Bulkhead Monitoring Report

Morgan Creek Harbor
Isle of Palms, South Carolina
June 18, 2019
Terracon Project No. 73055027

Prepared for:
Morgan Creek Harbor Association
1340-G Ben Sawyer Blvd.
Mt. Pleasant, South Carolina

Prepared by:
Terracon Consultants, Inc.
Columbia, South Carolina

June 18, 2019

Morgan Creek Harbor Association
c/o Property Management Services
1340-G Ben Sawyer Boulevard
Mt. Pleasant, South Carolina 29464

Attn: Ms. Laurie Schueler
Ph: (843) 881-5459
laurie@charlestonpms.com

Re: Bulkhead Monitoring Report
Morgan Creek Harbor
Isle of Palms, South Carolina
Terracon Project No.: 73055027

Dear Ms. Schueler:

Terracon has completed the Bulkhead Monitoring services for the above referenced project. This work was performed in general accordance with the scope of work outlined in our Master Proposal No. 12090301-G.R1, dated August 13, 2004. Included in this report are a summary of data collected, our field observations, and our general assessment of the overall condition of the bulkhead. Additional data are included in the Appendix of this report.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

Kevin Sohrabnia, PE
Senior Principal
SC Registration No. 16603

Phillip A. Morrison, P.E.
Senior Associate
SC Registration No. 17275

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Isle of Palms, South Carolina

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1.0 INTRODUCTION

This report provides a summary of our field observations and assessments of the bulkhead located at Morgan Creek Harbor in Isle of Palms, SC. The bulkhead consists of an interlocking sheetmetal piles with concrete filled I-beam cap. The sheet piles are supported on the top by a tieback system installed on alternating 4- and 8-foot centers. The total length of the bulkhead is approximately 6,000 linear feet with exposed height on the order of 8 to 10 feet above mud line.

The inspection was made on May 15, 2019 during the mid to low tide period with clear and mild weather. Observations of the wall conditions were made from the easement behind the wall and from floating docks on the front side. Wall measurements were made to the reference plate locations, which were originally established in 2005. In some cases, the reference marks were obscured/missing due to landscaping, recent paint work by residents, renovation, etc. In these cases, new marking was established for future use or the reading location was abandoned. Field measurement data and photographic log documenting current conditions are shown on Exhibits A-3 and A-4 in Appendix A.

2.0 PROJECT INFORMATION

ITEM	DESCRIPTION
Site Location and Layout	Morgan Creek Harbor, Isle of Palms, South Carolina. See Appendix A, Exhibits A-1 and A-2, Overall Site Location Plans
General Structure Description	Steel bulkhead wall totaling approximately 6,000 linear feet with the North Harbor Wall from Stations 0+00 to 27+80 and South Harbor Wall from Stations 27+00 to 60+13. The length of the sheet piles is about 45 to 50 feet, with an exposed height above mud line of about 8 to 10 feet. The exposed section of wall is supported by series of tie-back screw anchors installed on alternating 4 and 8-foot centers.
General Work Scope	Visual observation of bulkhead, checking for the overall wall conditions, evidence of backfill subsidence, the condition of concrete cap, evidence of abnormal wall movement, and overall condition of tie-back assembly and flapper valves.

3.0 SUMMARY OF FILED OBSERVATIONS

The field observation was performed on May 15, 2019. The following tasks were performed:

- Visual observations of bulkhead and its anchorage system from floating docks where possible and from the cap, otherwise.
- Measurements of movement of the bulkhead at reference plate locations. Approximately 25 percent of the locations (15 out of 60) was measured during this inspection.
- Photo documentation of the wall condition, anchorage system, and backfill subsidence.
- Preparation of a monitoring report.

The following provides a summary of our observations and assessments for each task item inspected during this inspection. The assessment considers the current condition of the wall, wall measurements, previous inspection reports and general maintenance program.

It should be noted that a key element impacting the life expectancy and performance of wall is related to the on-going corrosion issues. We understand that MCHA has contracted with a corrosion consultant to address this issue.

Topic	Overview Statement
Overall conditions	Based on visual observation of exposed wall sections and field measurements of reference plates, the bulkhead appears to be performing generally satisfactorily considering its age and environmental factors. Some exceptions apply and are noted in this report. The inspection was performed on May 15, 2019 during mid to low tide hours.
Subsidence	Isolated areas of backfill subsidence were noted during our inspections. Most appear to be due to irrigation and/or yard inlets present in the area. Subsidence impacts the overall stability and drainage behind the wall. We recommend that the backfill be periodically checked and any observed subsidence repaired. A sink hole (possible backfill erosion) is present near Station 51+55, about 3+/- feet behind the wall. The hole is about 6 inches in diameter at the top but gets larger with depth. The erosion/subsidence in this area should further be evaluated and repaired as soon as possible. Summary of subsidence noted are presented in the Tables 1 and 2 below.
Field Measurements	The wall movement (inward/outward) was randomly checked at several of the reference plates established in 2005. Approximately 25%, or 15 locations were measured during this inspection. All locations were measured during the 2017 inspection. The results of both measurements are included in the attached tabulation. The running average of last readings (where available) were compared to previously readings to check the net movement: ▪ The outward (top moving toward water) movements were generally less than 0.5 inches, except for 7 locations where the readings indicated movements of 1 to 1.3 inches. ▪ The inward (top moving toward land) movements were generally less than 0.5 inches, except for 6 locations where readings indicated movements of 1 to 2.16 inches. Movement (deflections) of 1 inch or less is generally considered to be within the acceptable range and accuracy of measuring devices. In some cases, the readings are impacted by access to the marker and other environmental factors (tide, temperature, etc.) at the time of readings. At locations indicating movements of greater than 1-inch, we did not notice any apparent signs of distress or movement of the wall and wall cap. Nevertheless, these locations should be observed and/or measured during next scheduled inspection program.

Topic	Overview Statement
Concrete Cap	The concrete filled cap for most part appears to be in fair to good conditions with several areas of surface damage, irregular cracks and joint spalling, exposed aggregates and age-related deterioration (photos 002, 003, 006 and 007 are examples of these conditions).
Flapper Valves	The flapper valves appeared to be in good condition and functioning as intended at the time of our inspection. We did not notice any missing valves or clogged outlet gates. The inspection was performed during mid to low tide. During this time, the valves were noted to be opening and closing as intended.
Tieback system	The tieback heads at the +4-level including the bearing plates, patch plates, rods and nuts show great deal of rust and surface corrosion. Marine growth is more abundant than in previous years and, in some cases, obscures the heads of the tiebacks at the zero level. This prevents a closer inspection of some of the zero level tiebacks and head assembles.
Corrosion	As has been stated in our previous monitoring reports, corrosion is an on-going issue that requires constant maintenance and attention. Corrosion appears to be more severe on the south side (A to J and Med Docks) as compared to the north side. The corrosion has gotten worse in last couple of years with development of new pin holes and enlargement of existing holes (Photos 020, 021 and 022 are typical examples). We understand that MCHA has been working with a corrosion consultant to address this issue.
House Keeping	Shrubs, trees, and heavy privacy landscaping have been planted very close to the wall in Morgan Place between Station Markers 30+50 to 33+00. (Photo 015). The wall has a granular drainage system which allows relief of hydrostatic pressure behind the wall. Heavy roots growing into the drainage media behind the wall impedes drainage which may result in excessive hydrostatic pressure on the wall. Vegetation close to the wall also prevents adequate inspection and makes it difficult to conduct wall movement measurements. Considerations should be given to limit the vegetation within 10 feet of wall to grass only, if possible.

Topic	Overview Statement
General Assessments and Recommendations	1. We recommend that inspections of the backfill conditions, flapper gates, etc. continue to be made as these inspections are important to the long-term performance of the bulkhead. The performance of the wall depends upon these inspections (among others) and must be performed on a regular basis. 2. The summary of backfill subsidence observed during this inspection are provided in tables 1 and 2 below. These areas should be periodically inspected and filled as necessary. Considerations should be given to locating future irrigation heads away from the bulkhead to minimize backfill subsidence. 3. The sinkhole observed near Station 51+55 should be repaired as soon as possible. A Terracon representative should observe the repair to check that the drainage system and backfill behind the wall are properly repaired. 4. The wall measurements and other observations were made for the 4th time since the 2012/2013 dredging. It appears that the dredging has not negatively impacted the wall. The pre-post dredging measurements as compared to recent readings do not indicate any abnormal wall performance. 5. Several locations indicated movements of 1 to 2 inches when compared to 2014 or earlier readings. The movements however had not changed or had only changed slightly (< 0.50 inch) when compared to the last three readings. Regardless, we recommend that wall measurements be continued annually to check for unusual or abnormal movements. 6. Corrosion continues to be major issue and should be addressed to improve life expectancy of the bulkhead. 7. Trees and shrubs should not be planted near the wall to maintain drainage for the wall and to allow for proper inspection and measurements. 8. The Association has a sizeable investment in the bulkhead, and in order to maintain it, periodic observations are necessary. It is recommended that continued maintenance along with periodic inspections continue to be conducted as it will help to extend the life of the bulkhead. Any unusual or suspicious conditions should be reported to Terracon immediately.

Table 1 – Backfill Subsidence Summary (South Harbor Wall)

Station Number	Description	Photograph Number
60+00	3 to 4 inches deep, about 10' long	001
58+00	3 to 4 inches deep, about 10' long	004
57+45	6+/- inch deep, about 15' long	005
51+55	Sinkhole, 6 inch diameter at top, gets larger at base, about 3' deep	009
47+55	6+/- inch deep, about 5' long	010
45+50	Multiple locations, 3 to 4 inches deep, about 10' long	011
43+00	3 to 4 inches deep, about 5' long	013
41+50	3 to 4 inches deep, about 5' long	014

Table 2 – Backfill Subsidence Summary (North Harbor Wall)

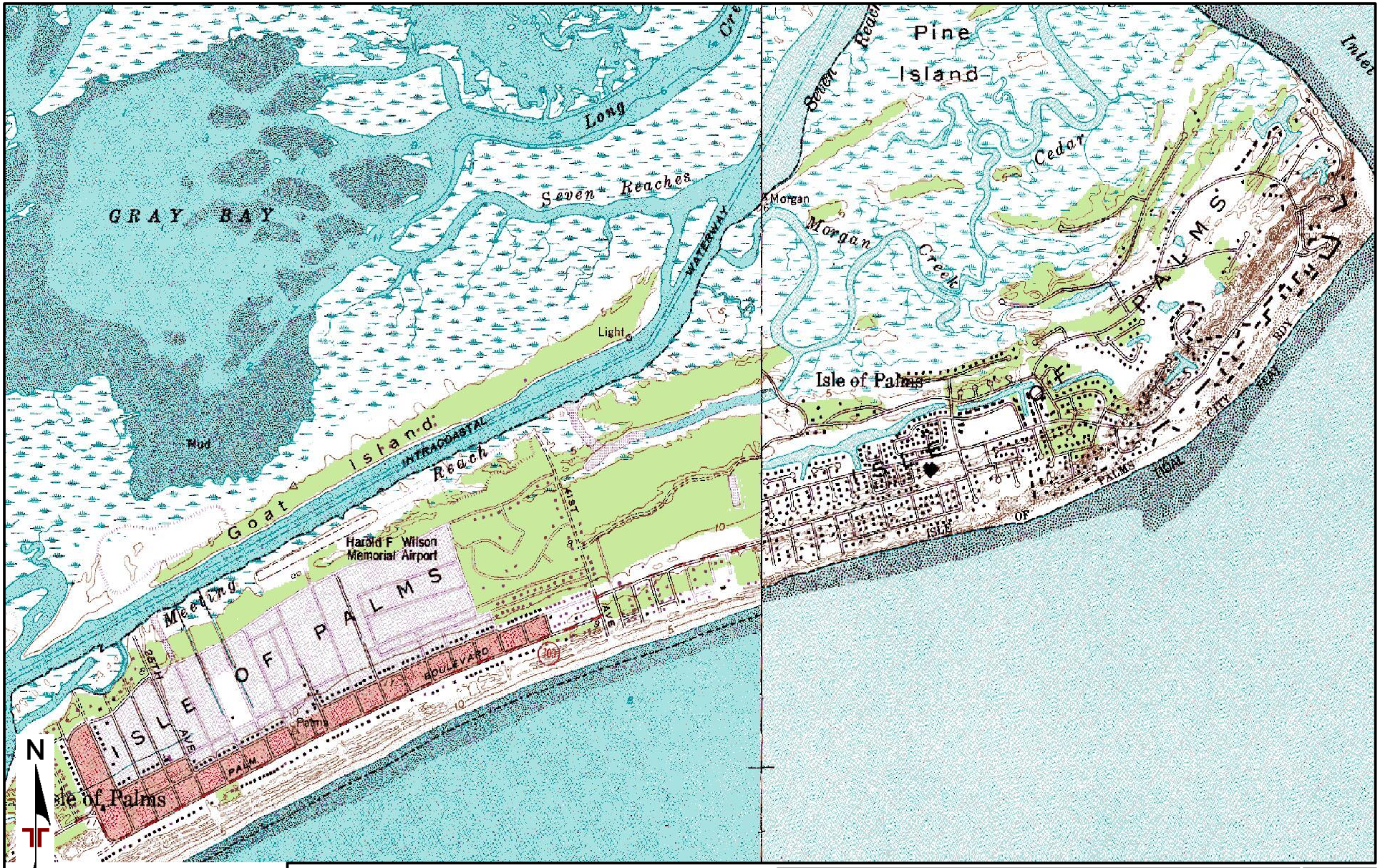
Station Number	Description	Photograph Number
15+20	Multiple locations, 3 to 4 inches deep, about 10' long	016
16+20	8 to 10 inches deep, about 15' long	017
17+30	6 to 8 inch deep, about 10' long	018
22+25	Multiple locations, 10+ inch deep, 10 to 15 feet long	019

4.0 GENERAL COMMENTS

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted engineering practices. No warranties, either expressed or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon Consultants, Inc. reviews the changes and either verifies or modifies the conclusions of this report in writing.

APPENDIX A

Exhibit A-1 and A-2	Overall Site Location Plans
Exhibit A-3	Bulkhead Wall Measurements
Exhibit A-4	Photographic Log



TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY QUADRANGLES INCLUDE: FORT MOULTRIE, SC (1/1/1979) and CAPERS INLET, SC (1/1/1992).

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager:	KS
Drawn by:	-
Checked by:	-
Approved by:	-

Project No.	73055027
Scale:	1"=2,000'
File Name:	-
Date:	-

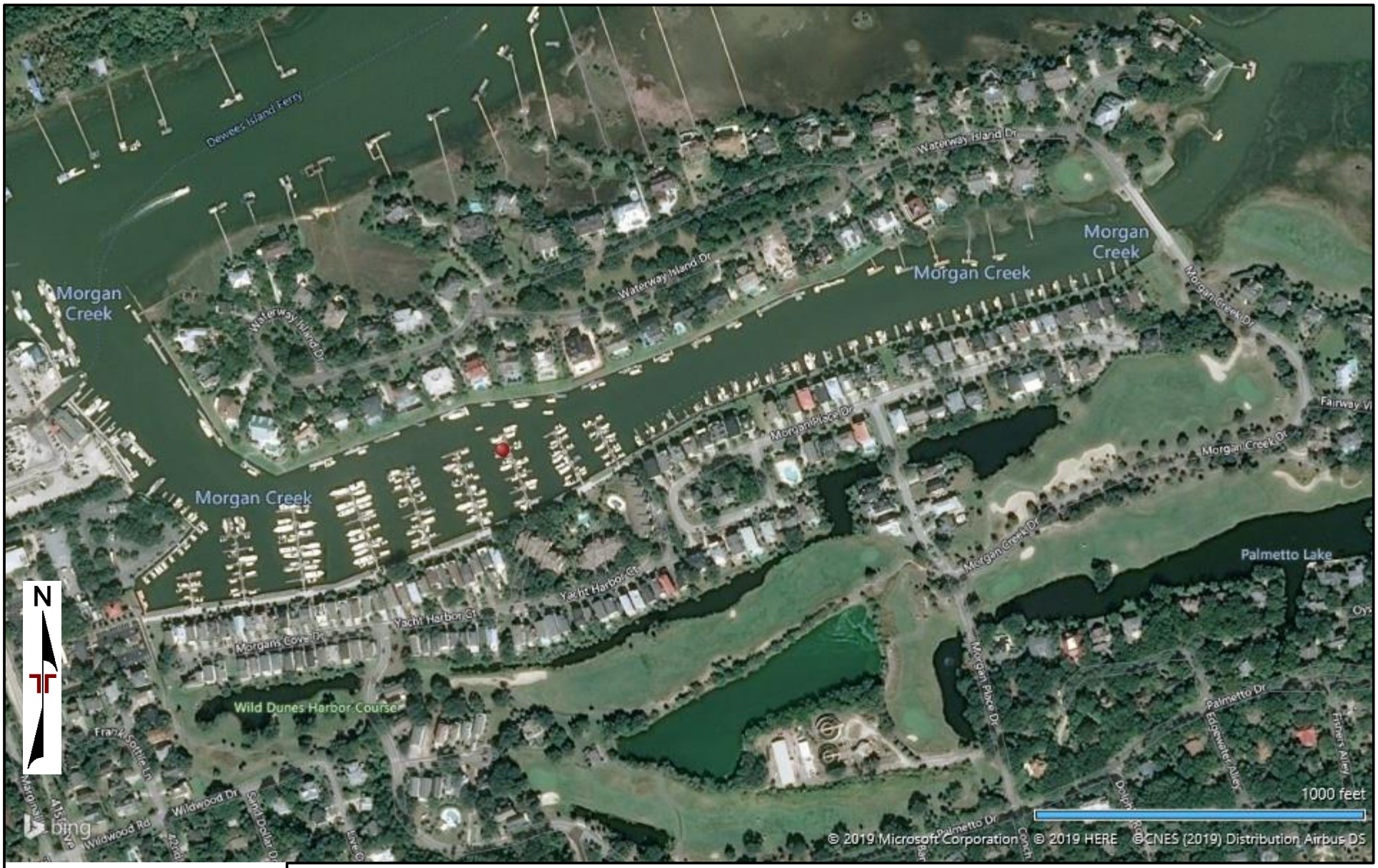
Terracon
521 Clemson Rd
Columbia, SC 29229-4307

SITE LOCATION

Morgan Creek Harbor
Isle of Palms
Isle of Palms, SC

Exhibit

A-1



AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager:	KS
Drawn by:	
Checked by:	
Approved by:	

Project No.	73055027
Scale:	AS SHOWN
File Name:	-
Date:	-

Terracon
521 Clemson Rd
Columbia, SC 29229-4307

EXPLORATION PLAN

Morgan Creek Harbor
Isle of Palms
Isle of Palms, SC

Exhibit

A-2

Table 1
MORGAN CREEK HARBOR - Bulkhead Wall Mesuremnts
May 15, 2019
Terracon Project No. 73055027

Reference Plate No.	Station No.	Distance to Reference Plate March 10-11, 2005	Distance to Reference Plate February 12, 2008	Distance to Reference Plate July 17, 2015	Distance to Reference Plate May 11, 2017	Distance to Reference Plate May 15, 2019	Running Average	Difference (inch)	General Notes
1	60+75.00	52.42	52.45	52.44	52.44	-	52.44	0.24	
2	60+ 53.85	46.95	46.98	46.98	46.98	46.99	46.98	0.40	
3	59+53.93	56.90	56.90	56.92	56.92	56.92	56.92	0.24	
4	58+15.55	53.70	54.04	-	-	-			shrubs on alignment, abandon
4A	58+15.55	-	28.50	28.46	28.46	28.46	28.46	(0.48)	back of sidewalk
5	57+32.40	56.22	56.49	56.50	56.50	-	56.50	0.12	new marker, '14
5A	57+32.40	-	26.21	26.21	26.21	-	26.21	0.00	back of sidewalk
6	55+02.48	54.10	54.15	54.13	54.12	-	54.13	0.30	corner of house
7	53+79.00	62.00	61.95	62.45	62.45	62.46	62.46	0.06	shrubs, new marker 2015
8	52+54.00	63.90	63.90	-	-	-	-	-	marker missing, abandon
8A	52+54.00	-	-	-	-	-	-	-	marker missing, abandon
8B	52+50.00	-	-	27.23	27.21	-	27.22	(0.12)	note 1
9	51+45.00	69.10	69.10	-	-	-	-	-	marker missing, abandon
9A	51+45.00		25.70	25.71	25.71	25.72	25.71	0.16	back of sidewalk
10	50+08.42	63.80	63.81	63.84	63.84	-	63.84	0.48	
11	48+13.10	50.50	50.47	-	-	-			marker missing, abandon
11A	48+13.10	-	-	27.59	27.59	27.60	27.60	0.06	Note 2
12	46+45.00	28.40	28.40	28.41	28.41	28.41	28.41	0.12	Note 3
13	44+50.00	62.40	62.42	62.42	62.41	62.41	62.41	0.16	corner of house
14	43+50.00	47.50	47.42	43.63	43.63	-	43.63	-	marker missing, abandon
15	42+14.93	42.60	42.53	42.55	42.54	-	42.55	(0.66)	
16	41+25.11	43.60	43.60	43.63	43.61	-	43.62	0.24	
17	40+50.00	55.50	55.53	-	-	-			diff. to access, abandon
17A	40+50.00		44.51	44.49	44.49	44.48	44.49	(0.28)	To step column
18	40+00.00	137.50	137.50	-	-	-	-		marker missing, abandon
18A(new)	39+78.00	-	44.55	-	-	-	-		marker missing, abandon
19	39+27.26	46.10	46.11	46.12	46.12	-	46.12	0.24	
20	38+34.69	44.90	44.90	-	-	-	-		marker missing, abandon
20A	38+34.69		-	44.65	44.65	-	44.65	0.00	marker on house trim
21	37+43.83	49.60	49.60	49.61	49.61	-	49.61	0.12	
22	37+00.00	51.60	51.58	-	-	-		-	marker missing, abandon
23	36+50.00	48.10	48.10	48.16	48.16	-	48.16	0.72	
24	35+50.00	42.40	42.42	53.71	49.33	-	51.52	-	marker missing, abandon
25	35+17.57	49.30	49.30	49.32	-	-	49.32	0.24	
26	34+44.28	47.00	46.97	47.00	47.15	47.01	47.05	0.64	
27	33+82.47	49.00	49.01	49.01	49.06	-	49.04	0.42	
28	33+37.63	46.20	46.20	46.20	46.25	-	46.23	0.30	
29	32+68.00	46.00	45.99	46.01	46.01	-	46.01	0.12	above spigiot
30	31+91.55	47.00	47.10	46.92	46.92	-	46.92	(0.96)	above spigiot on column
31	31+00.00	137.90	137.90	-	-	-	-	-	marker missing, abandon
32	30+39.00	45.40	45.38	-	-	-	-	-	marker missing, abandon
33	29+68.68	46.50	46.51	46.51	46.51	-	46.51	0.12	shrubs
34	28+63.00	45.80	45.77	45.78	45.78	-	45.78	(0.24)	
35	28+07.82	46.30	46.57	46.68	46.68	-	46.68	1.32	porch column, new marker 08

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36	0+57.38	34.00	33.99	34.09	34.09	-	34.09	1.08	porch column
37	1+58.75	45.60	45.57	42.96	42.96	-	42.96	-	new marker
38	2+89.23	44.00	43.95	43.97	43.97	-	43.97	(0.36)	
39	3+90.89	35.10	35.09	35.09	35.09	-	35.09	(0.12)	middle column
40	5+17.00	41.00	41.09	41.10	41.11	-	41.11	1.26	
41	7+94.37	71.00	-	-	-	-	-	-	marker missing, abandon
41A	-	-	37.06	36.88	36.88	36.88	36.88	(2.16)	corner, last 3 readings no change
42	9+20.00	60.30	60.30	60.31	60.32		60.32	0.18	
43	10+20.00	31.00	30.96	34.21	34.23	34.28	34.26	0.54	silt fence, no reading, RT post
44	12+00.00	45.00	45.03	45.01		45.01	45.01	0.12	
45A	13+10.00	-	36.77	36.77	36.77		36.77	0.00	5th post from RT
46	14+30.00	34.00	33.93	-	-	-	-	-	marker missing, abandon
47	15+10.00	63.70	63.67	-	-	-	-	-	marker missing, abandon
47A	15+10.00	-	-	35.70	35.69	35.69	35.69	(0.12)	corner, Note 4
48	16+86.00	35.00	34.95	-	-	-	-		shrubs, no reading, abandon
49	17+71.90	52.10	52.10	52.08	52.08	-	52.08	(0.24)	left post steps
50	18+30.00	72.30	72.31	72.31	72.31	-	72.31	0.12	left corner
51	19+00.00	34.10	34.14	34.16	34.16	34.16	34.16	0.72	corner post
52	19+62.55	45.30	45.23	45.24	45.21	-	45.23	(0.90)	corner
53	20+00.00	54.00	53.82	53.86	53.86	-	53.86	(1.68)	4th column from north corner
54	20+50.00	43.90	43.90	44.87	44.01	-	44.44	-	new maker
55	21+00.00	45.30	45.20	44.17	46.14	-	45.16	(1.74)	New Marker, left column, cinder block
56	21+50.00	54.80	54.87	-	-	-	-	-	marker missing, abandon
57	22+25.00	32.50	33.42	33.44	33.44	-	33.44	0.24	
58	23+00.00	39.90	39.87	39.93	39.93	-	39.93	0.36	By door
59	23+50.00	34.10	34.09	34.10	34.10	-	34.10	0.00	
60	24+25.00	34.20	34.20	34.20	34.20	-	34.20	0.00	

Table Notes:

1) *Measurement from back of the sidewalk at joint to station marker 52+50. Marker was established in 2013.*
2) *Measurement to the back of sidewalk, tangent to east side of fence post.*
3) *Measurements to the back of sidewalk at the construction joint.*
4) *New marker to RT column of pool deck.*

General Notes

a) *Positive numbers indicate outward (toward the water) and negative numbers (<>) indicate inward (toward land) movement.*
b) *Measurements were taken at low to mid tide, temperature in low seventies, light wind.*
c) *Measurements taken to bottom left corner of reference plate, unless noted otherwise.*
d) *Measurements were taken using a 100' long woven metallic tape.*
e) *Dashes " – " in the table indicates no measurements were made during this inspection*
f) *running average denotes aveergae of last three readings, if avilable.*

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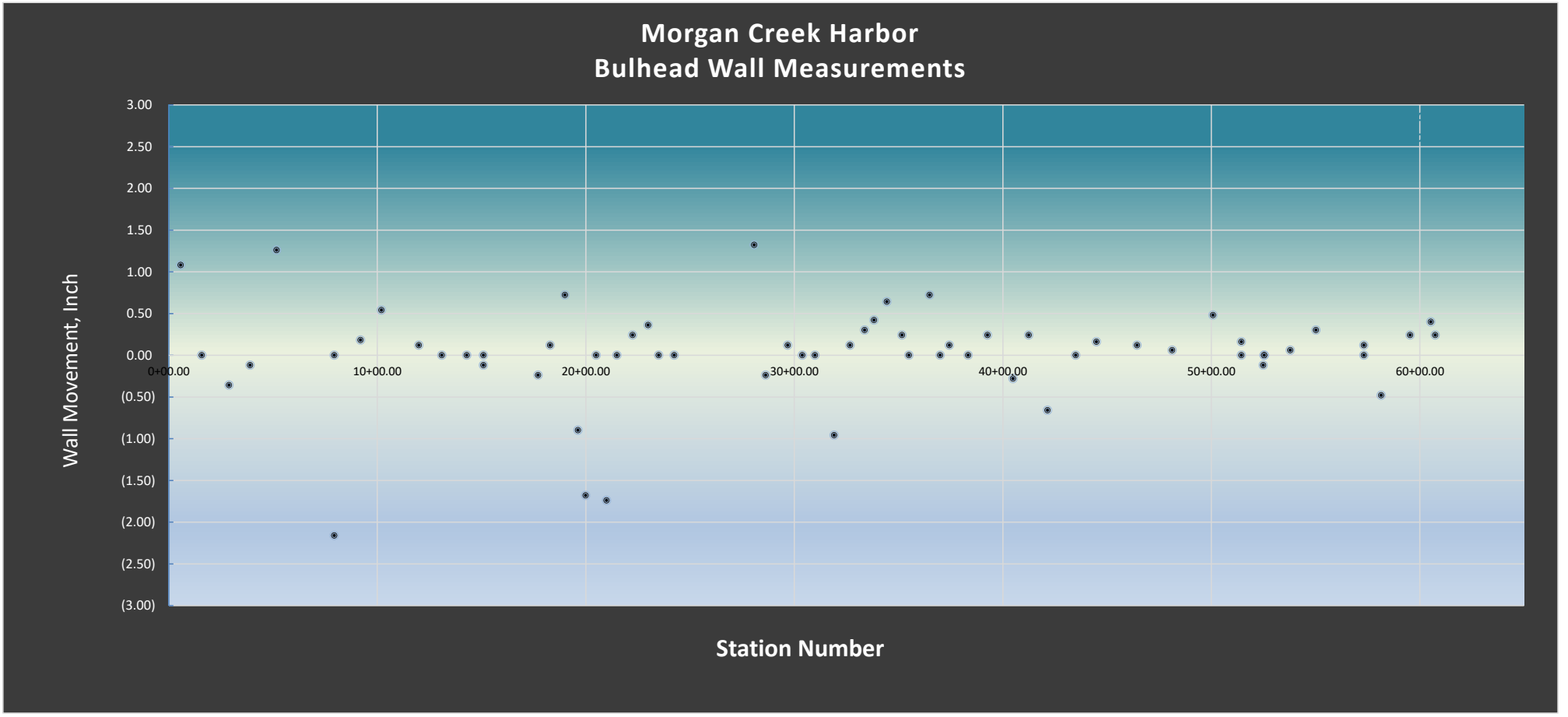

Photo 001 – subsidence, Station 60+00

Photo 002 – Cap deterioration/concrete spalling, Station 59+30

Photo 003 – cap deterioration, exposed aggregate, Station 59+00

Photo 004 – subsidence, Station 58+00

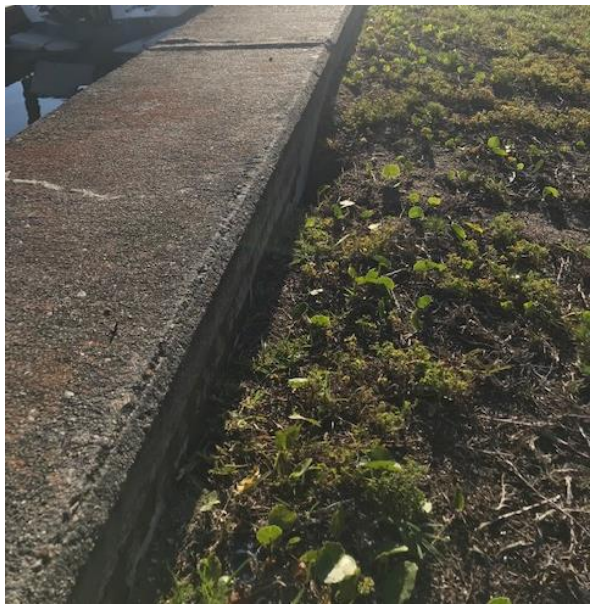

Photo 005 – subsidence, note sprinkler head nearby, Station 57+45

Photo 006 – cap joint displacement, Station 56+20

Photo 007- cap joint displacement, Station 56+00

Photo 008 – Flapper valve, functioning mid tide

Photo 009 – sinkhole/backfill erosion, the center of sinkhole was about 3 feet from wall, Station 51+55, nearby marker Plate #9

Photo 010 – subsidence, Station 47+55, note shrubs very near the wall.

Photo 011- subsidence Station 45+50

Photo 012 – rust/corrosion (typical) around flapper valve, anchorage and bulkhead, Station 45+50

Photo 013- subsidence, Station 43+00

Photo 014 – subsidence, Station 41+50

Photo 015 – Trees and shrubs have been planted very near to back side of the wall. The wall cap has completely been covered by overgrown shrubs and trees, Stations 30+70 to 33+00, typical

Photo 016 – subsidance, Station 15+20

Photo 017 – subsidence, Station 16+20

Photo 018 – subsidence, Station 17+30, note soil erosion below the cap flange.

Photo 019 – subsidence, Station 22+25, deep erosion below cap.

Photo 020- typical corrosion and marine build up. Note rust on patch plates. Also, numerous pinholes.

Photo 021- typical corrosion and marine build up. Note rust on anchorage assembly.

Photo 022 – corrosion on wall and anchorage assembly.