



Corrected 11/15/2016

November 2, 2016

Linda Tucker
City Administrator
City of Isle of Palms
PO Box 508
Isle of Palms, SC 29451

RE: Hurricane Matthew Beach Damage Assessment and Recommendations [CSE 2453]

Dear Linda,

Hurricane Matthew impacted the shoreline of Isle of Palms on 7-8 October 2016. The storm produced high water levels (surge), increased wave energy, and hurricane force winds as it passed within miles of the City. The storm resulted in extensive damage to the beach and dunes, beach walkovers, and led to small-scale flooding of inland areas. Damage varied along the oceanfront, and in many cases, the level of damage was related to the pre-storm beach condition. Areas with a healthy dune and sand supply tended to fair much better than areas with a low primary dune or areas lacking any dry sand beach prior to the storm (localized areas within Wild Dunes).

Figure 1 shows the water level record for Charleston Harbor around Hurricane Matthew. The tide station showed still water levels over +6.1 ft NAVD, which is ~3.5 ft above the normal high tide level. The maximum surge was ~5.9 ft recorded near 7:15 am at low tide. The surge was likely higher along the outer coast due to higher wave setup and larger wind fetch. For reference, the dry sand elevation at Isle of Palms is typically +6 ft NAVD, mean the still water elevation (without waves) overtopped the normal dry sand beach for a period of time during the storm. Fortunately, the maximum surge occurred during low tide, reducing the potential damage to the beachfront. In addition to the surge, wave energy created severe runup and overtopping of low dunes along the entire ocean-facing shoreline of the beach. Areas of high dunes eroded, leaving significant escarpments.

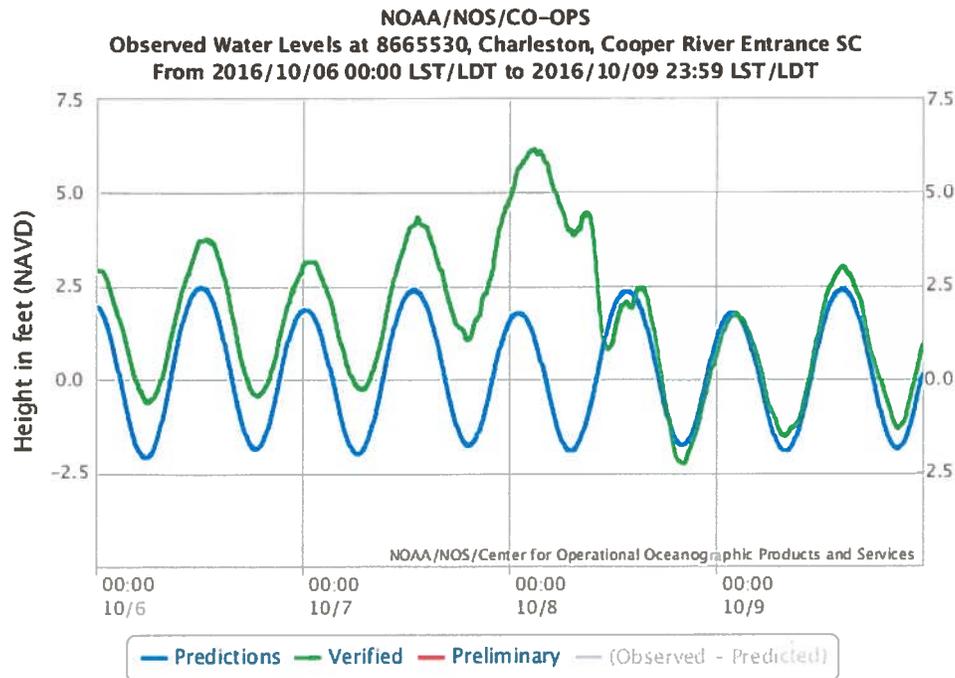


Figure 1. Water levels at the NOAA tide gauge in Charleston Harbor, SC.

CSE completed an initial post-storm beach assessment on 10 October, 2016. Visual assessments noted severe damage to several locations along the beach, including the area between Breach Inlet and 7th Avenue, the area between the Wild Dunes Grand Pavilion and Dunecrest Lane, and the area between the Port O’Call and Ocean Club condos. At these locations, the beach condition following the storm was eroded enough that oceanfront properties were immediately threatened for additional damage, especially with “king” tides predicted the week after the storm event. Other areas along the beachfront also sustained damage to the dune and walkovers; however, structure setbacks and remaining dunes are sufficient to protect structures from additional damage during normal weather and tides. Photos of the storm damage are included at the end of this letter.

Recommendation 1 –

The state of the beach in the critical areas mentioned above warranted emergency work to prevent further damage to public and private property, including residential structures, pools, fences, porches, beach access points, and emergency access points. The lack of significant dune or dry beach left little to no protection from damage likely to occur with the impending king tides. CSE recommended placement of an emergency berm along the critically eroded areas under an emergency order issued by SCDHEC-OCRM (16-EO-HM2) for sand scraping. CSE recommended a berm 6 ft high with a base width of 20 ft using sand scraped from the low-tide beach. This level of effort is considered the minimum needed to provide temporary protection to the properties until a larger restoration project can be constructed, if needed. Attachment 1 shows the locations of the critically



eroded area which required emergency berm placement. The City entered into a contract with a contractor to construct the emergency berm, which was completed between 12 and 21 October 2016 for a cost of \$127,000.

Storm Survey –

CSE completed a comprehensive beach condition survey ~2 weeks after the storm, obtaining beach profiles extending from landward of the post-storm escarpment to a minimum of 1,500 ft offshore. Profiles were obtained using RTK-GPS employing similar methods as previous work done by CSE for beach monitoring for the City. Profiles were obtained at intervals between 400 ft and 1,000 ft using stations regularly monitored by the City. Profiles were entered into CSE’s profile analysis software and compared to pre-storm profiles obtained in August 2016. Profiles are included in Attachment A.

Table 1 provides beach volumes and volume change values for the pre-storm and post-storm surveys. The Average-End-Area method was used to calculate total beach volumes between each station.

Table 1. Beach volumes and volume change values for pre and post Hurricane Matthew surveys

Line Number	Distance To Next	Aug 2016 Unit Volume (cy/ft)	October 2016 Unit Volume (cy/ft)	Unit Volume Change (cy/ft)	Total Volume Change (cy)	Line Number	Distance To Next	Aug 2016 Unit Volume (cy/ft)	October 2016 Unit Volume (cy/ft)	Unit Volume Change (cy/ft)	Total Volume Change (cy)
0	400	146.6	192.9	46.4	9,366	250	400	167.7	148.5	-19.2	-4,195
4	400	270.8	271.3	0.5	3,669	254	400	117.6	115.8	-1.8	636
8	400	298.8	316.6	17.9	3,590	258	400	113.0	118.0	5.0	651
12	400	357.8	357.9	0.1	1,069	262	400	160.0	158.3	-1.7	-1,924
16	400	323.2	328.4	5.3	1,679	266	400	225.6	217.7	-7.9	-1,566
20	1000	255.2	258.4	3.1	-2,886	270	400	231.4	231.5	0.1	-1,731
30	1000	302.2	293.3	-8.9	-9,659	274	400	243.9	235.2	-8.7	1,381
40	1000	298.7	288.3	-10.4	-6,780	278	400	326.6	342.2	15.6	-2,104
50	1000	288.9	285.7	-3.1	-6,526	280	400	496.9	470.8	-26.1	-7,597
60	1000	279.9	270.0	-9.9	-13,543	284	400	420.1	408.2	-11.8	-6,123
70	1000	294.8	277.6	-17.2	-5,938	288	400	372.9	354.2	-18.8	-8,363
80	1000	292.4	297.7	5.3	1,104	292	400	410.0	387.0	-23.0	-7,919
90	1000	331.0	327.9	-3.1	-5,808	296	400	381.6	365.1	-16.6	-1,933
100	1000	350.2	341.7	-8.5	-7,659	300	400	304.2	311.1	6.9	6,547
110	1000	341.9	335.1	-6.8	-3,806	304	400	212.0	237.9	25.8	8,099
120	1000	366.8	366.0	-0.8	-1,734	308	400	227.1	241.8	14.6	5,527
130	1000	322.1	319.4	-2.7	-7,097	312	400	139.0	152.0	13.0	3,194
140	1000	399.6	388.1	-11.5	-11,633	316	400	181.0	184.0	3.0	28
150	1000	347.8	336.1	-11.7	-115	320	400	168.0	165.1	-2.8	4,561
160	1000	349.6	361.1	11.5	7,077	324	400	293.0	318.6	25.6	5,721
170	1000	364.5	367.2	2.7	-892	328	200	342.4	345.4	3.0	-1,788
180	1000	322.4	317.9	-4.4	-4,746	330	400	349.1	328.2	-20.8	-9,775
190	1200	328.7	323.7	-5.0	4,094	334	400	239.2	211.2	-28.0	-6,726
202	400	303.4	315.3	11.9	2,209	338	400	216.4	210.8	-5.6	-1,643
206	400	306.0	305.2	-0.8	-3,955	342	400	236.1	233.5	-2.6	-1,590
210	400	287.7	268.7	-18.9	-5,164	346	400	215.7	210.4	-5.3	-1,675
214	400	295.9	289.1	-6.9	-2,026	350	400	176.7	173.6	-3.0	-1,272
218	400	311.3	308.1	-3.3	1,643	354	400	156.8	153.5	-3.3	-1,858
222	400	247.6	259.1	11.5	1,906	358	400	158.2	152.2	-6.0	-4,765
226	400	215.6	213.7	-1.9	-1,730	362	400	157.3	139.5	-17.8	-4,109
230	400	208.8	202.0	-6.7	-2,637	366	400	134.6	131.9	-2.7	-1,079
234	400	201.1	194.6	-6.5	-3,312	Total Island Change					-126,781
238	400	207.4	197.3	-10.1	-2,870	Erosional Area 1					-61,615
242	400	184.4	180.1	-4.3	-3,649	Erosional Area 2					-23,196
246	400	189.9	175.9	-14.0	-6,630	Total Reimbursable Losses					-84,812



Overall, Isle of Palms lost ~126,780 cy of sand during Hurricane Matthew. Erosion was observed over most of the island along the dune, though a few areas showed a net gain in volume due to underwater accretion (near Breach inlet and between Stations 300 and 324 near Summer Dunes Lane and Port O'Call). The area between Breach Inlet and 53rd Avenue is does not qualify as an engineered beach as it has not received nourishment sand before. This area lost ~64,500 cy of sand, mainly from the upper beach. Profiles show a classic beach response to a storm, with erosion of the dune and upper beach and buildup of an underwater bar. The bar developed at (~) -4 ft NAVD and the profile gained sand to the approximate closure depth (-10 ft).

The area between 53rd Ave and the groin along the 17th hole (stations 222+00 thru 348+00) was the 2008 beach nourishment project area and has been regularly monitored and maintained by the City. It qualified as an engineered beach during Hurricane Joaquin in 2015 and is eligible for Category G Public Assistance Funds. There were two erosional areas within the project limits (Figure 2). The first area encompassed 7,600 ft of beach between 54th Ave (Station 226+00) and Shipwatch (Station 296+00) and lost 61,615 cy of sand. This area includes the Wild Dunes Grand Pavilion and Beachwood East, which were left with no significant dune after the storm. The second area encompassed 2,200 ft of beach between stations 328+00 and 348+00 along the 17th and 18th holes of the links course. This area lost ~23,200 cy of sand during Hurricane Matthew. The dry-sand berm eroded over 100 ft along portions of the erosional area, and little sand was deposited offshore due to the inlet channel. Photos of the beach following Matthew are included at the end of this letter.

Recommendation 2 -

The total volume loss in two areas within the engineered beach boundary is 84,812 cy. This should be considered the reimbursement-eligible quantity for FEMA Category G assistance. This volume represents nearly 10% of the 2008 nourishment quantity, and is sufficient enough to warrant the City seeing FEMA reimbursement. CSE recommends the City pursue reimbursement in a manner similar to the process following Hurricane Joaquin. That storm resulted in 67,000 cy of eligible losses, and later coordination resulted in a plan to add this volume to a planned renourishment project the City is presently pursuing, with FEMA covering 67,000 cy worth of sand placement and a pro-rata share of mobilization, permitting, and engineering.

The City is presently pursuing a permit for a beach restoration project using an offshore borrow area. The project involves addition of 1,000,000 cy of sand between 53rd Ave and the 18th hole of the links course. The City should increase the planned nourishment volume to account for the volume lost during Hurricane Matthew. The 84,812 cy lost during Hurricane Matthew represents 7.8% of the total volume for this project. Table 2 outlines the anticipated project costs for the project, including breakdowns for FEMA reimbursement for Joaquin and Matthew. The estimated cost to restore the eroded volume, plus a pro rata share of engineering, construction administration, and monitoring is \$1,243,081. The City should apply to FEMA for this amount for Category G PA funds.

The sand source is offshore borrow areas ~2 miles off the shoreline of IOP. The City has obtained sufficient geotechnical borings to delineate two areas containing over 3 million cy of beach



compatible sand. Cultural resource and geophysical surveys are being planned to verify no historical features are present within the areas. The City has already coordinated with the SC State Historic Preservation Office to define the survey methods and outline conditions of construction should significant historic resources be located. Post-project sediment sampling and periodic surveys of the borrow area have been included in a monitoring plan presented in the permit application.

Work will occur on the beach both landward and seaward of the MHW line. The City has easements on hand which allow construction activities on private property adjacent to the beach. SC DHEC OCRM and USACE have authority over construction activities, and permits from each agency are required prior to construction.

CSE anticipates the timeframe for construction of an offshore nourishment project is no earlier than winter/spring of 2016/2017 due to the time required to obtain permits and conduct environmental reviews. Once permits are obtained, CSE anticipates construction to take ~6 weeks.

Required actions to implement the plan include:

- i. Obtaining permits from federal (USACE) and state (SCDHEC-OCRM) authorities responsible for construction activities in the action area (application submitted).
- ii. Engineering services to prepare the permit application and final project plan and bid documents for contractors
- iii. Construction administration including bid negotiation, construction observation, Quality Assurance/Quality Control, environmental compliance, and payment verification.
- iv. Construction of the project
- v. Environmental and physical monitoring before and after the project

Table 2. Opinion of Probable Construction Costs for Beach Restoration, Including FEMA Reimbursement for Hurricane Joaquin and Matthew.

Opinion of Probable Construction Cost	Unit Cost	FEMA Quantity - Matthew (cy)	FEMA Quantity - Joaquin (cy)	City Quantity (cy)	Total Quantity (cy)	Total Cost (\$)	FEMA Joaquin Pro Rata Share 6.7%	FEMA Matthew Pro Rata Share (7.8%)
Mobilization	\$ 2,500,000				1	2,500,000	167,500	195,000
Nourishment (cy)	\$ 10.00	84,812	67,000	933,000	1,084,812	10,848,120	670,000	848,120
Environmental Monitoring	\$ 40,000				1	40,000	2,680	3,120
Post-Project Monitoring	\$ 200,000				1	200,000	13,400	15,600
Engineering and	\$ 900,000				1	900,000	60,300	70,200
Contingency	10%				1	1,448,812	91,388	113,007
Total						15,936,932	1,005,268	1,245,047

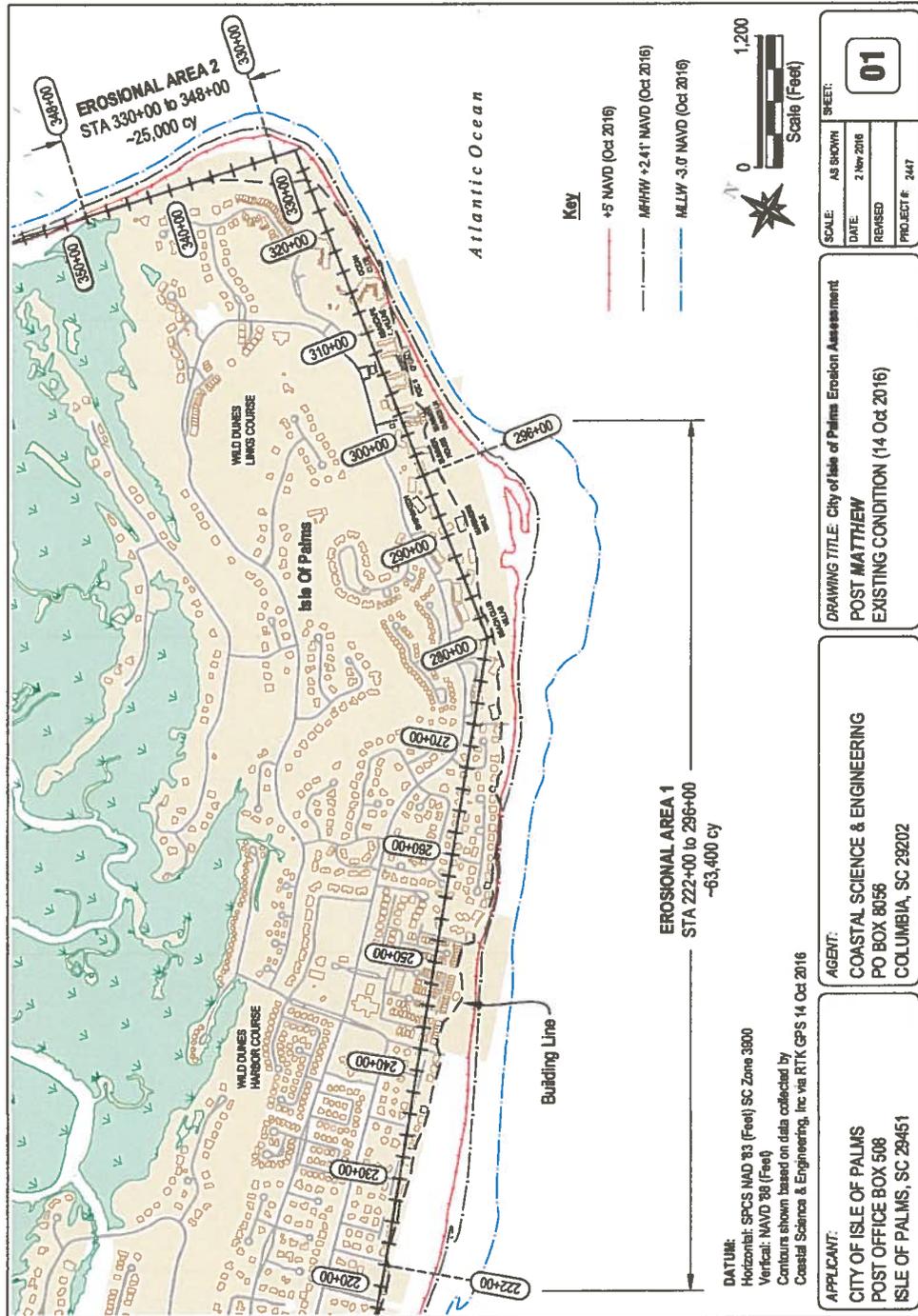


Figure 2. Erosional areas eligible for FEMA Category G Public Assistance Funds.



The above assessment and recommendations are provided to document the impacts of Hurricane Matthew to the shoreline at Isle of Palms and provide an opinion on the most prudent and logical method for restoration. Please let me know if you have any questions or need additional information.

Sincerely,

Coastal Science & Engineering (CSE)

A handwritten signature in black ink, appearing to read 'S. Traynum', written over a horizontal line.

Steven B Traynum
Coastal Scientist / Project Manager



Photos from the area between 2nd and 6th Avenues showing complete loss of the primary dune and low elevations fronting oceanfront



Near the Wild Dunes Grand Pavilion (Station 250+00) there was no dune and the high tide line reached sidewalks and decks.



Along Beachwood East (~Station 260+00), the beach is critically eroded and sand washed into houses and the road.



The high tide line reached the Seascape and Ocean Club buildings. No dune exists in these areas.