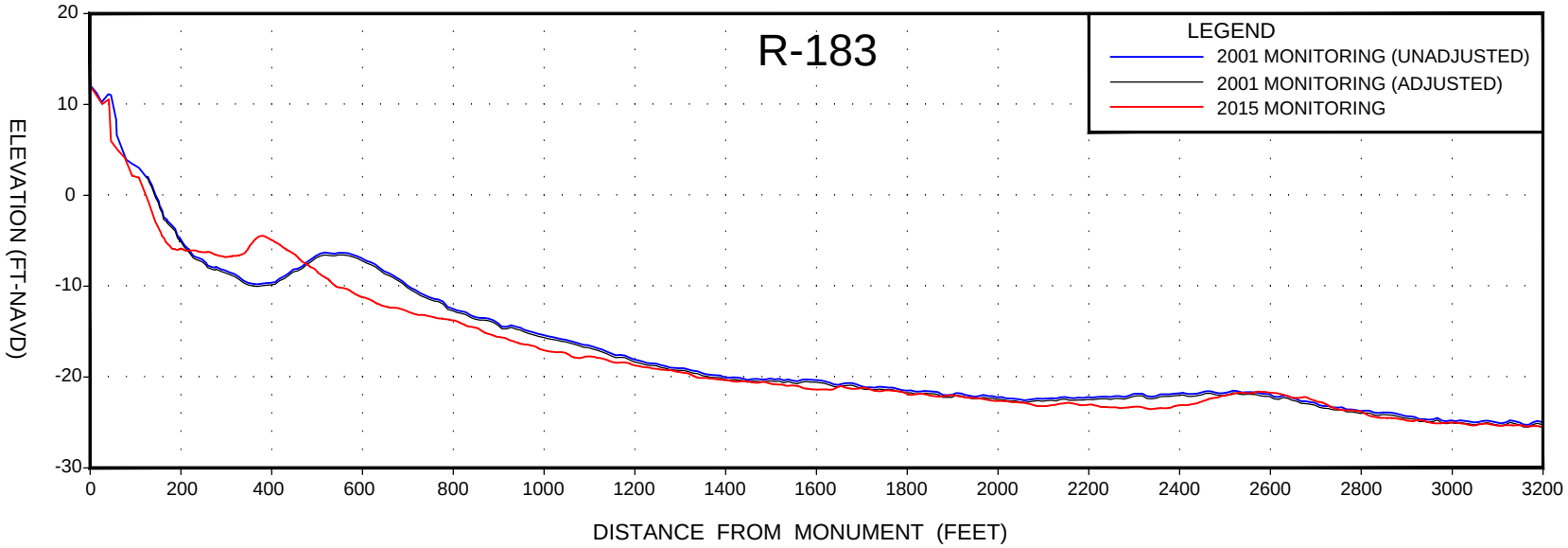
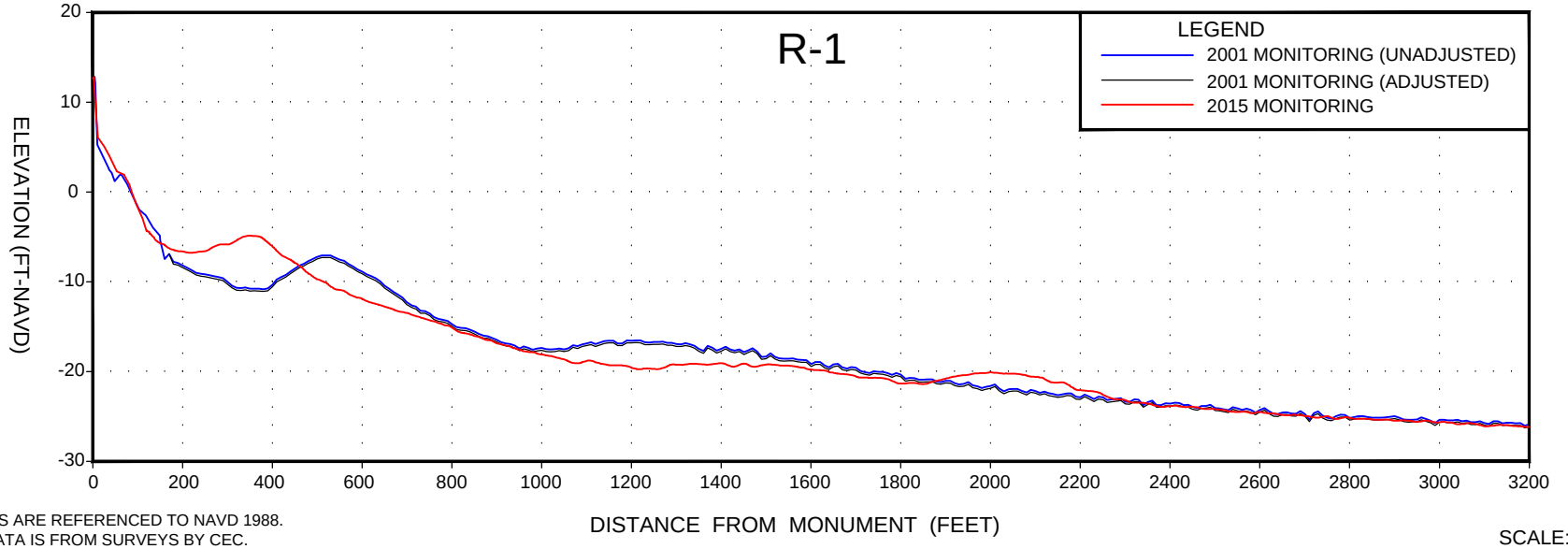
CLIENT: CHARLOTTE COUNTY

TITLE: R-15 MONITORING SURVEY

DATE: JUNE 2015		SCALE: AS SHOWN	
DRAWN: SDB		F.B.	
CHECKED: MTP		PG.	
SEC.	TWP.	RNG.	
ACAD NO. 15082 2001-2015 PROFILES adjusted.dwg			
REF. NO. 15.082			

NO.	DATE	BY	REVISION DESCRIPTION





NOTES:

1. ELEVATIONS ARE REFERENCED TO NAVD 1988.
2. PROFILE DATA IS FROM SURVEYS BY CEC.
   CEC JOB NO. 15.082.

SCALE: Horiz: 1" = 400'
Vert: 1" = 20'

SHEET 1
FILE NO.: 15082-ADJ-1

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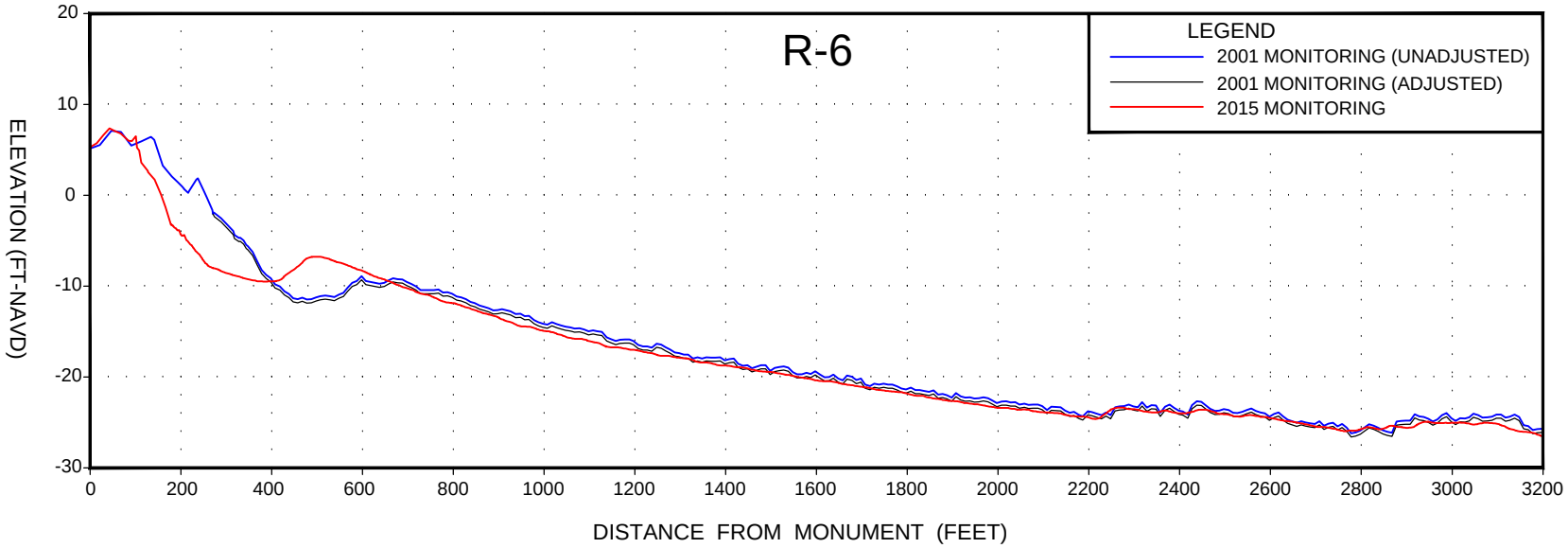
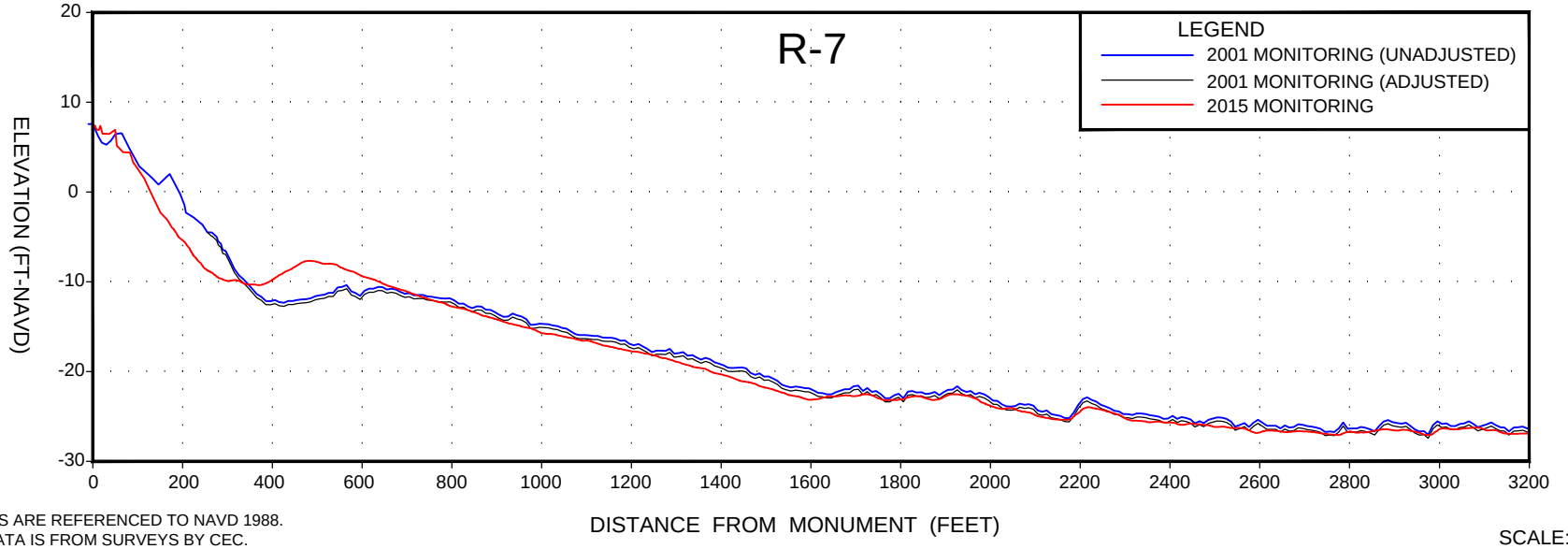
CLIENT: SARASOTA COUNTY

TITLE: R-183 & R-1 MONITORING SURVEY
ADJUSTED PROFILES

DATE: JUNE 2015	SCALE: AS SHOWN		
DRAWN: SDB	F.B.		
CHECKED: MTP	PG.		
SEC.	TWP.	RNG.	
ACAD NO. 15082_2001-2015 PROFILES adjusted vs unadjusted			
REF. NO. 15.082			

NO.	DATE	BY	REVISION DESCRIPTION





NOTES:

1. ELEVATIONS ARE REFERENCED TO NAVD 1988.
2. PROFILE DATA IS FROM SURVEYS BY CEC.
   CEC JOB NO. 15.082.

SCALE: Horiz: 1" = 400'
Vert: 1" = 20'

SHEET 2
FILE NO.: 15082-ADJ-2

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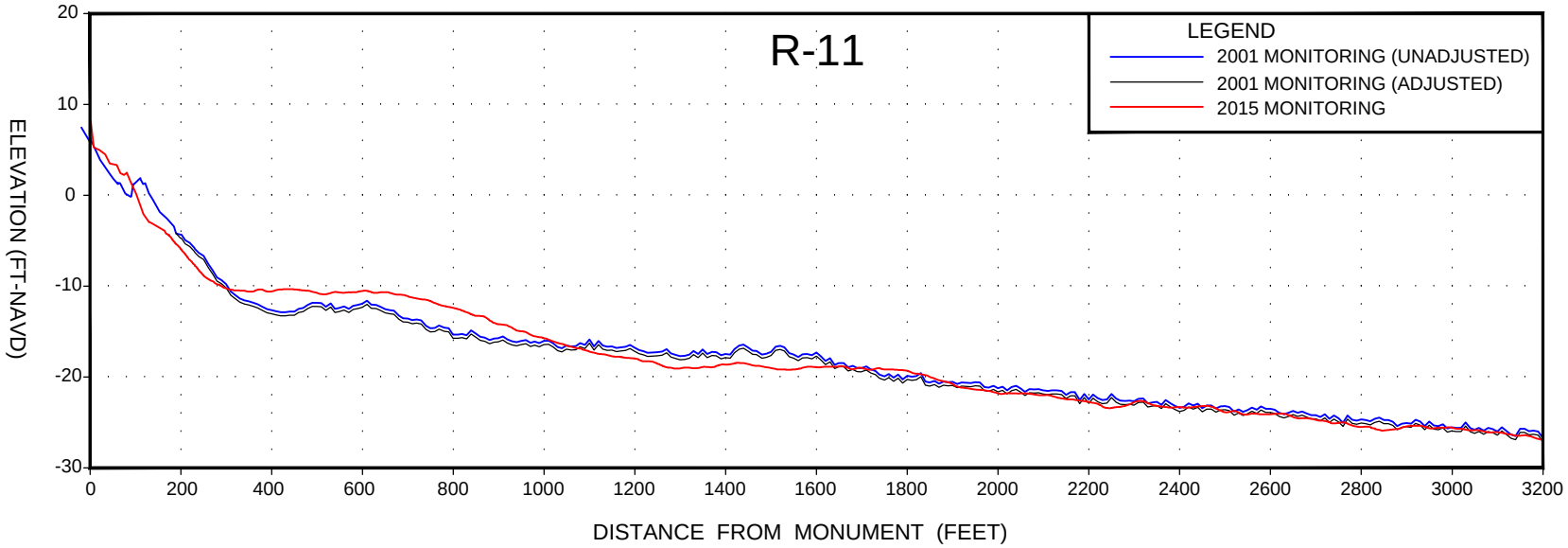
E-Mail: engcollier@cecifl.com

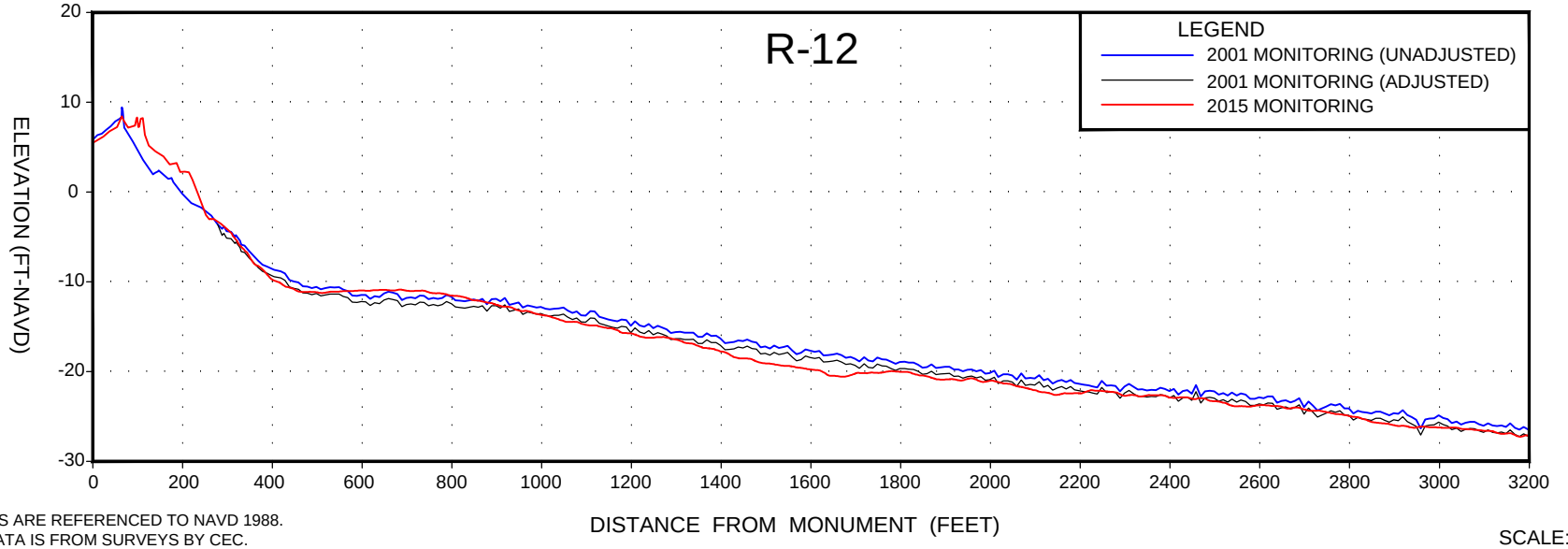
CLIENT: CHARLOTTE COUNTY

TITLE: R-6 & R-7 MONITORING SURVEY
ADJUSTED PROFILES

DATE: JUNE 2015		SCALE: AS SHOWN	
DRAWN: SDB		F.B.	
CHECKED: MTP		PG.	
SEC.	TWP.	RNG.	
ACAD NO. 15082 2001-2015 PROFILES adjusted vs unadjusted			
REF. NO. 15.082			

NO.	DATE	BY	REVISION DESCRIPTION





NOTES:

1. ELEVATIONS ARE REFERENCED TO NAVD 1988.
2. PROFILE DATA IS FROM SURVEYS BY CEC.
   CEC JOB NO. 15.082.

SCALE: Horiz: 1" = 400'
Vert: 1" = 20'

FILE NO.: 15082-ADJ-3
SHEET 3

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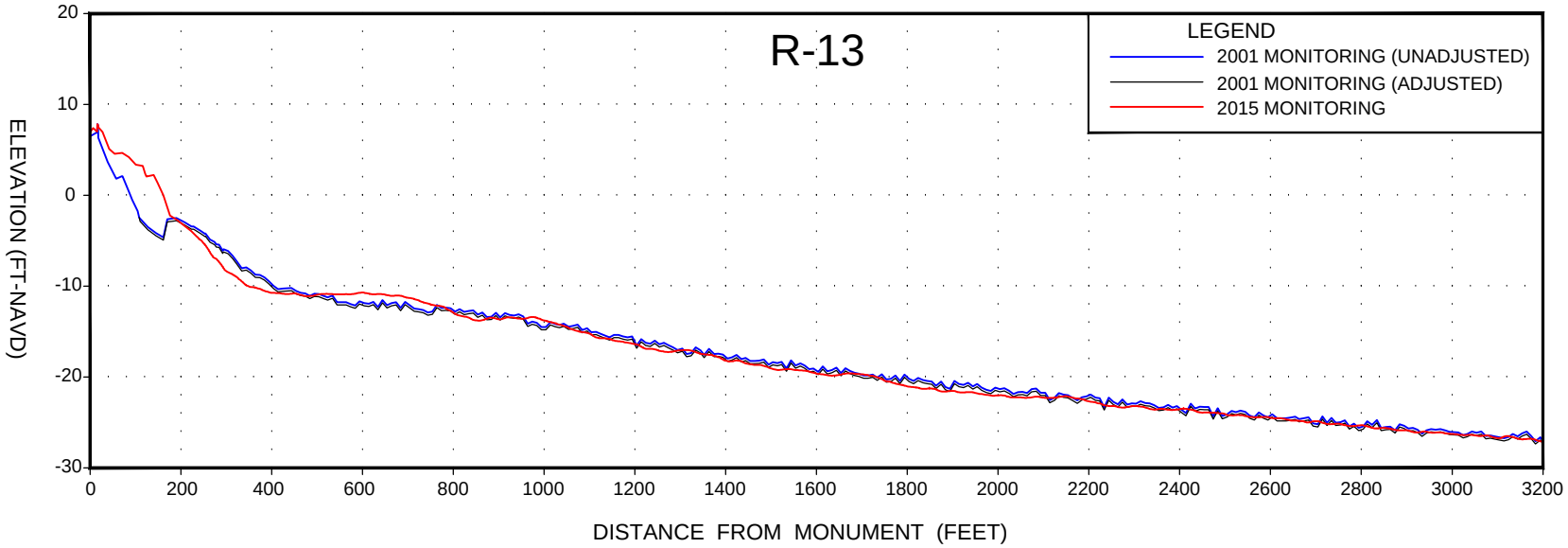
CLIENT: CHARLOTTE COUNTY

TITLE: R-11 & R-12 MONITORING SURVEY
ADJUSTED PROFILES

DATE: JUNE 2015		SCALE: AS SHOWN	
DRAWN: SDB		F.B.	
CHECKED: MTP		PG.	
SEC.	TWP.	RNG.	
ACAD NO. 15082_2001-2015 PROFILES adjusted vs unadjusted			
REF. NO. 15.082			

NO.	DATE	BY	REVISION DESCRIPTION



NOTES:

1. ELEVATIONS ARE REFERENCED TO NAVD 1988.
2. PROFILE DATA IS FROM SURVEYS BY CEC.
   CEC JOB NO. 15.082.

SCALE: Horiz: 1" = 400'
Vert: 1" = 20'

SHEET 4
FILE NO.: 15082-ADJ-4

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CLIENT: CHARLOTTE COUNTY

TITLE: R-13 MONITORING SURVEY
ADJUSTED PROFILES

DATE: JUNE 2015		SCALE: AS SHOWN	
DRAWN: SDB		F.B.	
CHECKED: MTP		PG.	
SEC.	TWP.	RNG.	
ACAD NO. 15082 2001-2015 PROFILES adjusted vs unadjusted			
REF. NO. 15.082			

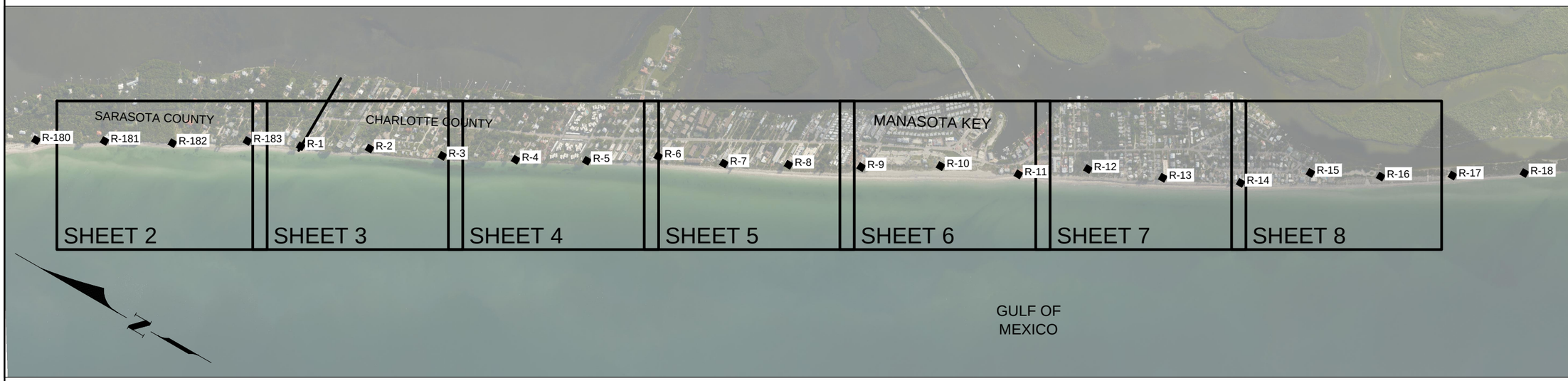
NO.	DATE	BY	REVISION DESCRIPTION

APPENDIX B: MANASOTA KEY NORTH EXISTING CONDITIONS

MANASOTA KEY NORTH
EXISTING CONDITIONS MAPS

PREPARED FOR:

CHARLOTTE COUNTY BOARD OF COMMISSIONERS



SHEET INDEX

1" = 1500'

INDEX:

1. COVER SHEET
2. R-181 TO R-183
3. R-1 TO R-3
4. R-4 TO R-5
5. R-6 TO R-8
6. R-9 TO R-11
7. R-12 TO R-14
8. R-14 TO R-16

NOTES

1. 2006 AERIAL PHOTOGRAPHY PROVIDED BY SPECTRUM FLORIDA, LLC, DATED SEPTEMBER 8, 2006.
2. 2014 AERIAL PHOTOGRAPHY PROVIDED BY PICKETT & ASSOCIATES, INC., DATED AUGUST 28, 2014.
3. 2015 AERIAL PHOTOGRAPHY PROVIDED BY PICKETT & ASSOCIATES, INC., DATED AUGUST 18, 2015.
4. HARDBOTTOM PHYSICAL SURVEY COMPLETED BY COASTAL ENGINEERING CONSULTANTS, INC. SEPTEMBER 16, 2015.
5. SIDESCAN SONAR SURVEY OF MANASOTA KEY NORTH NEARSHORE HARDBOTTOM PERFORMED BY SONOGRAHICS, INC. ON JULY 21, 2015.
6. INFORMATION SHOWN HEREON REFLECTS CONDITIONS AS THEY EXISTED ON THE DATES SHOWN AND CAN ONLY BE CONSIDERED INDICATIVE OF CONDITIONS AT THAT TIME.

NO.	DATE	BY	REVISION DESCRIPTION

DATE: 9/22/2015 SCALE: AS NOTED
DRAWN: SDB F.B.
CHECKED: MTP PG.
SEC. TWP. RNG.
ACAD NO. 15082-Existing Conditions.dwg
REF. NO. 15,082

CLIENT: CHARLOTTE COUNTY BOARD OF COMMISSIONERS

TITLE: MANASOTA KEY NORTH EXISTING CONDITIONS MAPS COVER SHEET

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SHEET 1

FILE NO.: 15082-EX-1

NO.	DATE	BY	REVISION DESCRIPTION

DATE: 9/22/2015
SCALE: AS NOTED
DRAWN: SDB
F.B.
CHECKED: MTP
PG.
SEC.
TWP.
RNG.
ACAD NO. 15082-Existing Conditions.dwg
REF. NO.
15,082

CLIENT: CHARLOTTE COUNTY BOARD OF COMMISSIONERS

TITLE: MANASOTA KEY NORTH EXISTING CONDITIONS MAPS R-181 TO R-183

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SHEET 2
FILE NO.: 15082-EX-2

NO.	DATE	BY	REVISION DESCRIPTION

DATE: 9/22/2015
SCALE: AS NOTED
DRAWN: SDB
F.B.
CHECKED: MTP
PG.
SEC.
TWP.
RNG.
ACAD NO. 15082-Existing Conditions.dwg
REF. NO.
15,082

CLIENT: CHARLOTTE COUNTY BOARD OF COMMISSIONERS

TITLE: MANASOTA KEY NORTH
EXISTING CONDITIONS MAPS
R-1 TO R-3

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SHEET 3
FILE NO.: 15082-EX-3

NO.	DATE	BY	REVISION DESCRIPTION

DATE: 9/22/2015 SCALE: AS NOTED
DRAWN: SDB F.B.
CHECKED: MTP PG.
SEC. TWP. RNG.
ACAD NO. 15082-Existing Conditions.dwg
REF. NO. 15,082

CLIENT: CHARLOTTE COUNTY BOARD OF COMMISSIONERS

TITLE: MANASOTA KEY NORTH
EXISTING CONDITIONS MAPS
R-4 TO R-5

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SHEET 4
FILE NO.: 15082-EX-4

NO.	DATE	BY	REVISION DESCRIPTION

DATE: 9/22/2015
SCALE: AS NOTED
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F.B.
CHECKED: MTP
PG.
SEC.
TWP.
RNG.
ACAD NO. 15082-Existing Conditions.dwg
REF. NO.
15.082

CLIENT: CHARLOTTE COUNTY BOARD OF COMMISSIONERS

TITLE: MANASOTA KEY NORTH
EXISTING CONDITIONS MAPS
R-6 TO R-8

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SHEET 5
FILE NO.: 15082-EX-5

NO.	DATE	BY	REVISION DESCRIPTION

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F.B.
CHECKED: MTP
PG.
SEC.
TWP.
RNG.
ACAD NO. 15082-Existing Conditions.dwg
REF. NO.
15,082

CLIENT: CHARLOTTE COUNTY BOARD OF COMMISSIONERS

TITLE: MANASOTA KEY NORTH EXISTING CONDITIONS MAPS R-9 TO R-11

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SHEET 6
FILE NO.: 15082-EX-6

NO.	DATE	BY	REVISION DESCRIPTION

DATE: 9/22/2015 SCALE: AS NOTED
DRAWN: SDB F.B.
CHECKED: MTP PG.
SEC. TWP. RNG.
ACAD NO. 15082-Existing Conditions.dwg
REF. NO. 15,082

CLIENT: CHARLOTTE COUNTY BOARD OF COMMISSIONERS

TITLE: MANASOTA KEY NORTH EXISTING CONDITIONS MAPS R-12 TO R-14

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SHEET 7
FILE NO.: 15082-EX-7

NO.	DATE	BY	REVISION DESCRIPTION

DATE: 9/22/2015
SCALE: AS NOTED
DRAWN: SDB
F.B.
CHECKED: MTP
PG.
SEC.
TWP.
RNG.
ACAD NO. 15082-Existing Conditions.dwg
REF. NO. 15,082

CLIENT: CHARLOTTE COUNTY BOARD OF COMMISSIONERS

TITLE: MANASOTA KEY NORTH
EXISTING CONDITIONS MAPS
R-14 TO R-16

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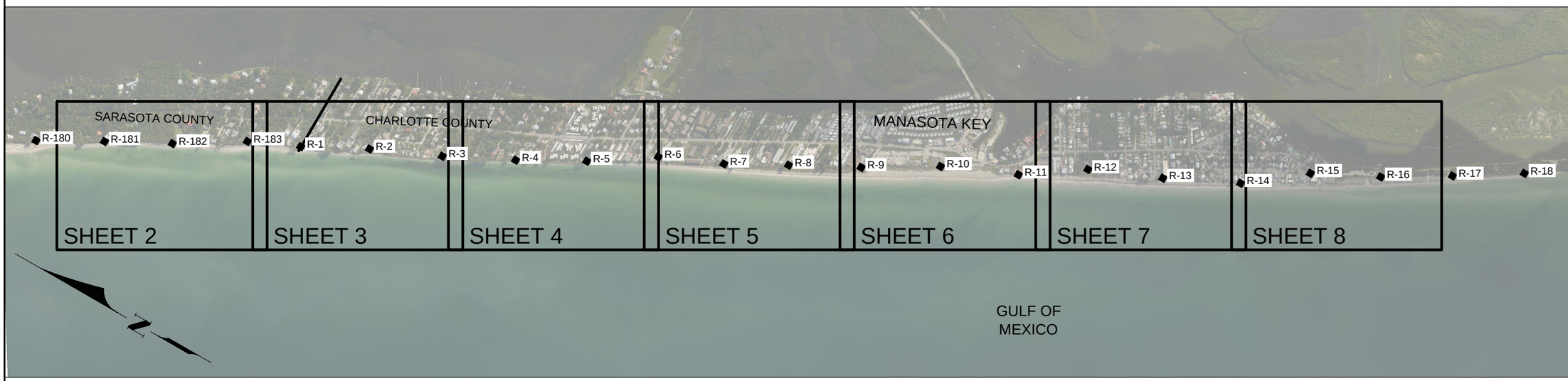
SHEET 8
FILE NO.: 15082-EX-8

APPENDIX C: CONCEPTUAL BEACH RESTORATION PLANS

MANASOTA KEY NORTH
CONCEPTUAL RESTORATION PLANS

PREPARED FOR:

CHARLOTTE COUNTY BOARD OF COMMISSIONERS



SHEET INDEX

1" = 1500'

INDEX:

1. COVER SHEET
2. R-181 TO R-183
3. R-1 TO R-3
4. R-4 TO R-5
5. R-6 TO R-8
6. R-9 TO R-11
7. R-12 TO R-14
8. R-14 TO R-16

NOTES

1. AERIAL PHOTOGRAPHY PROVIDED BY PICKETT & ASSOCIATES, INC., DATED AUGUST 18, 2015.
2. HARDBOTTOM PHYSICAL SURVEY COMPLETED BY COASTAL ENGINEERING CONSULTANTS, INC. SEPTEMBER 16, 2015.
3. SIDESCAN SONAR SURVEY OF MANASOTA KEY NORTH NEARSHORE HARDBOTTOM PERFORMED BY SONOGRAHICS, INC. ON JULY 21, 2015.
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NO.	DATE	BY	REVISION DESCRIPTION

DATE: 9/22/2015 SCALE: AS NOTED
DRAWN: SDB F.B.
CHECKED: MTP PG.
SEC. TWP. RNG.
ACAD NO. 15082_Conceptural Restoration Plans.dwg
REF. NO. 15,082

CLIENT: CHARLOTTE COUNTY BOARD OF COMMISSIONERS

TITLE: MANASOTA KEY NORTH CONCEPTUAL RESTORATION PLANS COVER SHEET

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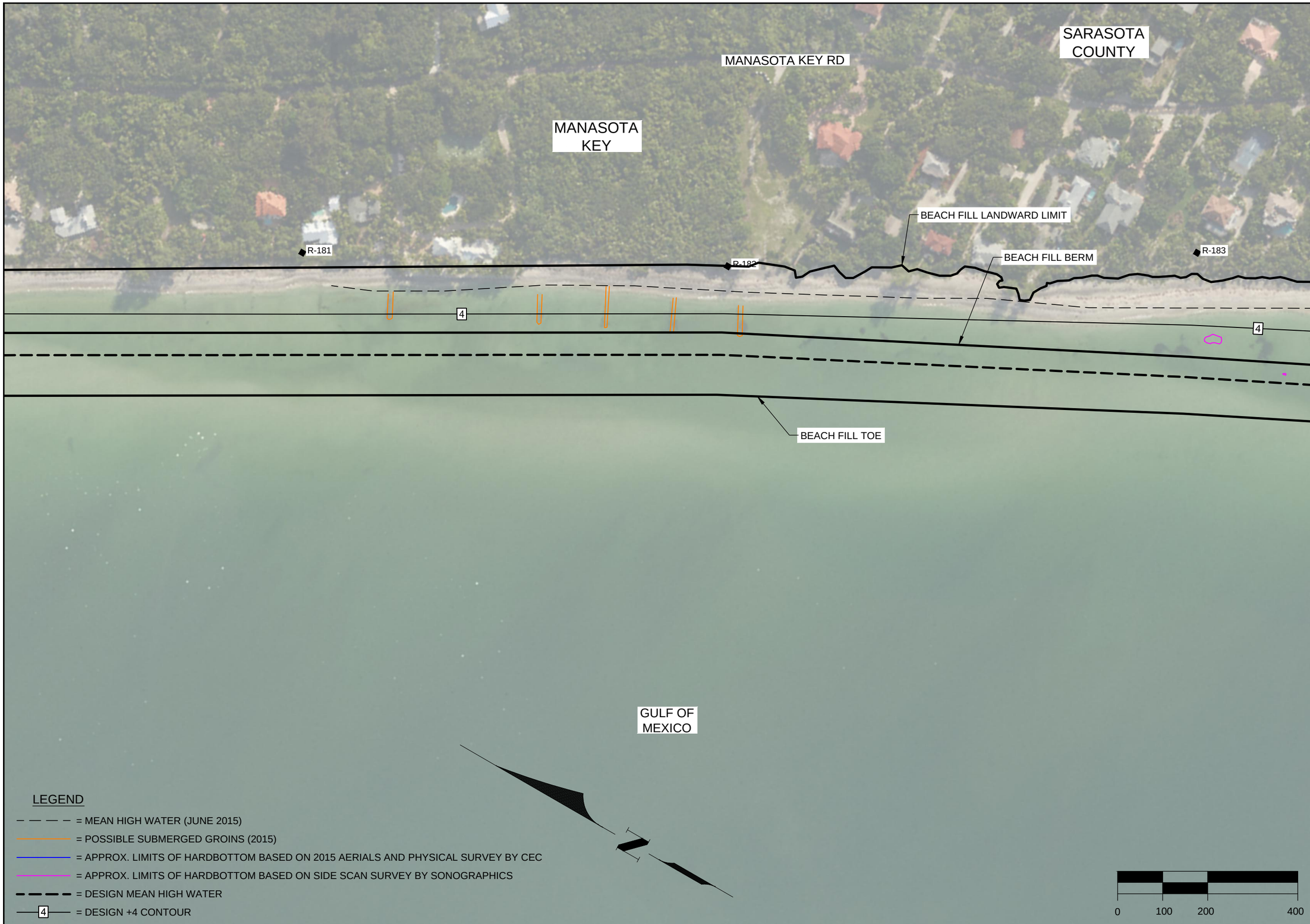
SHEET 1

FILE NO.: 15082-EX-1



NO.	DATE	BY	REVISION DESCRIPTION

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F.B.
CHECKED: MTP
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SEC.
TWP.
RNG.
ACAD: 15082_Conceptural Restoration Plans.dwg
REF. NO.
15,082

CLIENT: CHARLOTTE COUNTY BOARD OF COMMISSIONERS

TITLE: MANASOTA KEY NORTH CONCEPTUAL RESTORATION PLANS R-181 TO R-183

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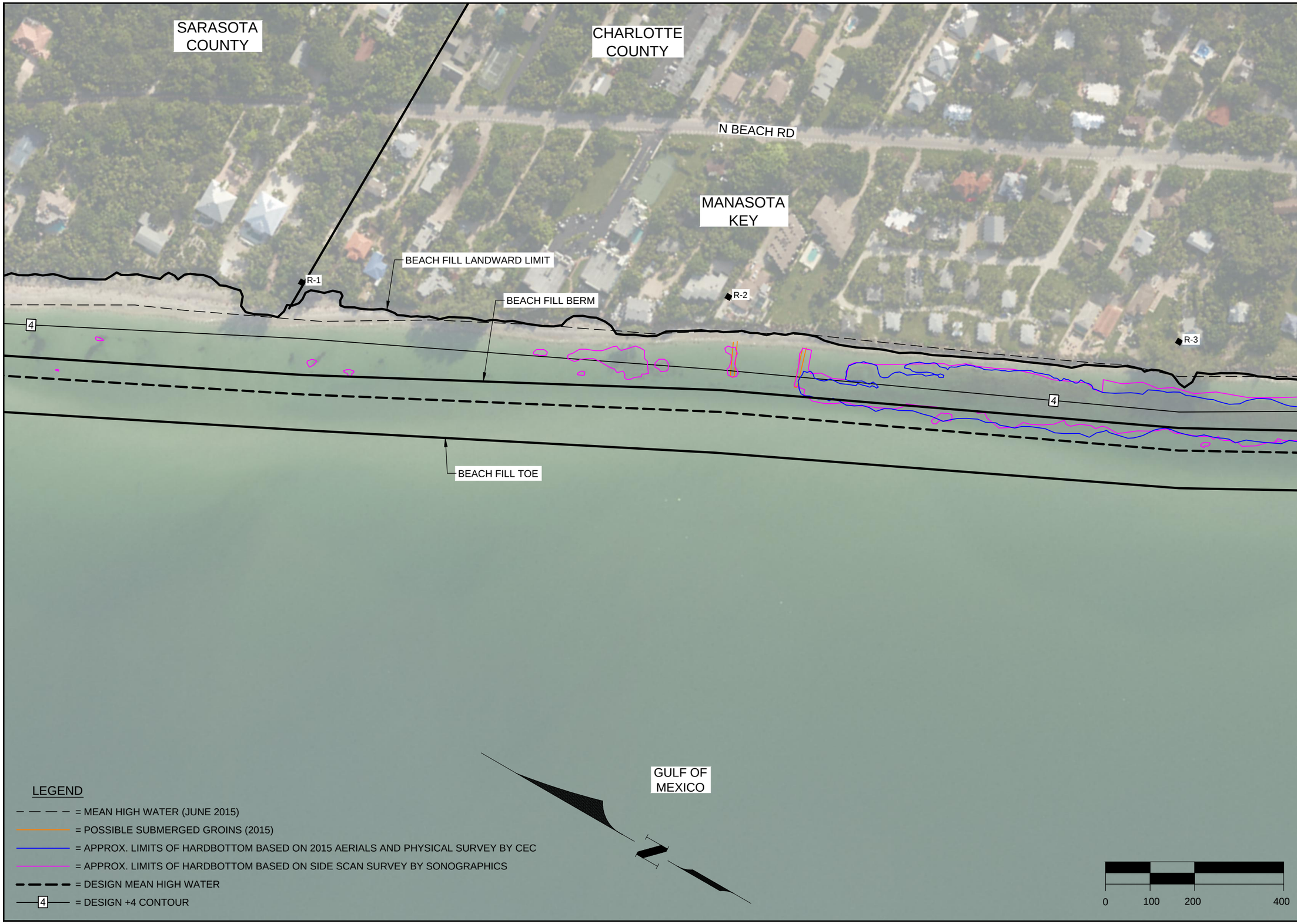
SHEET 2

FILE NO.: 15082-EX-2



LEGEND

- = MEAN HIGH WATER (JUNE 2015)
- = POSSIBLE SUBMERGED GROINS (2015)
- = APPROX. LIMITS OF HARDBOTTOM BASED ON 2015 AERIALS AND PHYSICAL SURVEY BY CEC
- = APPROX. LIMITS OF HARDBOTTOM BASED ON SIDE SCAN SURVEY BY SONOGRAPHICS
- = DESIGN MEAN HIGH WATER
- 4 = DESIGN +4 CONTOUR

NO.	DATE	BY	REVISION DESCRIPTION

DATE: 9/22/2015
SCALE: AS NOTED
DRAWN: SDB
F.B.
CHECKED: MTP
PG.
SEC.
TWP.
RNG.
ACAD: 15082_Conceptural Restoration Plans.dwg
REF. NO.
15,082

CLIENT: CHARLOTTE COUNTY BOARD OF COMMISSIONERS

TITLE: MANASOTA KEY NORTH CONCEPTUAL RESTORATION PLANS R-1 TO R-3

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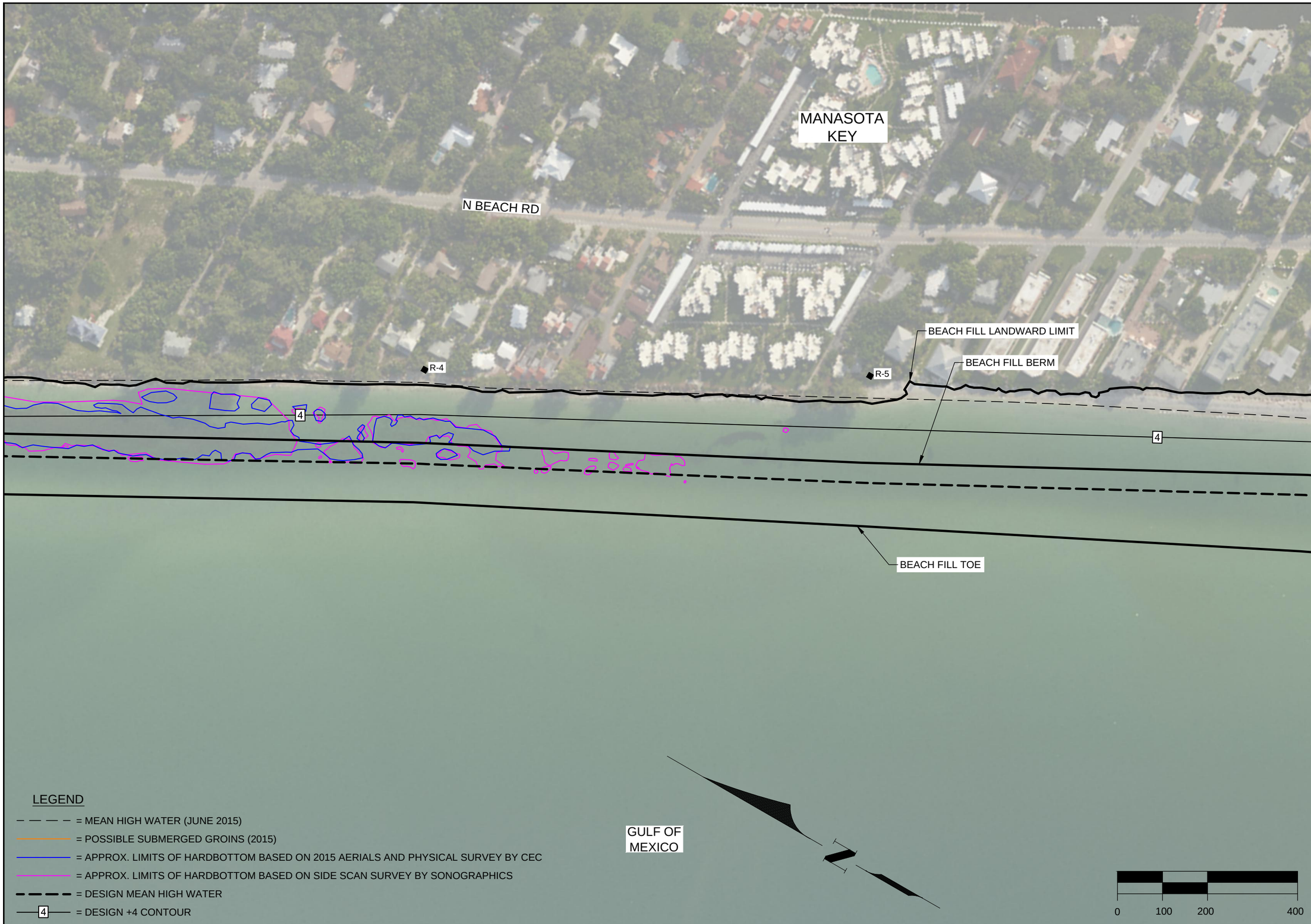
SHEET 3
FILE NO.: 15082-EX-3



LEGEND

- = MEAN HIGH WATER (JUNE 2015)
- = POSSIBLE SUBMERGED GROINS (2015)
- = APPROX. LIMITS OF HARDBOTTOM BASED ON 2015 AERIALS AND PHYSICAL SURVEY BY CEC
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SCALE: AS NOTED
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F.B.
CHECKED: MTP
PG.
SEC.
TWP.
RNG.
ACAD: 15082_Conceptural Restoration Plans.dwg
REF. NO.
15.082

CLIENT: CHARLOTTE COUNTY BOARD OF COMMISSIONERS

TITLE: MANASOTA KEY NORTH CONCEPTUAL RESTORATION PLANS R-4 TO R-5

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SHEET 4
FILE NO.: 15082-EX-4

NO.	DATE	BY	REVISION DESCRIPTION

DATE: 9/22/2015
SCALE: AS NOTED
DRAWN: SDB
F.B.
CHECKED: MTP
PG.
SEC.
TWP.
RNG.
ACAD: 15082_Conceptural Restoration Plans.dwg
REF. NO.
15.082

CLIENT: CHARLOTTE COUNTY BOARD OF COMMISSIONERS

TITLE: MANASOTA KEY NORTH CONCEPTUAL RESTORATION PLANS R-6 TO R-8

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SHEET 5
FILE NO.: 15082-EX-5

NO.	DATE	BY	REVISION DESCRIPTION

DATE: 9/22/2015
SCALE: AS NOTED
DRAWN: SDB
F.B.
CHECKED: MTP
PG.
SEC.
TWP.
RNG.
ACAD: 15082_Conceptural Restoration Plans.dwg
REF. NO.
15.082

CLIENT: CHARLOTTE COUNTY BOARD OF COMMISSIONERS

TITLE: MANASOTA KEY NORTH CONCEPTUAL RESTORATION PLANS R-9 TO R-11

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SHEET 6

FILE NO.: 15082-EX-6

NO.	DATE	BY	REVISION DESCRIPTION

DATE: 9/22/2015
SCALE: AS NOTED
DRAWN: SDB
F.B.
CHECKED: MTP
PG.
SEC.
TWP.
RNG.
ACAD: 15082_Conceptural Restoration Plans.dwg
REF. NO.
15.082

CLIENT: CHARLOTTE COUNTY BOARD OF COMMISSIONERS

TITLE: MANASOTA KEY NORTH CONCEPTUAL RESTORATION PLANS R-12 TO R-14

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SHEET 7
FILE NO.: 15082-EX-7

NO.	DATE	BY	REVISION DESCRIPTION

DATE: 9/22/2015
SCALE: AS NOTED
DRAWN: SDB
F.B.
CHECKED: MTP
PG.
SEC.
TWP.
RNG.
ACAD: 15082_Conceptural Restoration Plans.dwg
REF. NO.
15,082

CLIENT: CHARLOTTE COUNTY BOARD OF COMMISSIONERS

TITLE: MANASOTA KEY NORTH CONCEPTUAL RESTORATION PLANS R-14 TO R-16

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SHEET 8
FILE NO.: 15082-EX-8