March 28, 2017

Year Three Monitoring Report

NOISETTE CREEK SALT MARSH RESTORATION

Prepared for: Natural Resource Damage Trustees

Prepared By: Tidewater, A JMT Division

On behalf of: Evergreen International, S.A. c/o Mr. Sean Houseal, Womble Carlyle Sandbridge & Rice, PLLC

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1.0 INTRODUCTION

On September 30, 2002, a container vessel owned by Evergreen International, S.A. accidentally released an estimated 12,500 gallons of No. 6 fuel oil into the Cooper River in the immediate vicinity of the former U.S. Naval Base and within the Noisette Creek drainage area. In order to compensate for impacts that occurred as a result of the accidental oil spill, the Natural Resource Damage Trustees (herein, Trustees) required Evergreen International, S.A. to restore, enhance, and/or create tidal saltmarsh by increasing hydrologic (tidal) exchange between Noisette Creek and a former golf course located within the impacted area. The project site is located off Noisette Boulevard in North Charleston, Charleston County, South Carolina at the former U.S. Naval Base to the northeast of the intersection of N. Hobson Avenue and Avenue D (Figure 1). The purpose of the salt marsh restoration was to restore the functionality of the system.

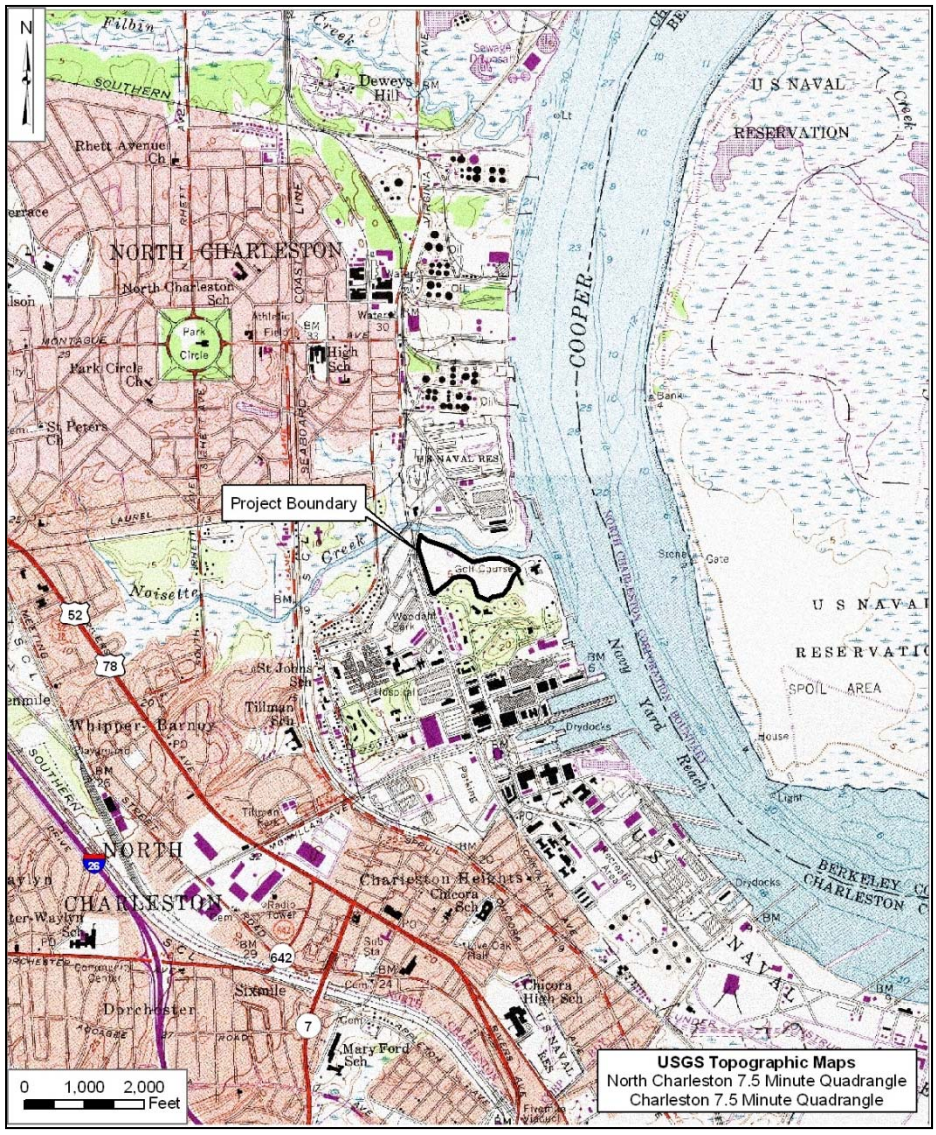


Figure 1. Site Location Map

The Baseline Mitigation Monitoring Report (revised February 7, 2012) was submitted August 10, 2011. The baseline report provided an overview of pre-construction hydrology and vegetation conditions. The Time Zero Monitoring Report was submitted July 24, 2013, to document the post-construction condition of the vegetation, berm breaches and constructed tidal creeks. The Year One Monitoring Report was originally submitted November 24, 2014, to document the vegetation and hydrology changes for the first year following construction; a final revised version of the Year One Monitoring Report was submitted October 15, 2015. The revised version outlined specific changes to the monitoring plan at the reference site. The Year Two Monitoring Report was submitted May 18, 2016 to document the vegetation and hydrology changes for the second year following construction. This Year Three Monitoring Report documents the vegetation and hydrology changes for the third year following construction.

Section 2.0 provides a narrative documentation of the restoration and maintenance activities. Section 3.0 provides an overview of the methods used to monitor the restoration area and compare it to the reference area. Section 4.0 describes the water level monitoring and restored hydrologic connections. Section 5.0 describes the vegetation monitoring that has occurred. Section 6.0 provides an overview of visual assessments of avian and aquatic wildlife. Section 7.0 documents the photographs taken of the site and vegetation quadrats in September 2016. Lastly, Section 8.0 discusses development of the restoration area.

2.0 IMPLEMENTATION

The Proposed Salt Marsh Restoration Plan (herein, Restoration Plan), dated May 16, 2007, for the former golf course was developed by Lewis Environmental Services, Inc. The final restoration plan and construction drawings were developed by URS with assistance from Tidewater Environmental Services Inc. (Tidewater) and Lewis Environmental Services, Inc. The restoration plan is depicted on Figures 2 and 3.

Construction occurred on the restoration area between February 11, 2013, and May 18, 2013. An As-Built Survey of the restoration area was included with the Time Zero Monitoring Report. Per the Final Restoration Plan, hydrologic (tidal) exchange was increased by breaching portions of an existing east-west earthen berm located along the southern bank of Noisette Creek, by removing portions of existing subsurface drainage tiles (culverts) from the project area, and by excavating tidal creek channels within the project area. Core matting secured with stakes was installed to prevent erosion immediately after construction of the tidal creeks. Drainage tiles to remain were plugged with grout and/or crushed in place. Restoration measures also included the removal of two existing concrete slabs and one existing wooden bridge, the removal of cart path gravel and former road beds, and the removal of an existing dilapidated dock. A site visit with the Trustees occurred April 15, 2013 to confirm completion of earthwork portion of restoration plan. Invasive species such as Chinese Tallow (*Triadica sebifera*) and Chinese Privet (*Ligustrum sp.*) were chemically treated at the restoration area and smooth cordgrass (*Spartina alterniflora*) was planted on May 17, 2013.

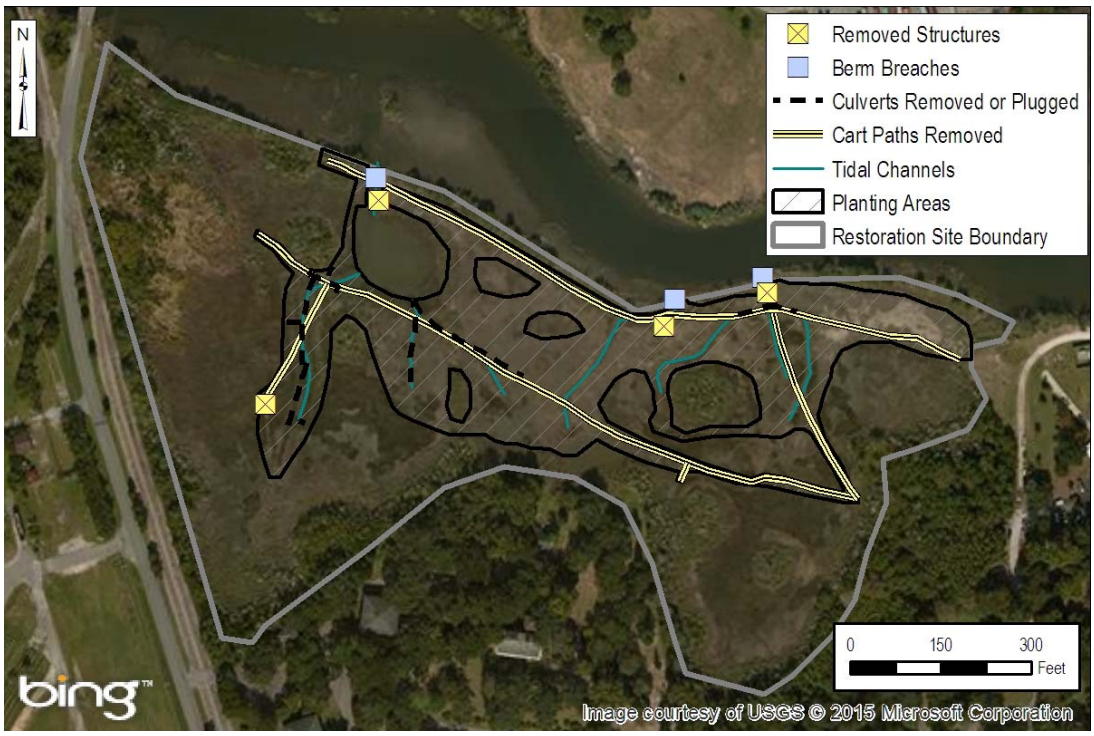


Figure 2. Restoration Plan

Figure 3. Restoration Plan – Constructed Channels

3.0 MONITORING PLAN

A Monitoring Plan, dated February 12, 2010, was developed in cooperation with the Trustees that outlined the methods to evaluate vegetative and hydrologic conditions at the site. In accordance with the Monitoring Plan, the restoration and reference areas have been or will be evaluated pre-construction (baseline monitoring), Time-Zero (post-construction), and annually for (up to) five years following construction to ensure the pre-determined success criteria have been met. Monitoring locations at the restoration area and reference site are shown in Figures 4 and 5, respectively. The reference area is located on Daniel Island, South Carolina; refer to Figure 6 for the location of the reference area in relation to the restoration area. Per the Monitoring Plan, annual monitoring at the restoration site utilized the baseline monitoring stations established prior to construction, as discussed below.

Hydrology – Hydrology is being monitored with three HOBO Water Level Loggers at the restoration site and one Water Level Logger at the reference site. Data is recorded by the loggers at 15-minute intervals. The hydrology data from the loggers is downloaded on a regular basis. At the restoration site, a hydrologic connection at a berm cut and the constructed tidal creeks are also being monitored annually by taking depth measurements along permanently-established cross sections (see locations in Figure 4). These locations are also used as permanent photograph stations to document conditions at the berm breaches and constructed tidal creeks.

Vegetation – Vegetation is being monitored within four 1m² quadrats established within the restoration site and four 1m² quadrats established within the reference site. Additionally, two 30m line intercept transects are monitored within the restoration site and four 30m line intercept transects are monitored within the reference site. The location of quadrats and transects within the reference area were revised as approved by the Trustees in late 2015. All vegetation within the quadrats is identified and overall percent cover is documented. The representative height of plants within the quadrats, as well as the percent bare ground, is recorded. All vegetation intersected by the line transects is identified and overall percent coverage for each species is documented. In addition, randomized stem counts are conducted within four 0.0625 m² sub-quadrats that are part of each of the established 1m² quadrats. The sampled sub-quadrats are selected by numbering the sub-quadrats from 1 to 16 and using a random number generator to identify the four sub-quadrats to be sampled within each quadrat. Photographs are taken at the permanent stations at each 1m² quadrat and 30m line intercept transect to document change in the development of the restoration site. Vegetation monitoring occurs once per year in the late summer.

Additional Information – Photographs are taken at the permanent stations established during baseline monitoring of the restoration site. In addition, qualitative visual assessments of fishes, invertebrates and avian wildlife utilizing the restoration and reference sites are being performed during the hydrologic and vegetation monitoring events.

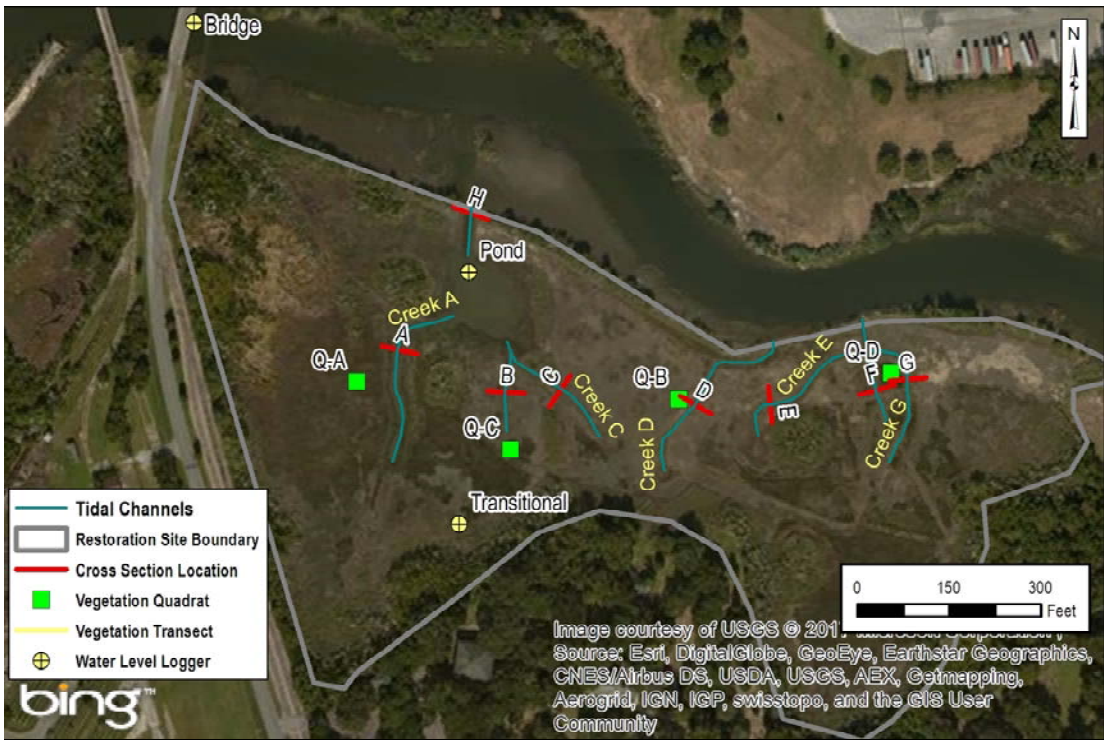


Figure 4. Restoration Site Monitoring Locations

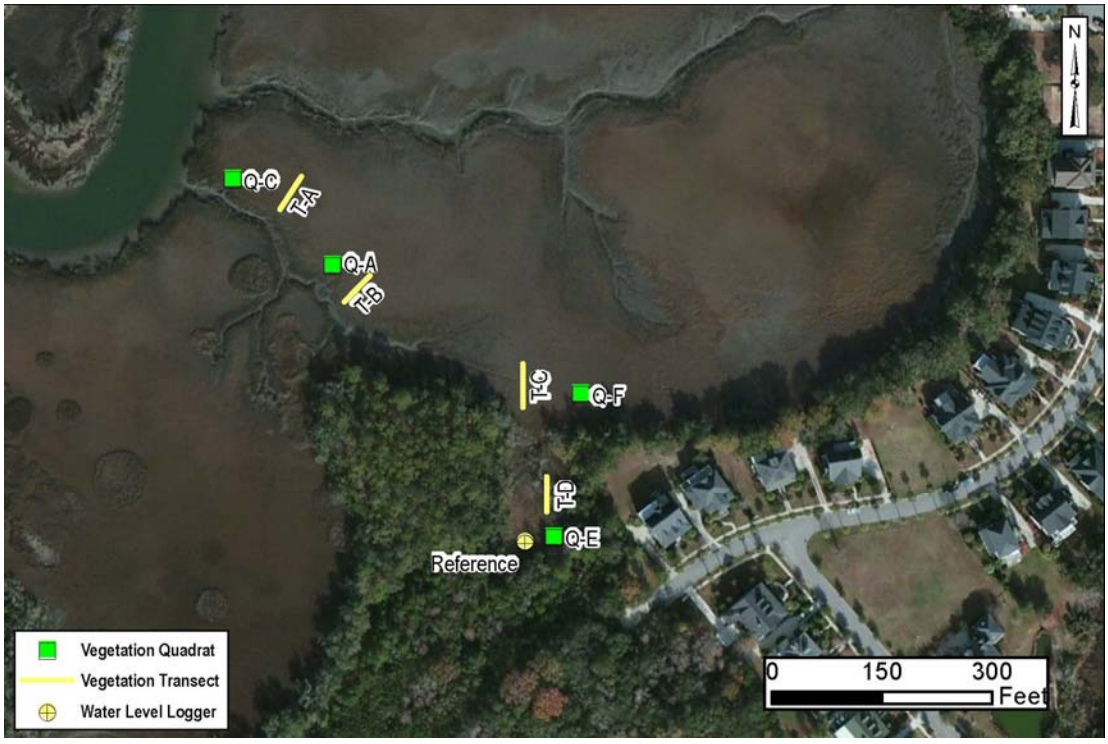


Figure 5. Reference Site Monitoring Locations

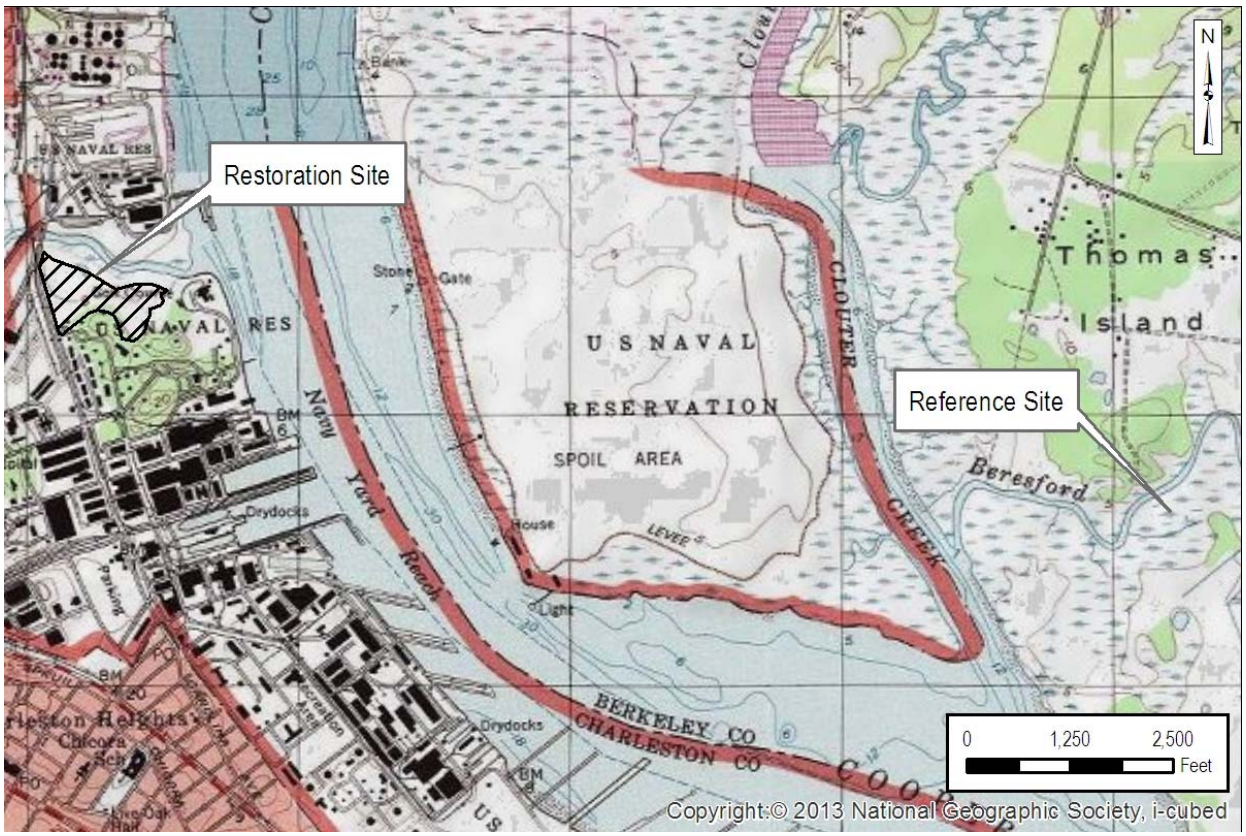


Figure 6. Restoration site location compared to the reference site location

4.0 HYDROLOGY

The data loggers record water levels every fifteen minutes. The data is downloaded by Tidewater personnel approximately every 90 days. Daily rainfall data for the area is obtained from an online database maintained by Weather Underground. The Baseline Monitoring Report (revised February 7, 2012) provides water level data collected from July 2010 through April 2011 and prior to construction. Year One hydrology data was collected from May 18, 2013 to June 6, 2014 (384 days). Year Two hydrology data was collected from June 7, 2014 to June 16, 2015 (374 days). Year Three hydrology data was collected from June 17, 2015 to December 19, 2016 (552 days) and is shown in Appendix A: Hydrology Data. Due to numerous logger failures in 2015, the reference data logger was relocated from a dock on Beresford Creek to its current location in a transitional marsh area as shown on Figure 5.

Graphs that depict tidal elevations for this monitoring period are located Appendix A. Table 1 compares mean high water (MHW) and mean higher high water (MHHW) during the preconstruction and post construction period. All elevations are reported in NGVD29 (subtract 0.99' for NAVD88). As discussed in the Year 2 Monitoring Report, data from 2015 was removed from MHW and MHHW calculations due to numerous logger failures. MHW and MHHW calculations for 2016 begin with data collected on April 18, 2016, after all loggers were replaced at the restoration site.

Table 1. Hydrology Data Summary

Well #	Mean High Water (ft NGVD29)			Mean Higher High Water (ft NGVD29)		
	Baseline	2013/14	2016	Baseline	2013/14	2016
1	4.04	4.69	4.60	4.07	4.76	4.61
Pond	3.28	4.40	3.91	3.54	4.70	4.26
Bridge	3.28	3.92	3.81	3.594	4.23	4.17
Reference[1]	3.60	-	4.89	3.95	-	4.89

[1]Reference well was moved from dock on Beresford Creek to transitional marsh located in 2015.

When compared to pre-construction data, post-construction tidal data shows that the wells within the restoration area no longer exhibit a delay in reaching high tide. A seven-day excerpt of hydrologic data taken from early August 2016 (refer to Chart 1) shows that high tide occurs simultaneously at the bridge in Noisette Creek and at the well locations within the restoration area. Data from the baseline monitoring report that demonstrates the tidal delay that existed between the creek and the restored marsh is depicted in Chart 2.

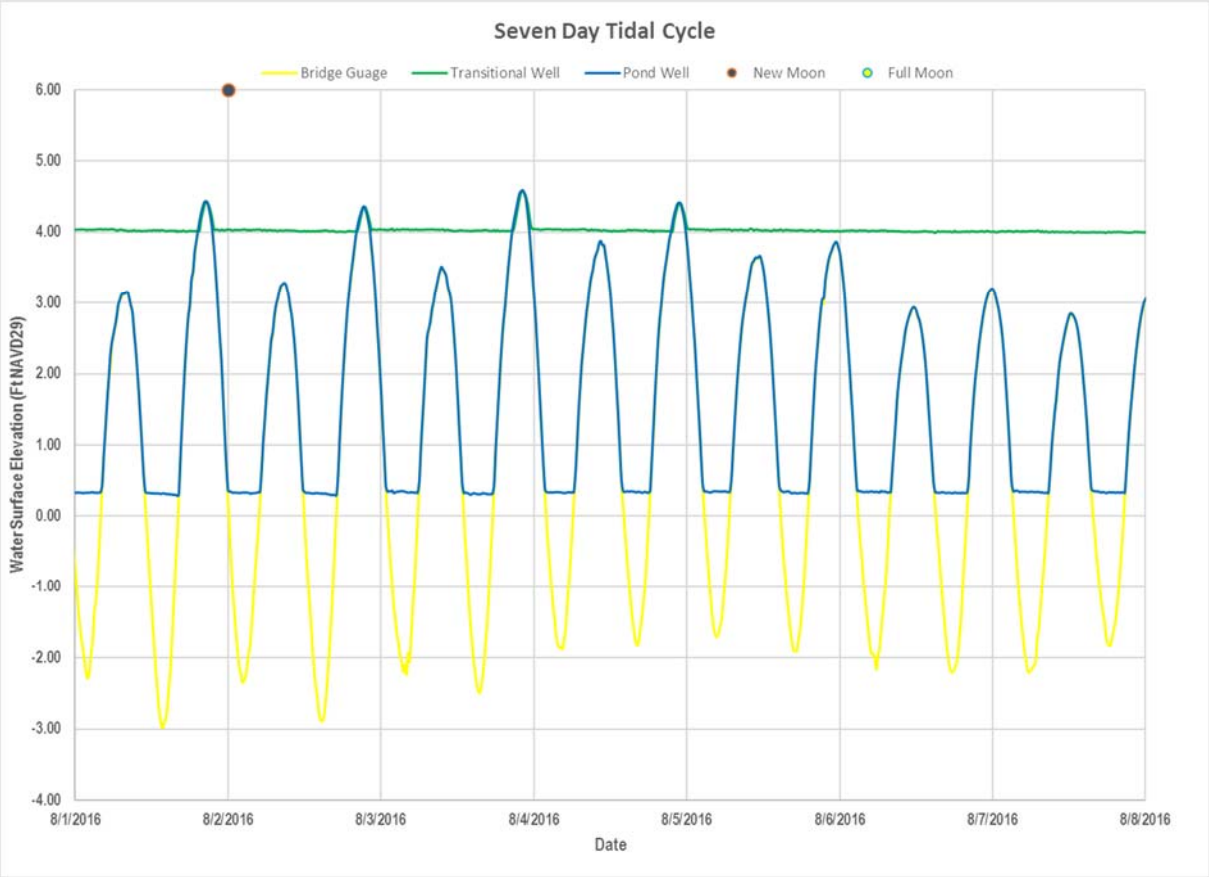


Chart 1: Tidal Data from August 1 through August 7, 2016

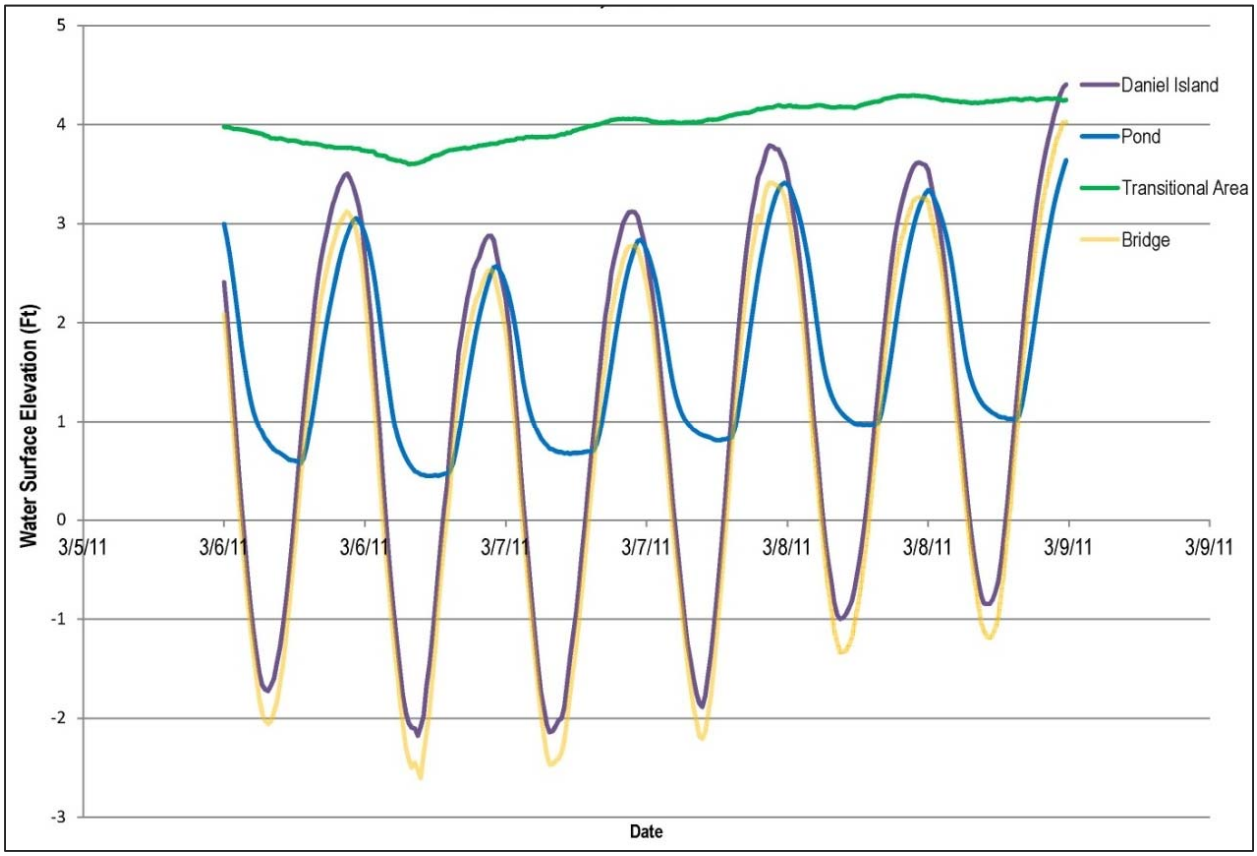


Chart 2: Baseline Tidal Data from March 6, 2011 through March 9, 2011

Note that tidal inundation is not recorded at the transitional well until the tide reaches the equivalent elevation of the transitional well at the bridge and pond. Additionally, the peak tides recorded at the Transitional Well is consistent with the levels recorded at Bridge and Pond Wells. Similarly, as shown in Chart 3, the tidal levels recorded at the transitional wells at the restoration and reference sites are consistent. MHW and MHHW are higher at the transitional wells at the restoration and reference sites than what is recorded at the bridge and the pond because these areas are only inundated on larger (or spring) tides. Based upon this information, it appears that the tidal flows between Noisette Creek and the marsh have been restored to normal conditions.

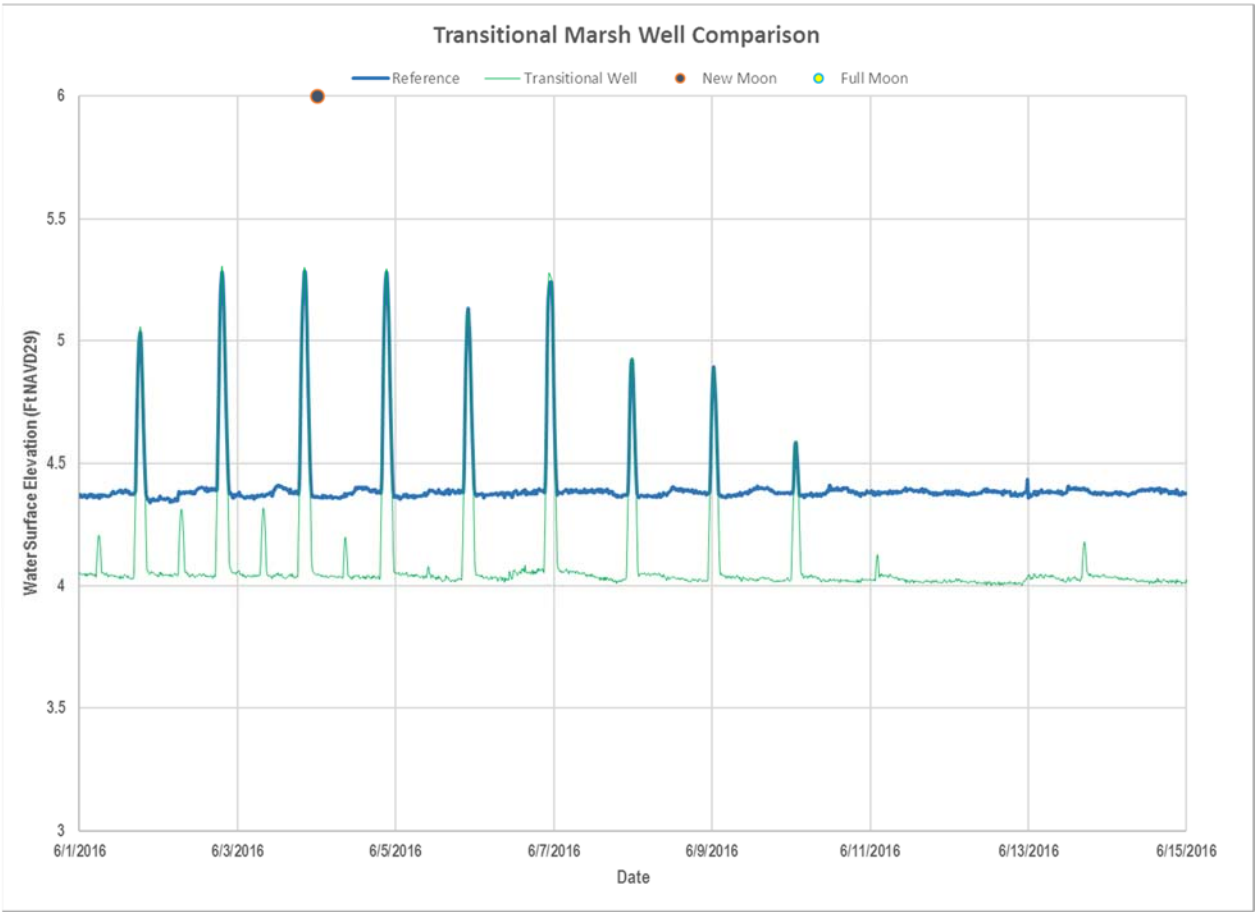


Chart 3: Transitional Well Tidal Data from Restoration and Reference Sites

Cross sections of the constructed tidal channels and permanent photograph stations were established for the as-built survey included in the Time-Zero Monitoring Report. At that time, the surveyor failed to install monuments to mark the locations of the cross sections in the field. Therefore, slight differences in the ground surface elevation adjacent to the channels is likely due to variances in survey location. Permanent benchmarks were installed when the cross section data was collected for the Year One Monitoring Report. Station location is relative to the installed benchmark. Due to the absence of a benchmark for the as-built survey, station location for the as-built cross sections is relative to the thalweg of the channel for the Year One monitoring event. The station locations are shown in Figure 7 and the data is presented in Appendix B. Visual inspections of the area indicate that the site is continuing to progress toward a stable vegetated tidal saltmarsh. Photographs of the constructed channels and surrounding vegetation were taken were taken at the permeant photo stations at high tide on October 17, 2016. As depicted in the photographs, the presence of vegetation now obstructs the view of the constructed channels from the permanent photograph stations.

The smallest constructed channels (channels B, C, and D) have become slightly shallower and narrower since construction. The remainder of the constructed channels have changed very little since construction. Changes in channel dimensions are anticipated during the monitoring period as the site is now a functioning tidal saltmarsh system.

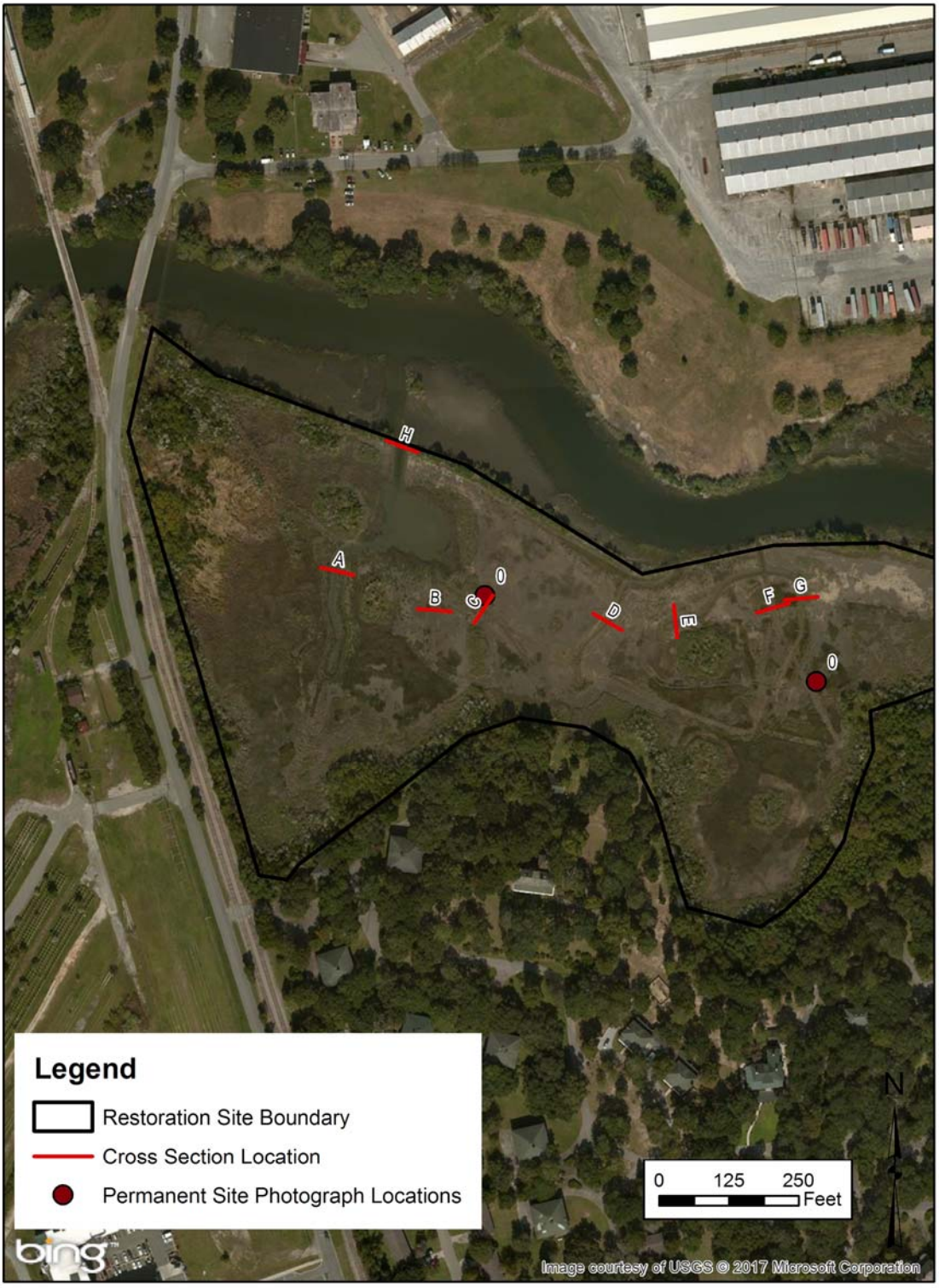


Figure 7. Permanent Cross Sections and Photograph Station Locations

Figure 8 shows the number of acres that are inundated on a regular basis based upon site topography and the mean high water (MHW) and mean higher high water (MHHW) elevations from the Year Three Monitoring Report. Based upon visual observations of the site, it appears that MHW and MHHW accurately reflects site conditions, and the acreage of restored saltmarsh is verified by data collected from the wells during Year Three. Based upon these observations, the project appears to have completed the goal of restoring a natural tidal regime to the site.

Figure 8: Restored Acreage of Salt Marsh

5.0 VEGETATION

On May 17, 2013, several species were planted in areas that were disturbed during construction. As outlined below, species were planted at specific elevations to facilitate survivability.

Species	Elevation (NGVD 29)
Juncus roemarianus	> 3.5'
Spartina patens	2.8' to 3.5'
Spartina alterniflora	< 2.8'

Vegetation monitoring was conducted on September 27, 2016, at the reference site and on October 17, 2016, at the restoration area. Locations of the vegetation quadrats at the restoration and reference areas are shown in Figure 4 and Figure 5, respectively. Representative plant height was documented at each $1m^2$ quadrat by measuring five *Spartina alterniflora* stems and calculating an average plant height. Both planted and non-planted *S. alterniflora* stems are included in stem counts. The number of stems that were counted within each sub-quadrat is shown below.

A Man-Whitney U test revealed there is not a significant difference in stem counts or percent coverage between the reference and restoration site. Calculations for the Mann-Whitney U test are shown in Appendix C.

RESTORATION SITE - QUADRATS

Q-A Rest: Undisturbed

Species: *Spartina alterniflora*

Overall Percent Cover: 97

Percent Bare Ground: 3

Representative Plant Height (inches): 28

Sub-quadrat	Stem Count
14	12
16	15
2	11
5	9

Q-B Rest: Disturbed by Construction

Species: *Salicornia virginica, Spartina alterniflora*

Overall Percent Cover: 45

Percent Bare Ground: 55

Representative Plant Height (inches): 22

Sub-quadrat	Stem Count (*S. alterniflora*)	Stem Count (*S.virginica*)
4	17	0*
7	8	0*
8	12	0*
2	7	0*

*Recent excavation noted within and around quadrat.

Q-C Rest: Disturbed by Construction

Species: *Spartina alterniflora*

Overall Percent Cover: 85

Percent Bare Ground: 15

Representative Plant Height (inches): 27

Sub-quadrat	Stem Count
12	19
4	9
1	15
2	18

Q-D Rest: Disturbed by Construction

Species: *Spartina alterniflora*

Overall Percent Cover: 85

Percent Bare Ground: 15

Representative Plant Height (inches): 18

Sub-quadrat	Stem Count
7	15
14	12
8	17
3	19

RESTORATION SITE - TRANSECTS

30m Line Transects

Transect	Species	Wetland Indicator Status	Sum of Intercept Length (cm)	% Relative Coverage
T-A Restoration	*Salicornia virginica*	OBL	228	19
	Iva frutescens	FACW	12	1
	Spartina alterniflora	OBL	561.6	46.8
	Borrichia frutescens	OBL	540	45
T-B Restoration	*Spartinia alterniflora*	OBL	780	65
	Borrichia frutescens	OBL	852	71
	Salicornia sp.	OBL	108	9

REFERENCE AREA - QUADRATS

Q-A Ref: Undisturbed

Species: *Spartina alterniflora*

Overall Percent Cover: 45

Percent Bare Ground: 55

Representative Plant Height (inches): 30

Sub-quadrat	Stem Count
6	13
8	14
2	13
11	18

Q-C Ref: Undisturbed

Species: *Spartina alterniflora*

Overall Percent Cover: 85

Percent Bare Ground: 15

Representative Plant Height (inches): 40

Sub-quadrat	Stem Count
9	17
11	16
4	17
12	15

Q-E Ref

Species: *Spartina alterniflora*

Overall Percent Cover: 75

Percent Bare Ground: 25

Representative Plant Height (inches): 25

Sub-quadrat	Stem Count
2	17
10	17
15	21
13	9

Q-F Ref

Species: *Spartina alterniflora*

Overall Percent Cover: 50

Percent Bare Ground: 50

Representative Plant Height (inches): 18

Sub-quadrat	Stem Count
15	37
3	27
1	15
13	16

RESTORATION SITE - TRANSECTS

30m Line Transects

Transect	Species	Sum of Intercept Length (cm)	% Relative Coverage
T-A Ref	*Spartina alterniflora*	2750	92
T-B Ref	*Spartina alterniflora*	2790	93
T-C Ref	*Spartina alterniflora*	2740	89
T-D Ref	*Spartina alterniflora*	2377	78
	Borrichia frutescens	518.2	12
	Iva frutescens	30.5	1
	Spartina bakeri	944.8	31

Q-A Rest was undisturbed by construction and continues to have tall, developed *S. alterniflora* that covers more than 97% of the area. Q-B Rest was disturbed by construction and recently was vandalized as evidenced by excavation that has occurred within the quadrat area. Q-C Rest and Q-D Rest were disturbed by construction as well. Overall, the density of *S. alterniflora* has increased at the restoration site since the Year One monitoring was performed and now covers 85% of the area. The vegetation in the disturbed

restoration site quads, except for Q-B Rest, has similar percent cover, height, and stem counts when compared to the undisturbed Q-A Rest and the reference site quadrats, indicating that vegetation at the restoration site is comparable to reference conditions.

The vegetation within Q-B Rest was vandalized as evidenced by excavation that occurred adjacent to the permanent pipe that marks the monitoring location. The quadrat now only includes *S. alterniflora*. It appears that an area was used for a possible archeological evaluation. Local archeological firms and schools were contacted to determine who conducted the work, but the party was not identified. The excavation affected a 1 m2 area within the quadrat. Overall, the density of *S. alterniflora* and *Salicornia virginica* within Q-B Rest was less than that documented in the Year Two Monitoring Report. Nonetheless, the excavation affected a very small portion of the overall restoration site, and the remainder of the site continues to show an increase in the amount of salt tolerant plants that are present.

Vegetation for the restoration site is approaching densities found in the reference site and have reached acceptable levels as defined in the Monitoring Plan. A functioning salt marsh appears to have been restored as evidenced by the amount of *S. alterniflora* and other salt tolerant plants that are growing in the restoration area.

PHOTOGRAPHIC DOCUMENTATION

A photograph of each 1 m^2 vegetative quadrat was taken from the northeast corner looking toward the center of the quadrat to document vegetative conditions within the restoration and reference site. Refer to Appendix C for photographs taken in September and October 2016 showing the vegetation of each quadrat.

MAPPING AREAS DEVOID OF VEGETATION

The restoration site project area was reviewed using recent aerial imagery and field verified during multiple site inspections to locate areas devoid of vegetation. Areas previously mapped as devoid of vegetation within the restoration area have been fully vegetated with salt tolerant species. Based upon visual observations, areas previously devoid of vegetation have become vegetated and continue to grow denser with various salt marsh species, including *S. alterniflora*.

The vegetation data collected during the baseline, time zero, year one and year two monitoring periods are compared in Table 2.

Table 2. Total Sub-Quadrat Stem Count Comparison between the Baseline Monitoring Report and the Year Three Monitoring Report.

Restoration Site									
Q-A Rest					Q-B Rest[1]				
Baseline Sub-Quad Stem Count	Time Zero Sub-Quad Stem Count	Year One Sub-Quad Stem Count	Year Two Sub-Quad Stem Count	Year Three Sub-Quad Stem Count	Baseline Sub-Quad Stem Count	Time Zero Sub-Quad Stem Count	Year One Sub-Quad Stem Count	Year Two Sub-Quad Stem Count	Year Three Sub-Quad Stem Count
4	8	13	9	12	10	0	3	15	17
8	7	4	13	15	9	0	0	28	8
15	13	7	7	11	12	0	3	30	12
12	11	7	12	9	15	0	1	25	7
Q-C Rest					Q-D Rest				
Baseline Sub-Quad Stem Count	Time Zero Sub-Quad Stem Count	Year One Sub-Quad Stem Count	Year Two Sub-Quad Stem Count	Year Three Sub-Quad Stem Count	Baseline Sub-Quad Stem Count	Time Zero Sub-Quad Stem Count	Year One Sub-Quad Stem Count	Year Two Sub-Quad Stem Count	Year Three Sub-Quad Stem Count
19	23	14	13	19	9	6	15	17	15
12	15	12	6	9	12	8	12	12	12
18	14	9	15	15	6	10	13	6	17
9	12	6	5	18	16	13	9	9	19

[1]Includes *Salicornia virginica*

Reference Site									
Q-A Ref					Q-B Ref[2]				
Baseline Sub-Quad Stem Count	Time Zero Sub-Quad Stem Count	Year One Sub-Quad Stem Count	Year Two Sub-Quad Stem Count	Year Three Sub-Quad Stem Count	Baseline Sub-Quad Stem Count	Time Zero Sub-Quad Stem Count	Year One Sub-Quad Stem Count	Year Two Sub-Quad Stem Count	Year Three Sub-Quad Stem Count
10	8	6	20	13	8	7	8	NA	NA
13	14	11	12	14	11	11	10		
13	5	10	15	13	10	6	6		
9	10	8	14	18	8	10	7		
Q-C Ref[3]					Q-D Ref[2]				
Baseline Sub-Quad Stem Count	Time Zero Sub-Quad Stem Count	Year One Sub-Quad Stem Count	Year Two Sub-Quad Stem Count	Year Three Sub-Quad Stem Count	Baseline Sub-Quad Stem Count	Time Zero Sub-Quad Stem Count	Year One Sub-Quad Stem Count	Year Two Sub-Quad Stem Count	Year Three Sub-Quad Stem Count
8	14	5	13	17	9	8	4	NA	NA
11	18	6	12	16	5	4	6		
9	20	7	11	17	7	5	5		
12	17	8	14	15	8	6	8		
Q-E Ref[4]					Q-F Ref[4]				
Baseline Sub-Quad Stem Count	Time Zero Sub-Quad Stem Count	Year One Sub-Quad Stem Count	Year Two Sub-Quad Stem Count	Year Three Sub-Quad Stem Count	Baseline Sub-Quad Stem Count	Time Zero Sub-Quad Stem Count	Year One Sub-Quad Stem Count	Year Two Sub-Quad Stem Count	Year Three Sub-Quad Stem Count
NA	NA	NA	14	17	NA	NA	NA	16	37
			9	17				17	27
			8	21				17	15
			11	9				9	16

[2]Quadrat removed after Year One

[3]Includes *Aster tenuifolius*, except for Year Two

[4]Quadrat installed for Year Two Monitoring

6.0 VISUAL ASSESSMENTS

Qualitative visual assessments of fish, invertebrates and avian wildlife utilizing the restoration area and the reference area were made on November 24, 2015, February 2, 2016, February 28, 2016, June 16, 2016, September 22, 2016, and December 19, 2016. Following is a list of species that have been identified utilizing the areas.

Wildlife Observed Utilizing the Restoration Area: Northern mocking bird (*Mimus polyglottos*); barn swallow (*Hirundo rustica*); red-winged blackbird (*Agelaius phoeniceus*); great blue heron (*Ardea herodias*); great egret (*Ardea alba*); snowy egret (*Egretta thula)*; cormorant (*Phalacrocorax brasilian*us); Sora (*Porzana carolina*); clapper rail (Rallus longirostris); pigeon (family Columbidae); fiddler crab (*Uca* spp.); blue crab (*Callinectes* sapidus); periwinkle snail (family Littorinidae); golden dragonflies; unidentified fish in the creeks.

Wildlife Observed Utilizing the Reference Area: White ibis (*Eudocimus albus*); fiddler crab (*Uca sp*.); oyster (*Crassostrea virginica*) beds in the unnamed tidal creek; periwinkle snail; and various unidentified shells.

7.0 CONCLUSION

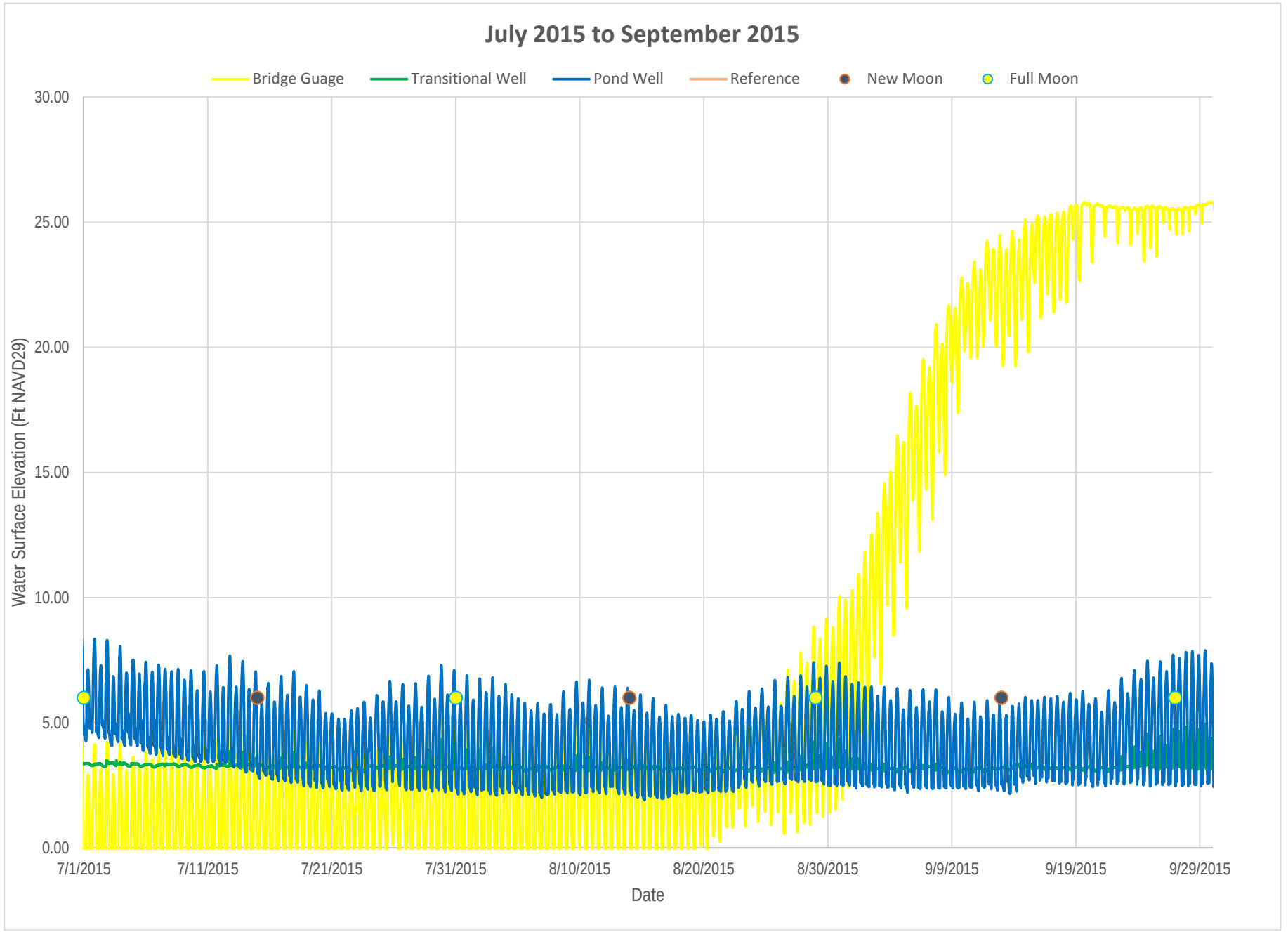
This Year Three Monitoring Report describes the post-construction condition of the vegetation and the constructed tidal channels at the restoration area three years after the completion of construction. Year Three monitoring at the restoration area occurred at the same locations as the baseline monitoring stations established prior to construction. However, since construction adjustments have been made to the hydrologic and vegetative monitoring stations at the reference site. The water level monitoring data shows that low marsh portions of the restoration site experience a semidiurnal tidal cycle and inundation while the transitional areas experience inundation during higher tides, as expected. Based upon water level data collected during Year Three, it has been determined that the tidal connection between Noisette Creek and the restoration areas is consistent with what is typically observed in natural marsh areas.

Vegetation within impacted areas of the restoration site has recovered and is comparable to vegetation at the reference site. Areas within the restoration site have become fully vegetated; vegetation has covered all bare spots and the density is continuing to increase in sparsely covered areas. Invasive species have been removed from the restoration site and have not re-established.

Overall, the data supports the conclusion that 13.5 acres of saltmarsh have been enhanced and/or restored as a result of mitigation activities. Year Three monitoring data documents the development of the restoration area. Having met all restoration goals outlined in the Mitigation Plan or other documents, Evergreen International, S.A. request concurrence from the Trustees that the site has been restored and that monitoring efforts can be concluded.

APPENDIX A:

HYDROLOGY DATA


July 2015 to September 2015
Bridge Guage
Transitional Well
Pond Well
Reference
New Moon
Full Moon
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Water Surface Elevation (Ft NAVD29)
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7/11/2015
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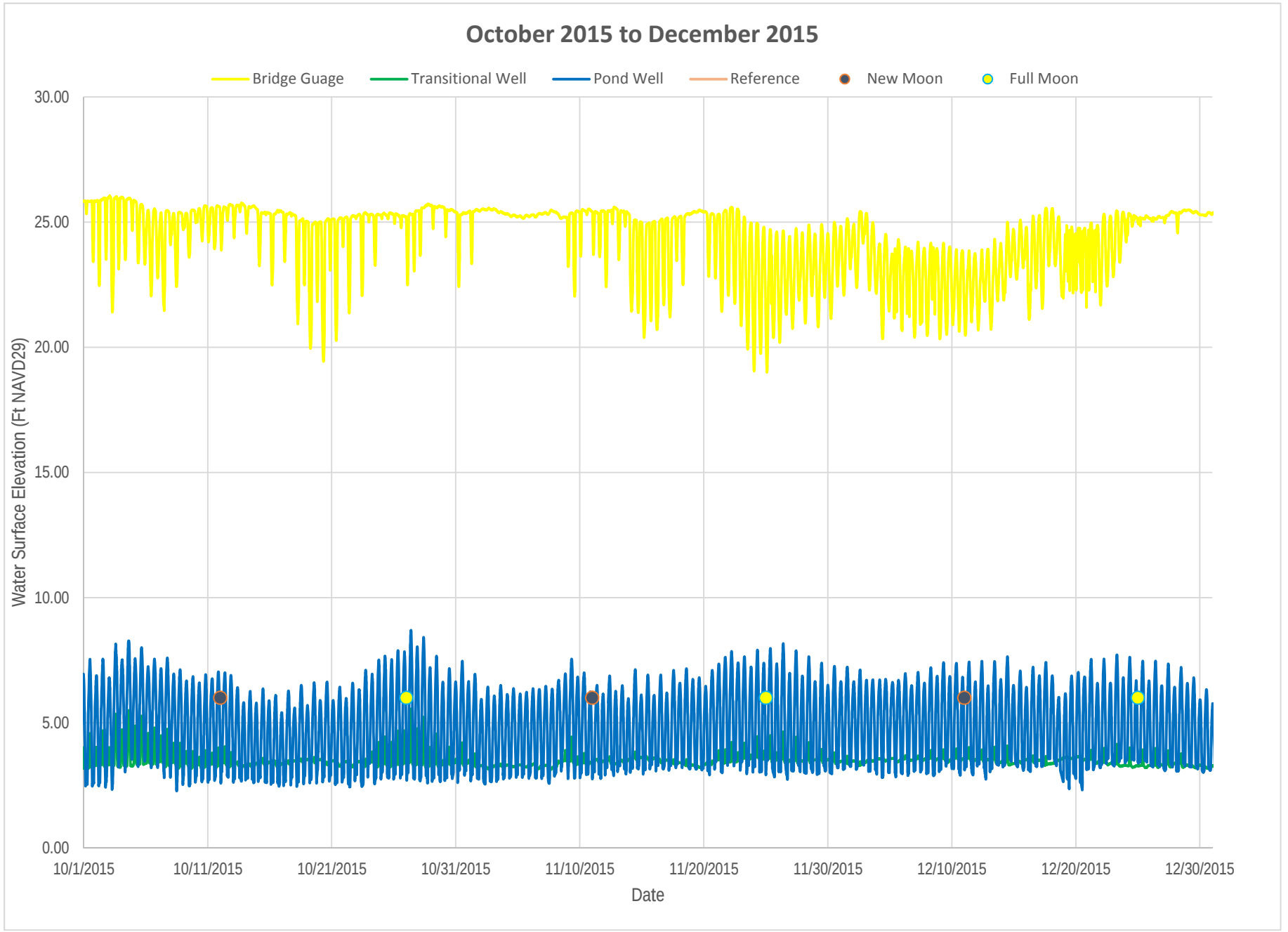
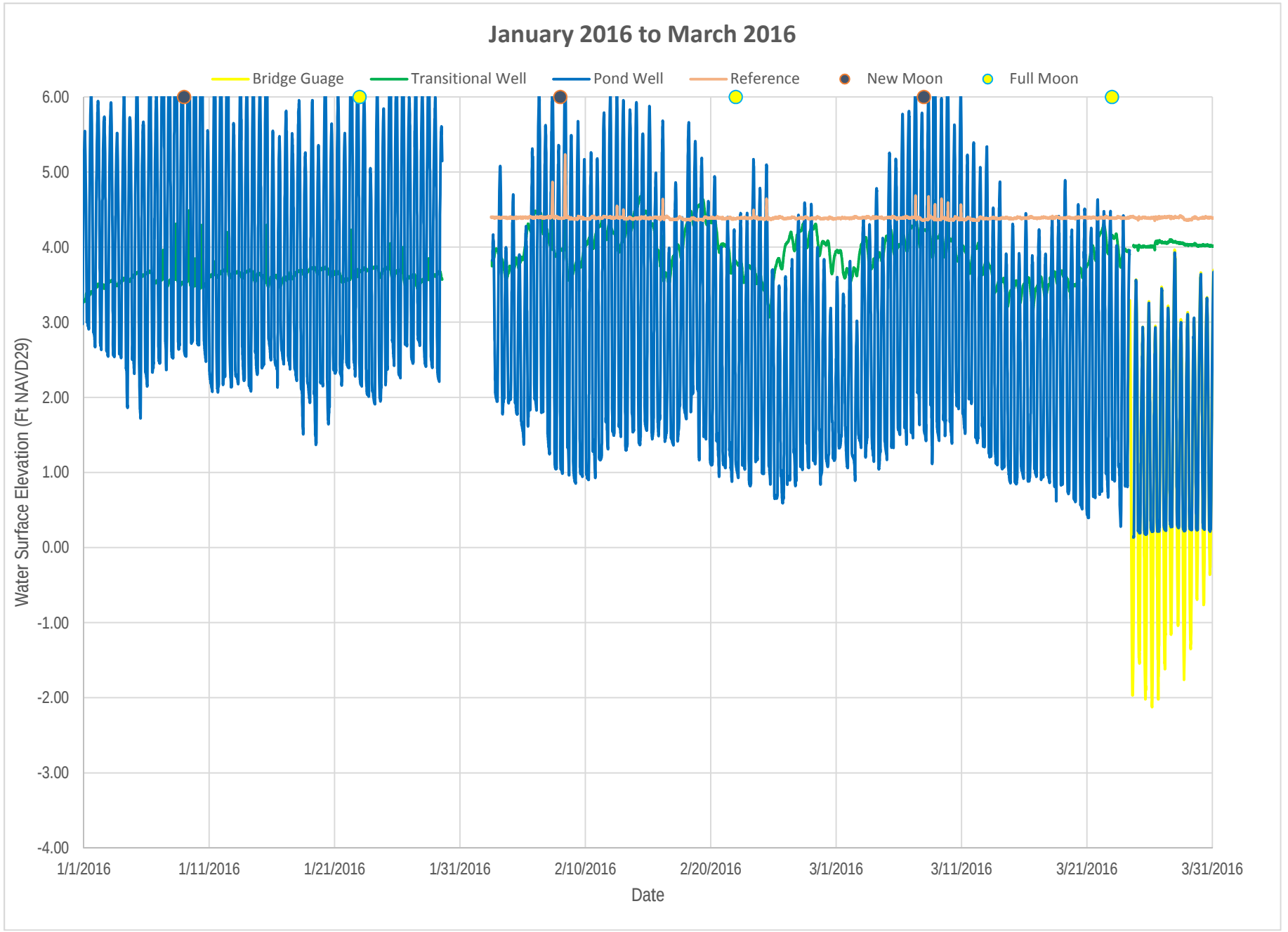
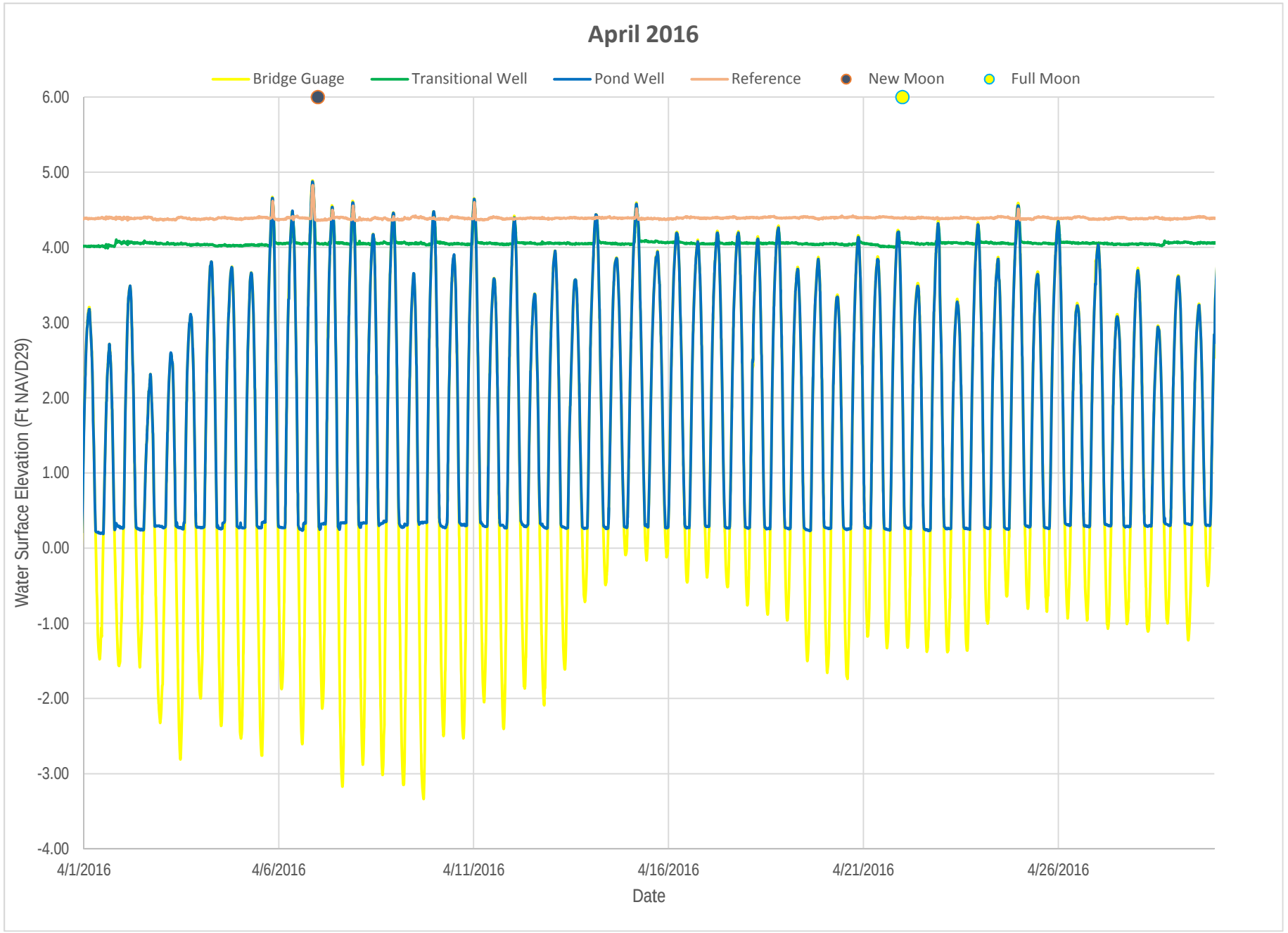
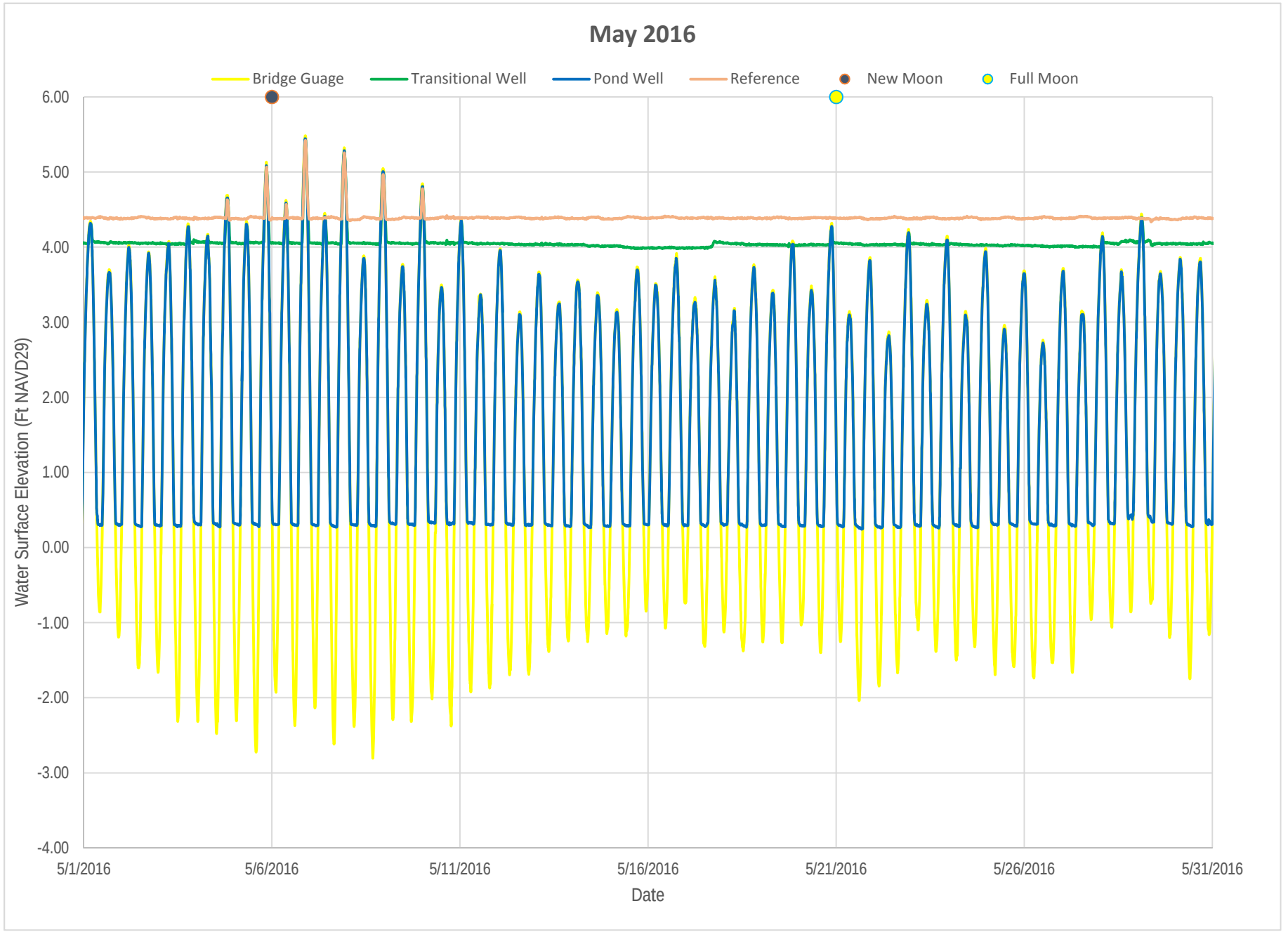
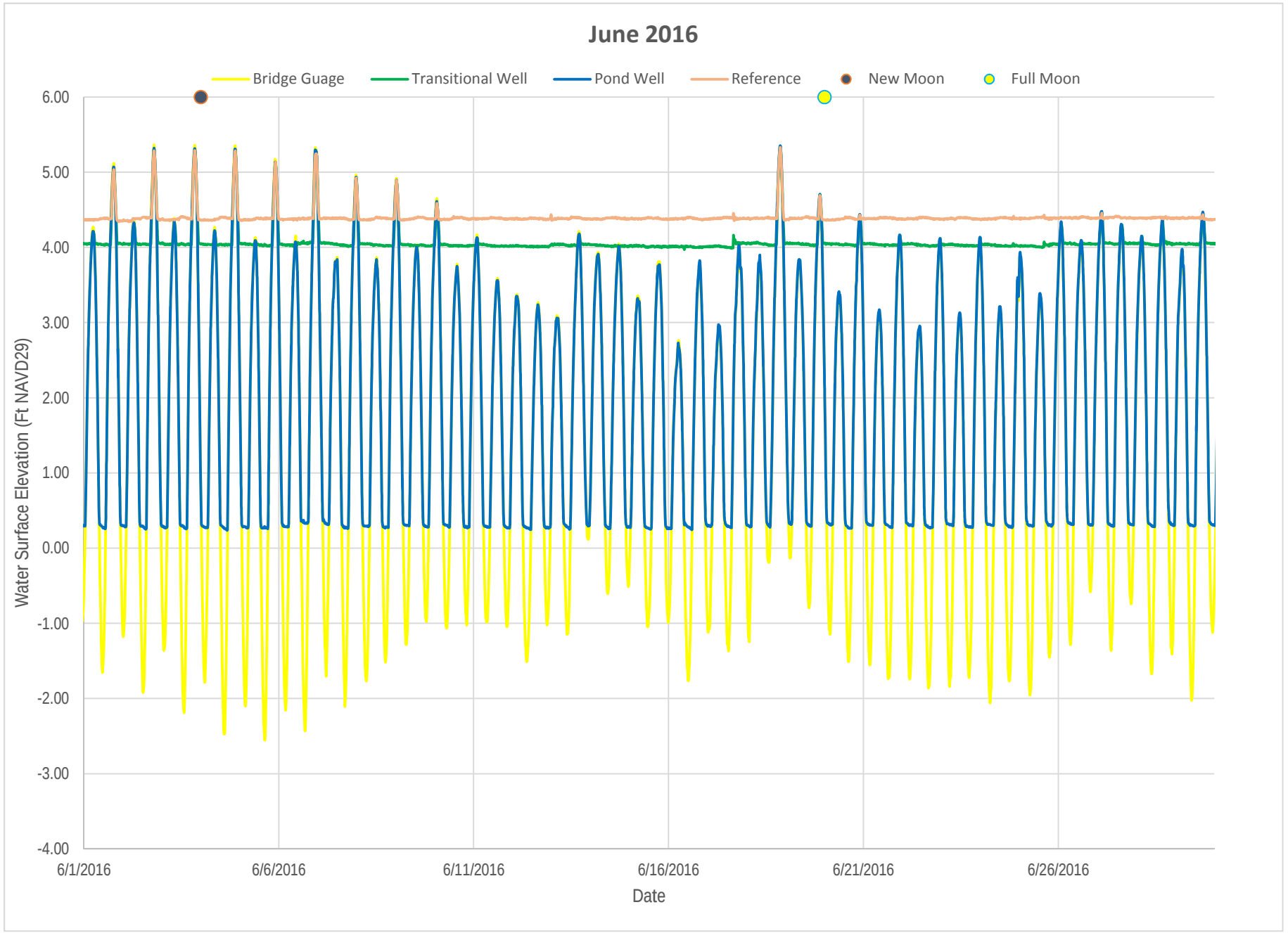
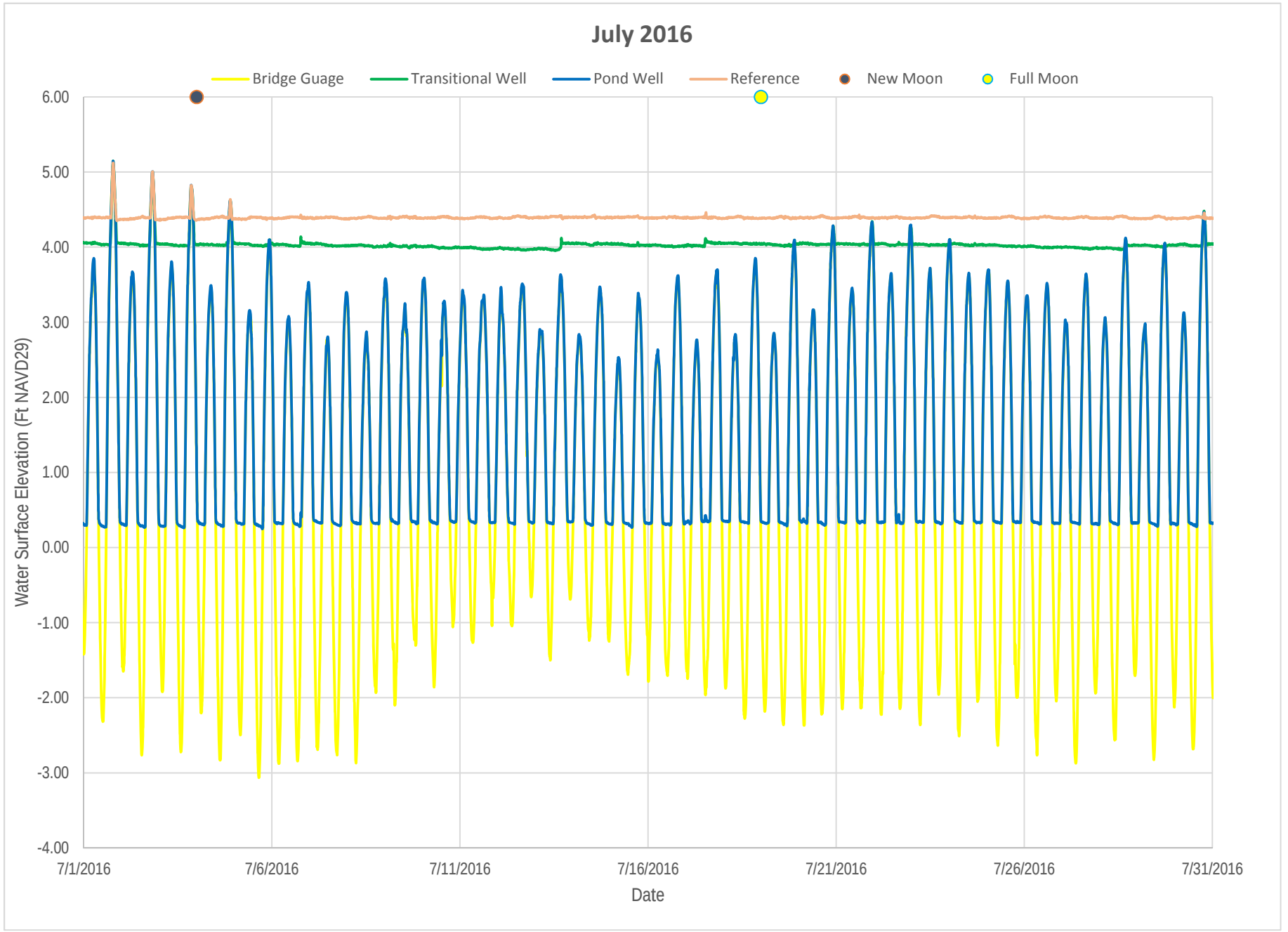

October 2015 to December 2015
Bridge Guage
Transitional Well
Pond Well
Reference
New Moon
Full Moon
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Water Surface Elevation (Ft NAVD29)
10/1/2015
10/11/2015
10/21/2015
10/31/2015
11/10/2015
11/20/2015
11/30/2015
12/10/2015
12/20/2015
12/30/2015
Date

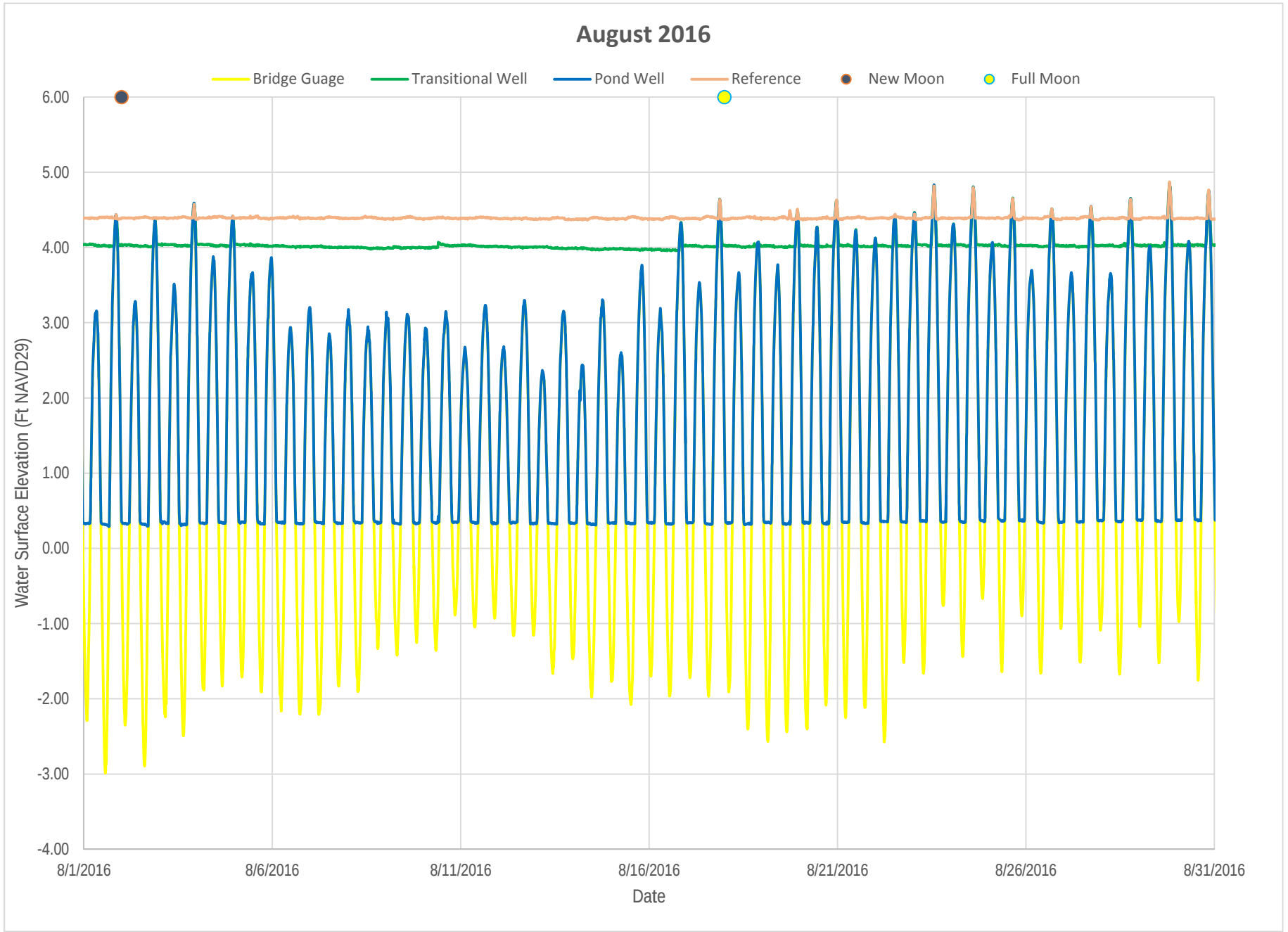

January 2016 to March 2016
Bridge Guage
Transitional Well
Pond Well
Reference
New Moon
Full Moon
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
-4.00
Water Surface Elevation (Ft NAVD29)
1/1/2016
1/11/2016
1/21/2016
1/31/2016
2/10/2016
2/20/2016
3/1/2016
3/11/2016
3/21/2016
3/31/2016
Date

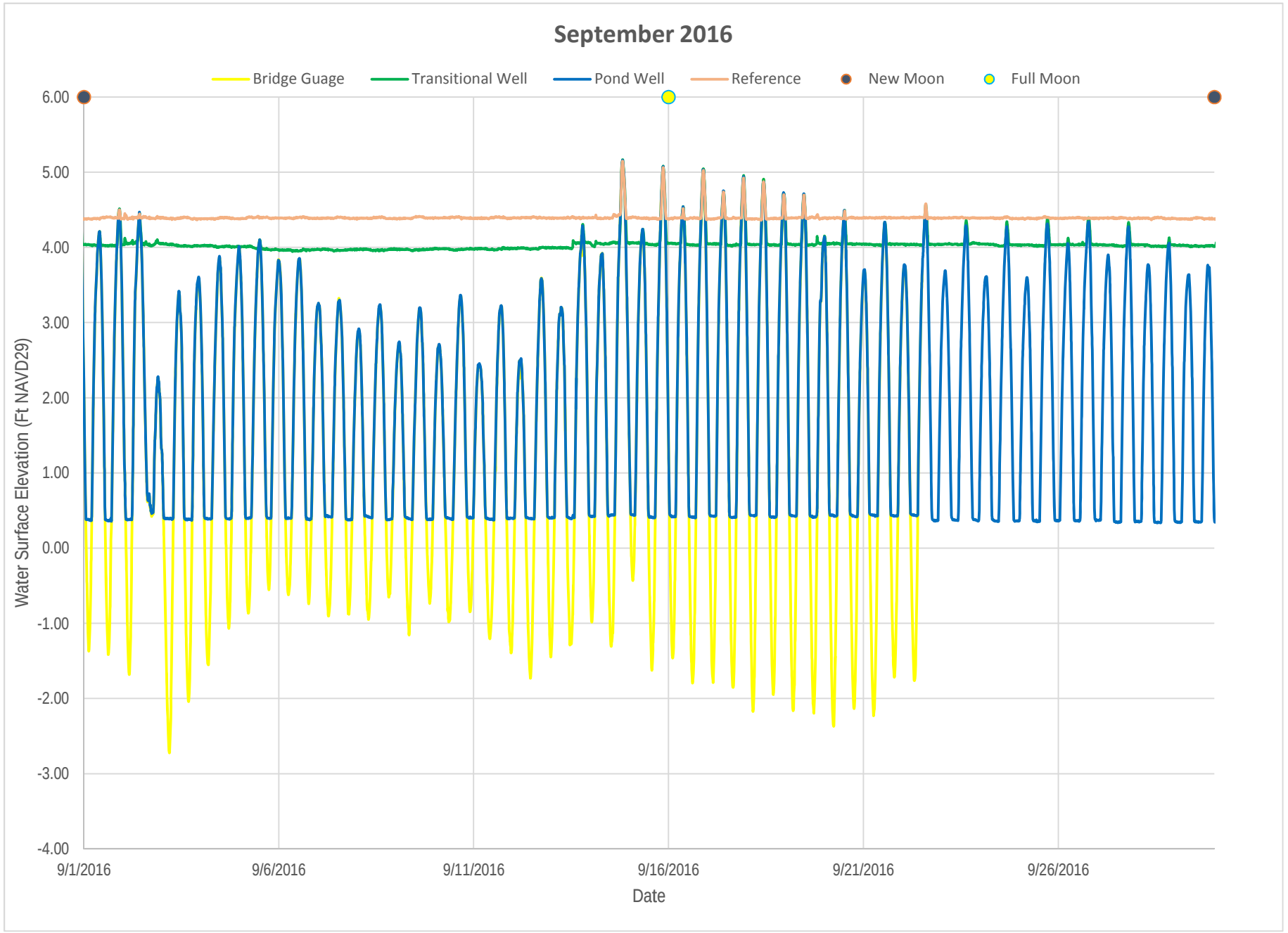

April 2016
Bridge Guage
Transitional Well
Pond Well
Reference
New Moon
Full Moon
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
-4.00
Water Surface Elevation (Ft NAVD29)
4/1/2016
4/6/2016
4/11/2016
4/16/2016
4/21/2016
4/26/2016
Date

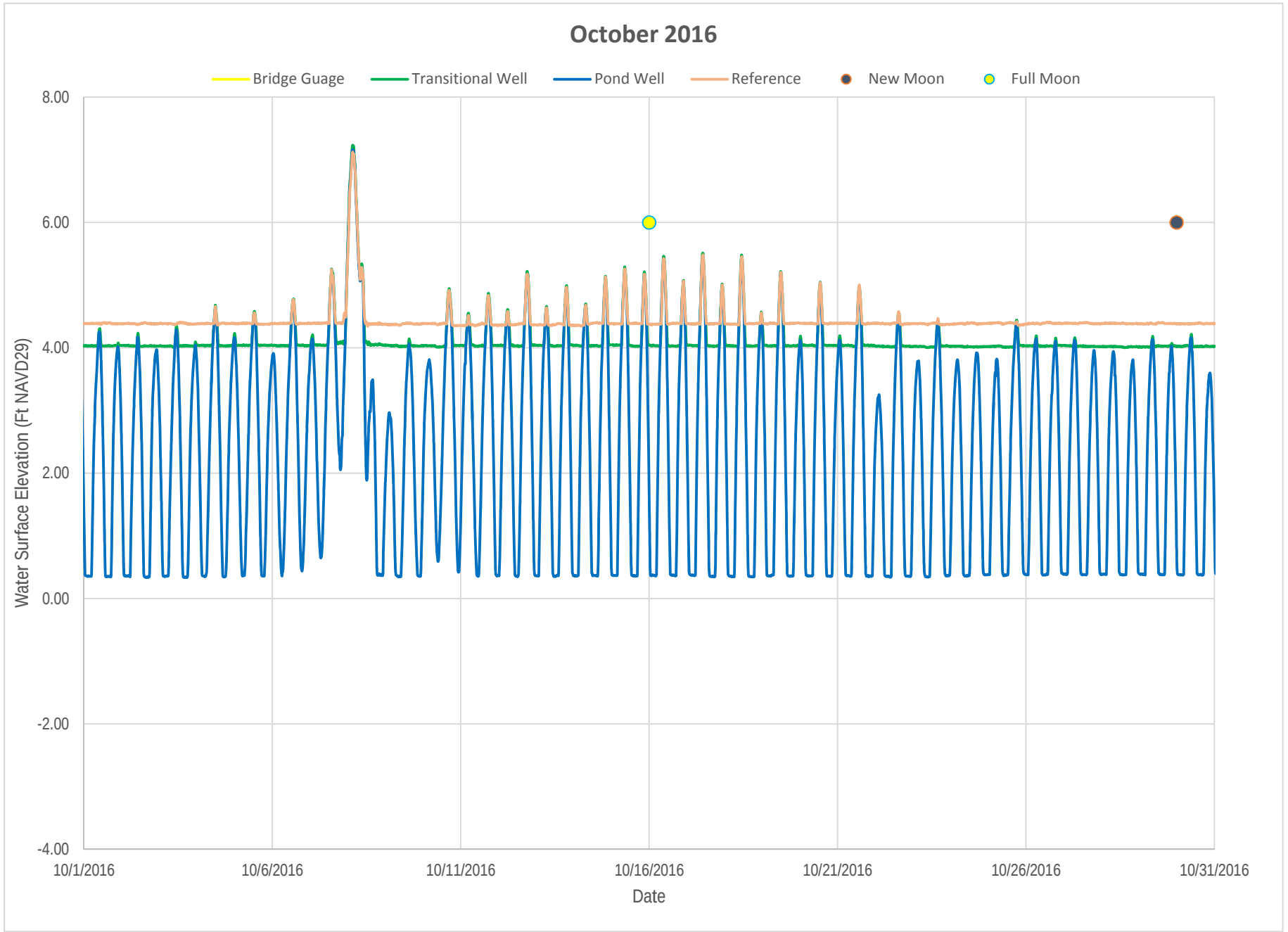

May 2016
Bridge Guage
Transitional Well
Pond Well
Reference
New Moon
Full Moon
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
-4.00
Water Surface Elevation (Ft NAVD29)
5/1/2016
5/6/2016
5/11/2016
5/16/2016
5/21/2016
5/26/2016
5/31/2016
Date

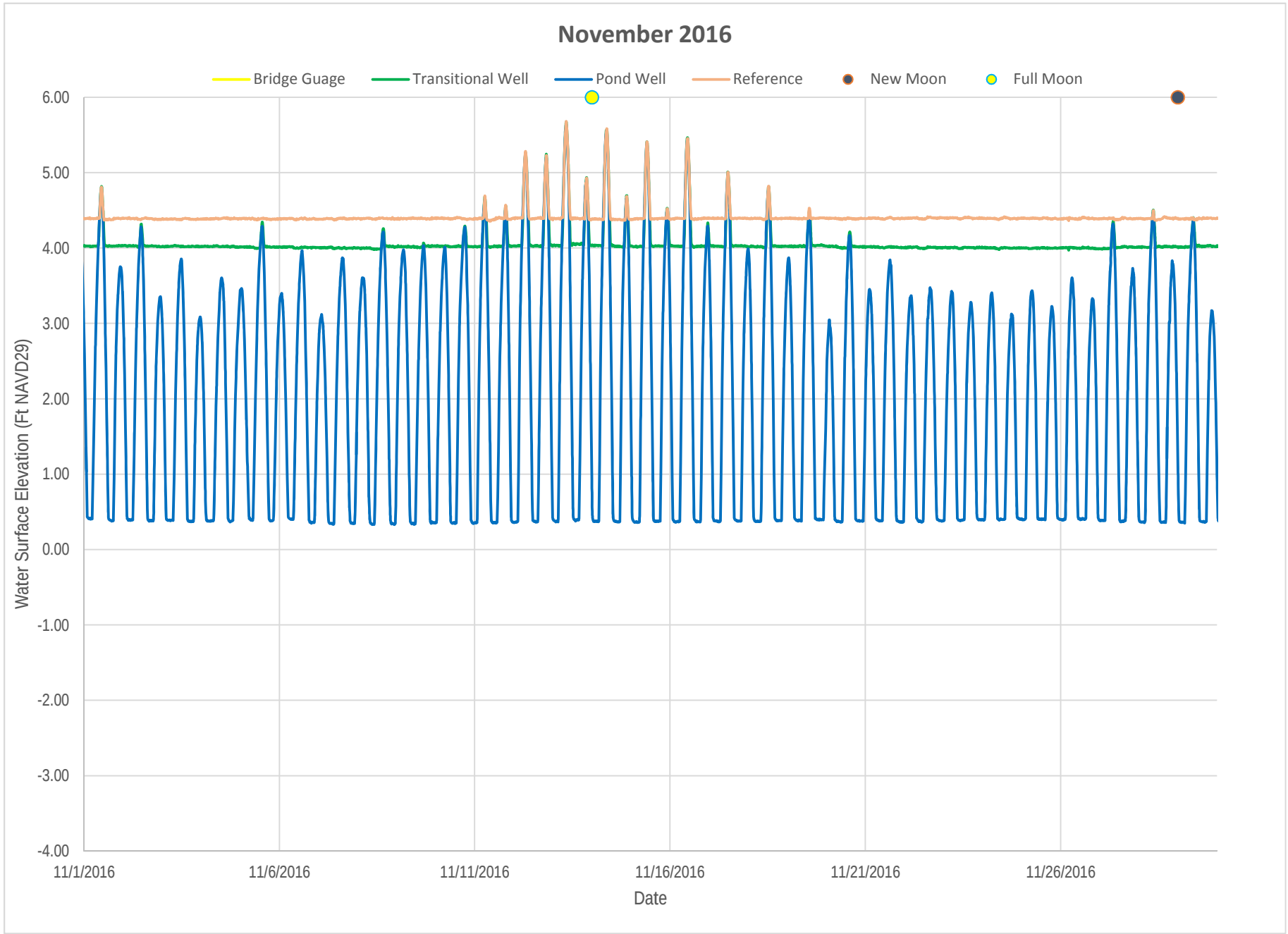

June 2016
Bridge Guage
Transitional Well
Pond Well
Reference
New Moon
Full Moon
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
-4.00
Water Surface Elevation (Ft NAVD29)
6/1/2016
6/6/2016
6/11/2016
6/16/2016
6/21/2016
6/26/2016
Date

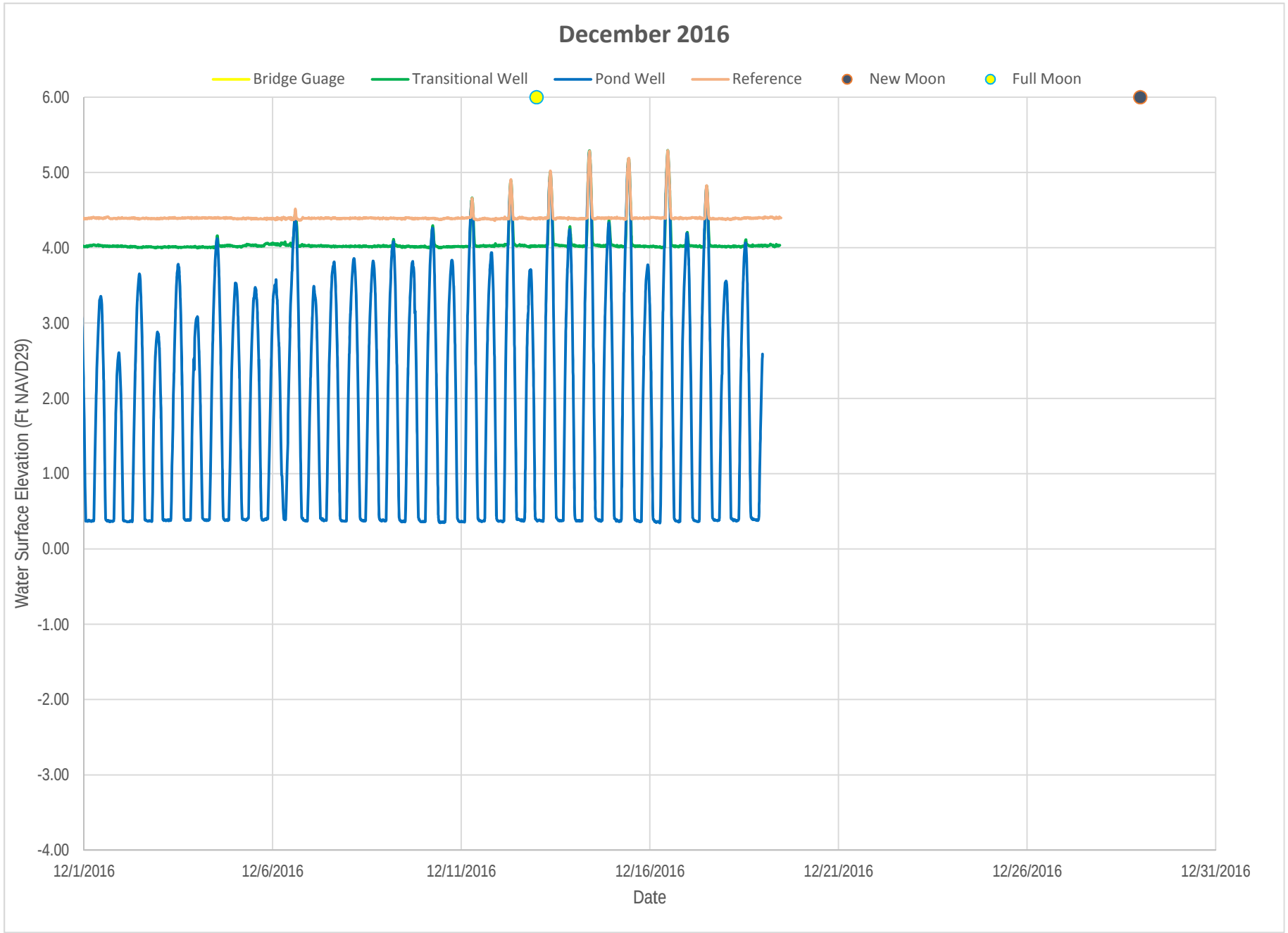

July 2016
Bridge Guage
Transitional Well
Pond Well
Reference
New Moon
Full Moon
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
-4.00
Water Surface Elevation (Ft NAVD29)
7/1/2016
7/6/2016
7/11/2016
7/16/2016
7/21/2016
7/26/2016
7/31/2016
Date

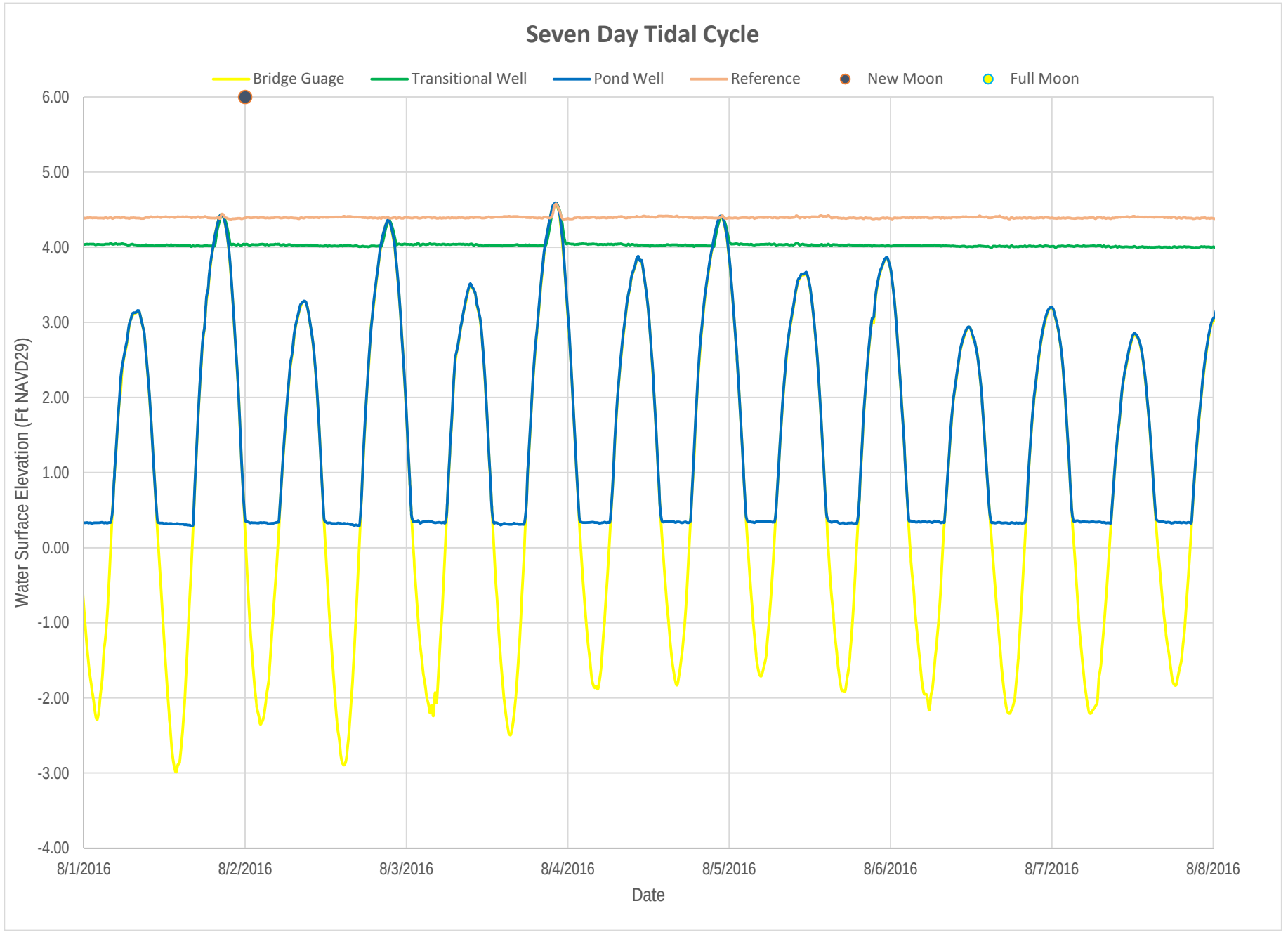

August 2016
Bridge Guage
Transitional Well
Pond Well
Reference
New Moon
Full Moon
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
-4.00
Water Surface Elevation (Ft NAVD29)
8/1/2016
8/6/2016
8/11/2016
8/16/2016
8/21/2016
8/26/2016
8/31/2016
Date


September 2016
Bridge Guage
Transitional Well
Pond Well
Reference
New Moon
Full Moon
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
-4.00
Water Surface Elevation (Ft NAVD29)
9/1/2016
9/6/2016
9/11/2016
9/16/2016
9/21/2016
9/26/2016
Date


October 2016
Bridge Guage
Transitional Well
Pond Well
Reference
New Moon
Full Moon
8.00
6.00
4.00
2.00
0.00
-2.00
-4.00
Water Surface Elevation (Ft NAVD29)
10/1/2016
10/6/2016
10/11/2016
10/16/2016
10/21/2016
10/26/2016
10/31/2016
Date

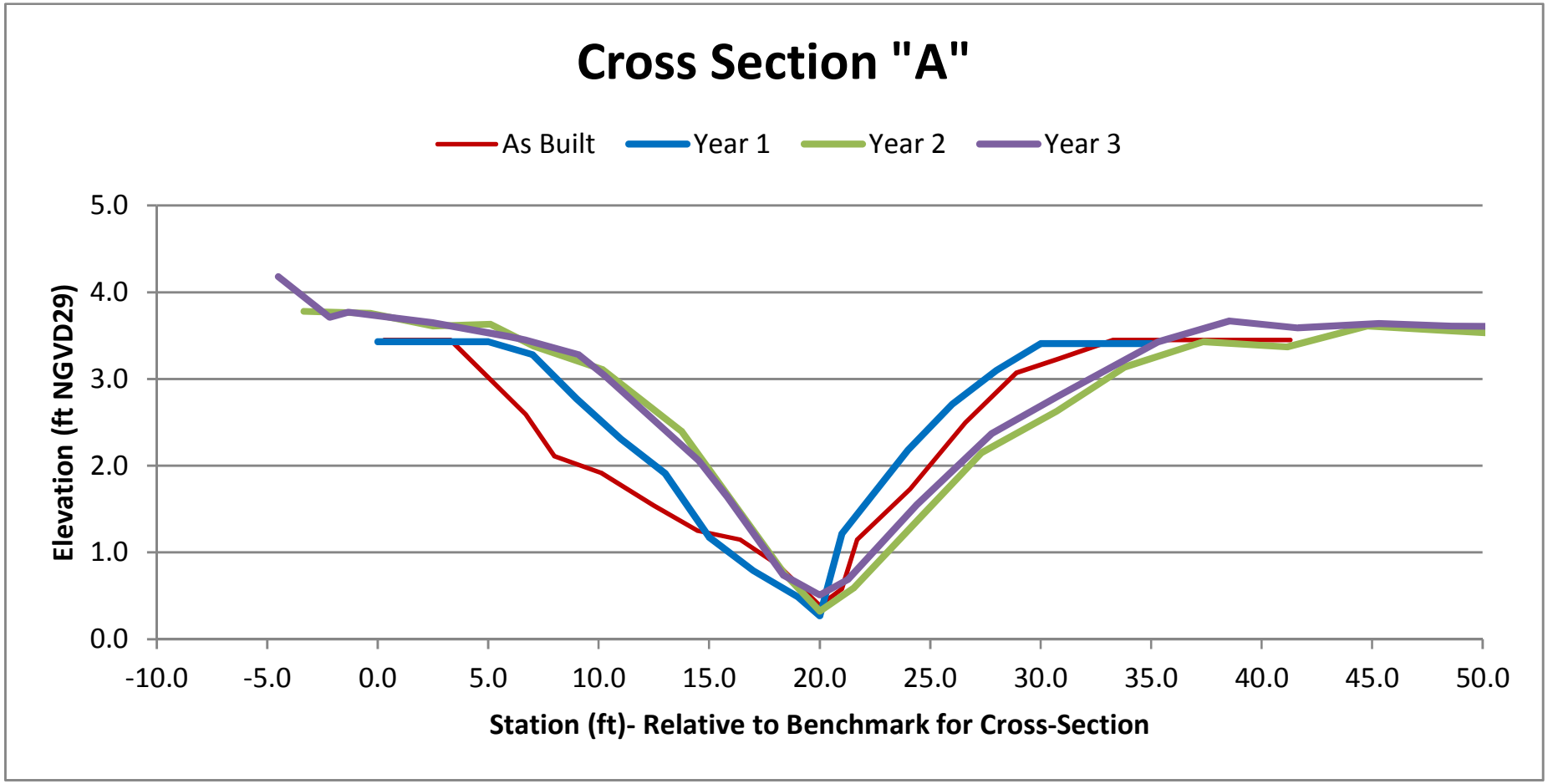

November 2016
Bridge Guage
Transitional Well
Pond Well
Reference
New Moon
Full Moon
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
-4.00
Water Surface Elevation (Ft NAVD29)
11/1/2016
11/6/2016
11/11/2016
11/16/2016
11/21/2016
11/26/2016
Date

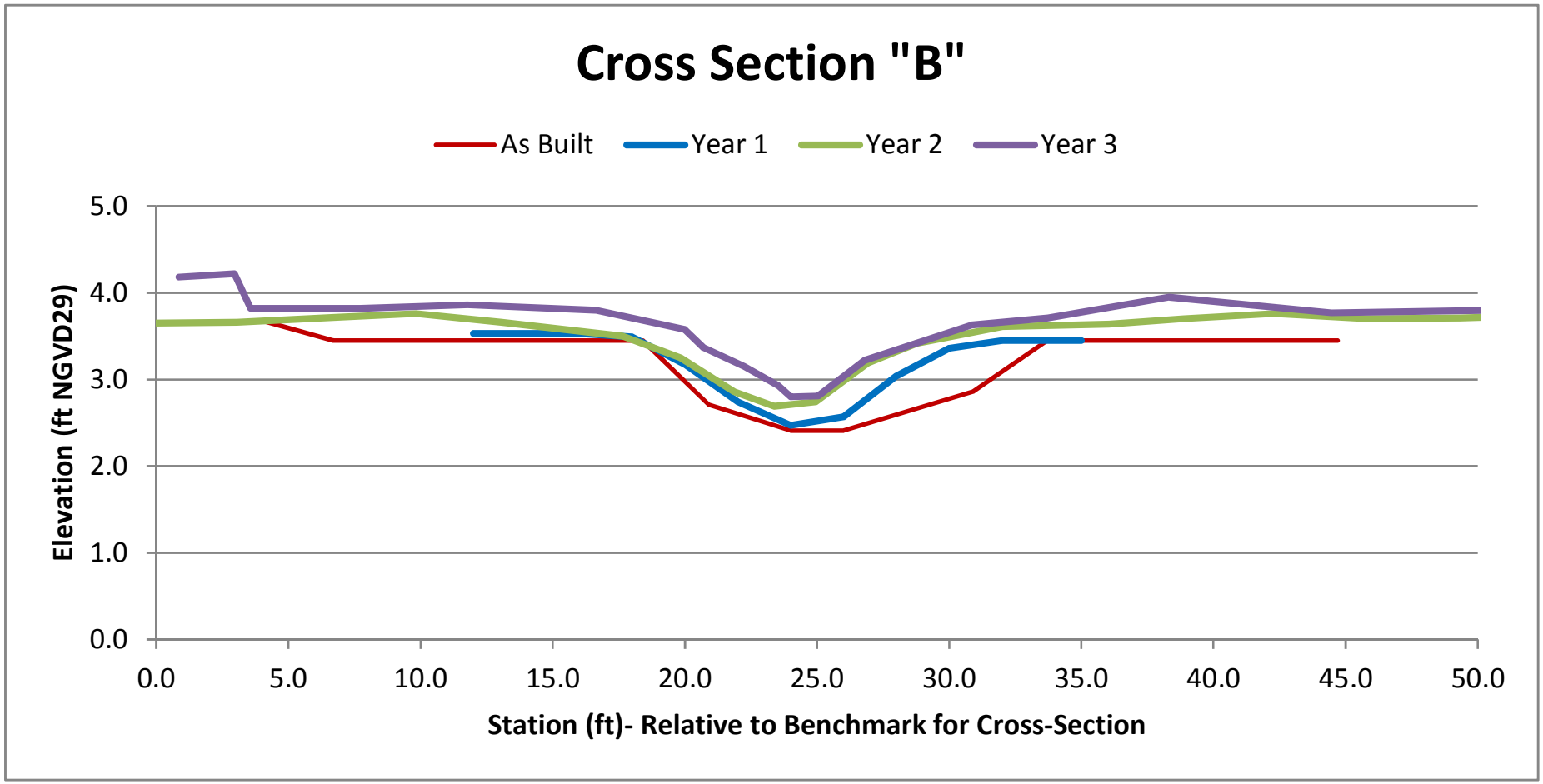

December 2016
Bridge Guage
Transitional Well
Pond Well
Reference
New Moon
Full Moon
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
-4.00
Water Surface Elevation (Ft NAVD29)
12/1/2016
12/6/2016
12/11/2016
12/16/2016
12/21/2016
12/26/2016
12/31/2016
Date

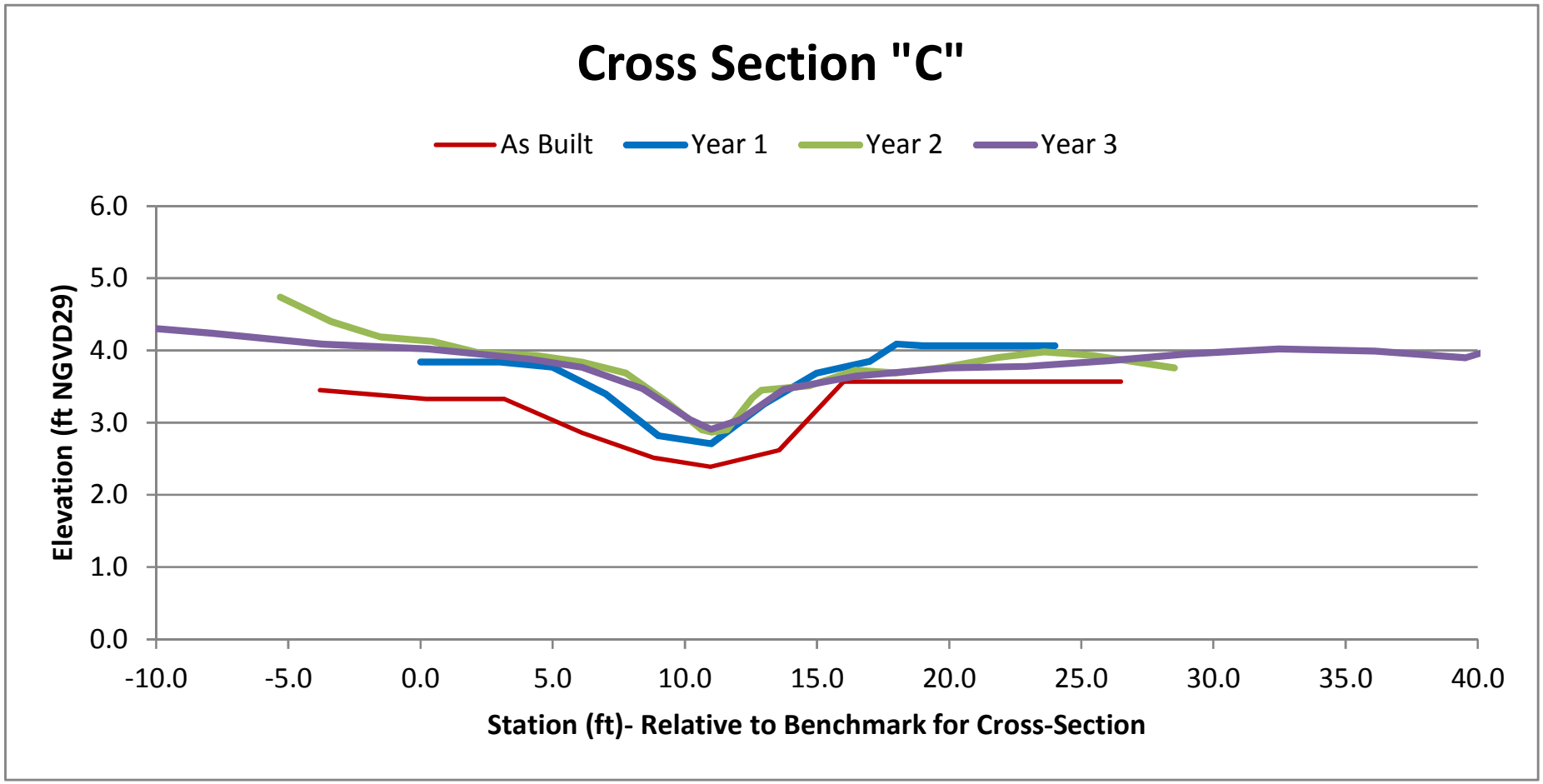

Seven Day Tidal Cycle
Bridge Guage
Transitional Well
Pond Well
Reference
New Moon
Full Moon
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
-4.00
Water Surface Elevation (Ft NAVD29)
8/1/2016
8/2/2016
8/3/2016
8/4/2016
8/5/2016
8/6/2016
8/7/2016
8/8/2016
Date

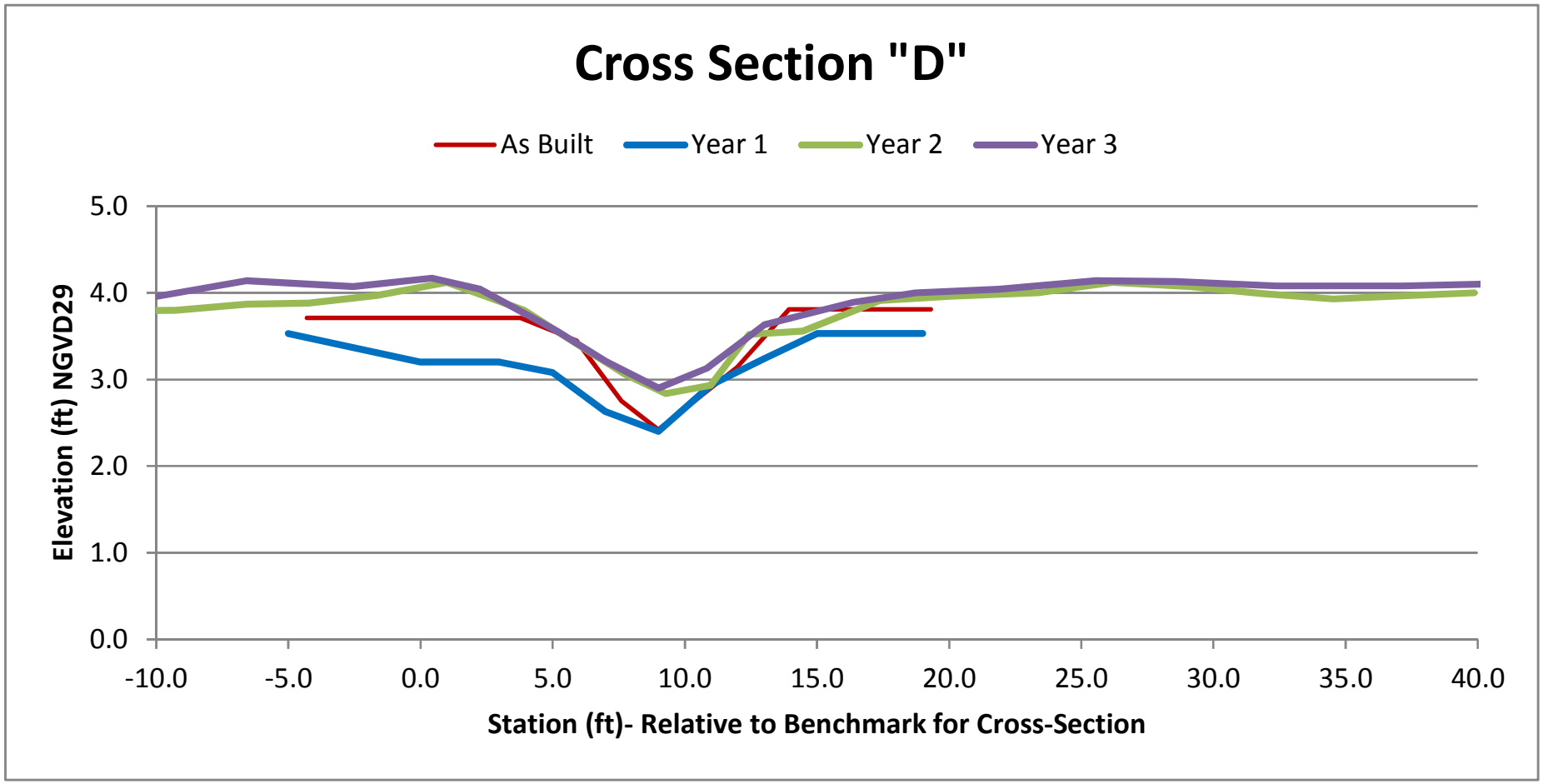
APPENDIX B:

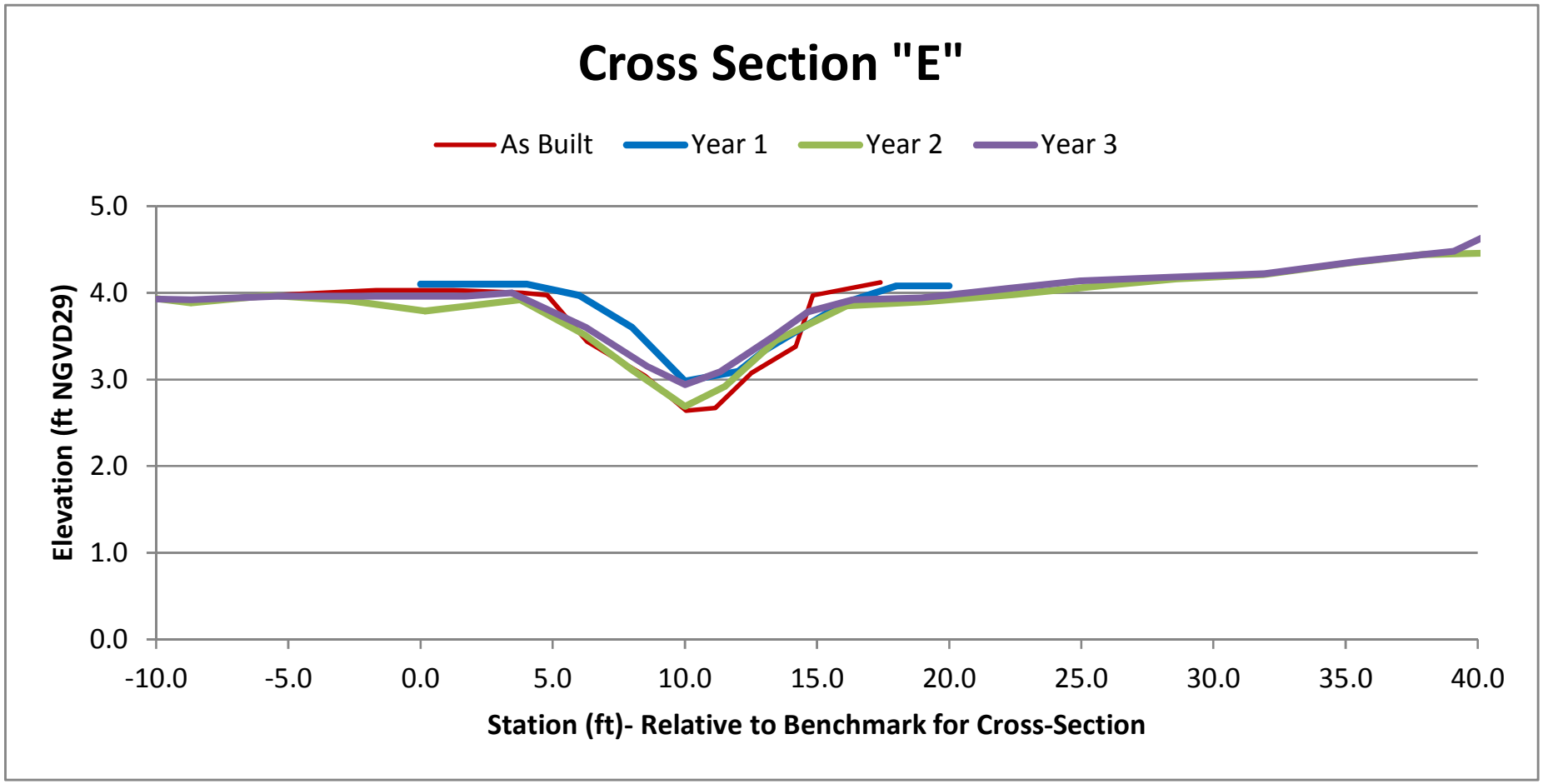
CROSS SECTION DATA

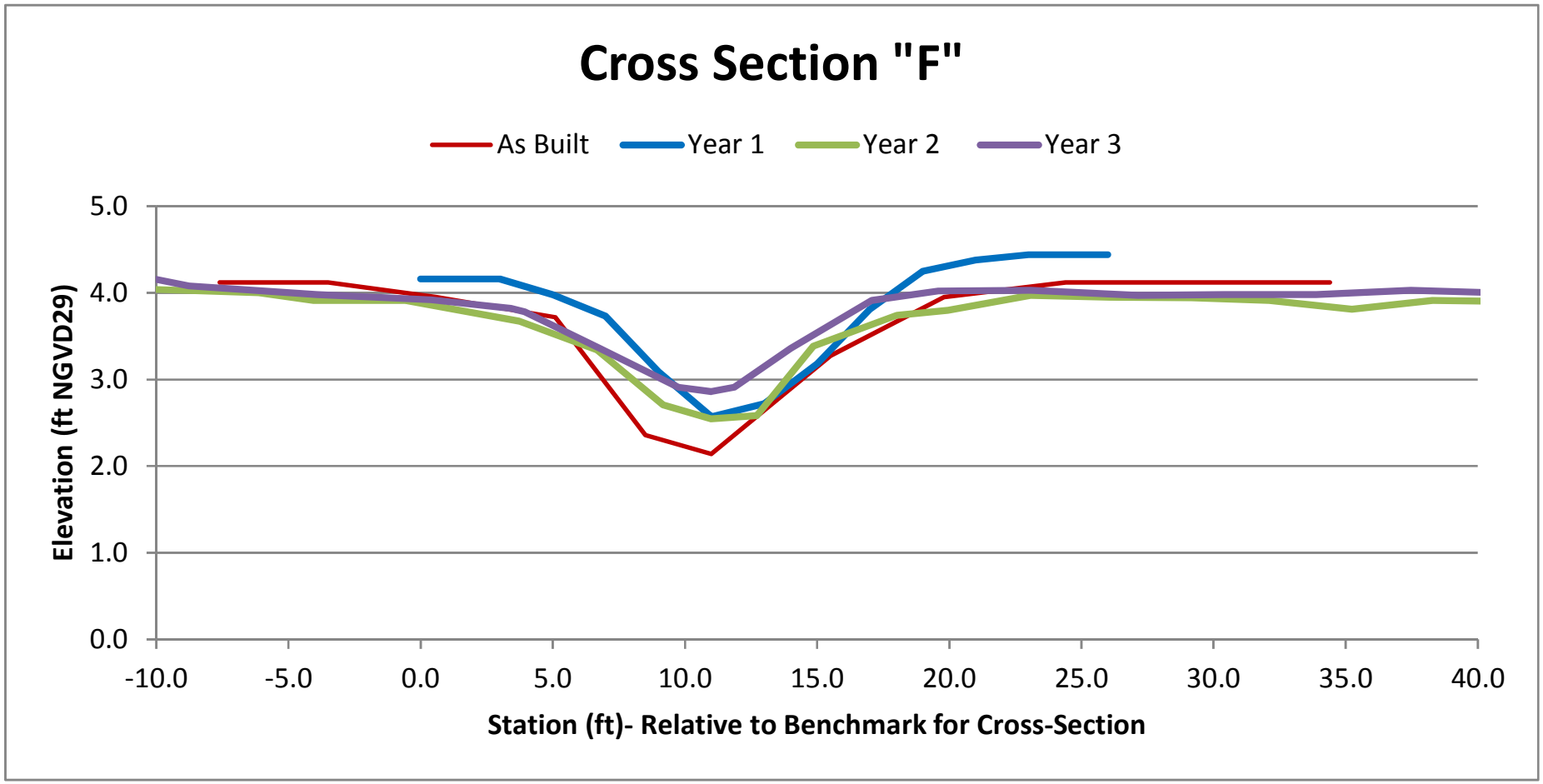

Cross Section "A"
As Built
Year 1
Year 2
Year 3
5.0
4.0
3.0
2.0
1.0
0.0
Elevation (ft NGVD29)
-10.0
-5.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
Station (ft)- Relative to Benchmark for Cross-Section

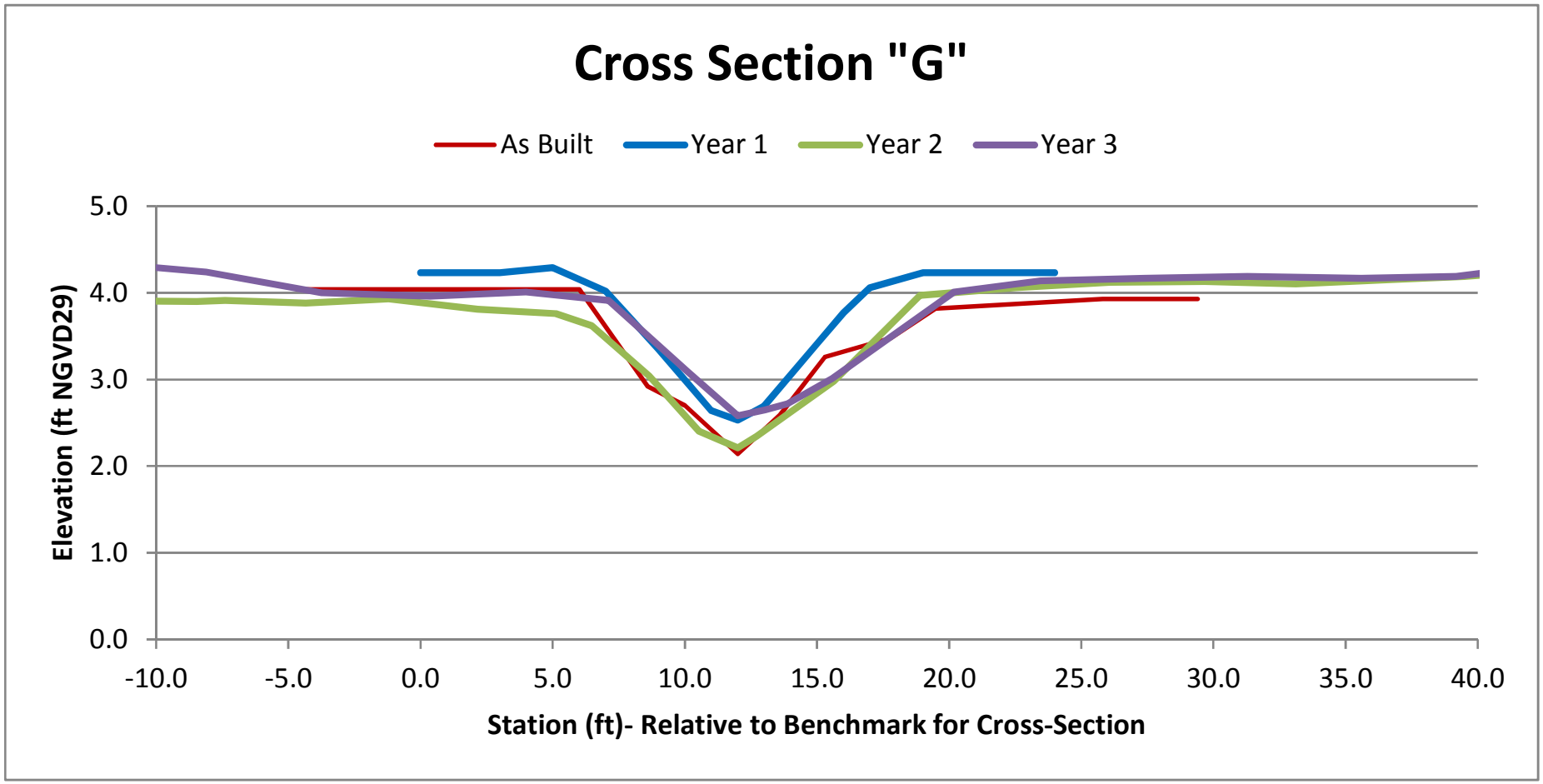

Cross Section "B"
As Built
Year 1
Year 2
Year 3
5.0
4.0
3.0
2.0
1.0
0.0
Elevation (ft NGVD29)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
Station (ft)- Relative to Benchmark for Cross-Section

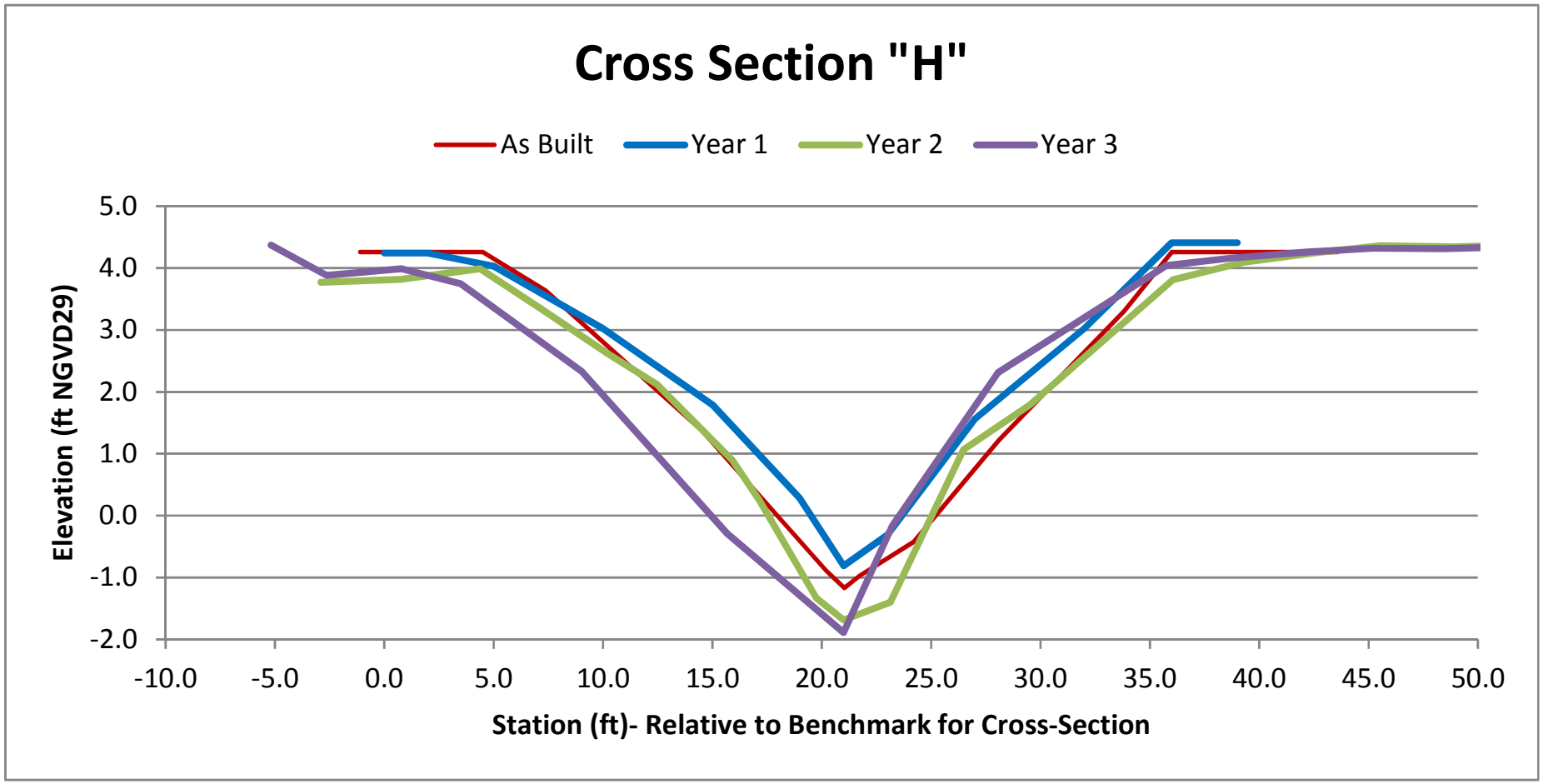

Cross Section "C"
As Built
Year 1
Year 2
Year 3
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Elevation (ft NGVD29)
-10.0
-5.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
Station (ft)- Relative to Benchmark for Cross-Section


Cross Section "D"
As Built
Year 1
Year 2
Year 3
5.0
4.0
3.0
2.0
1.0
0.0
Elevation (ft) NGVD29
-10.0
-5.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
Station (ft)- Relative to Benchmark for Cross-Section


Cross Section "E"
As Built
Year 1
Year 2
Year 3
5.0
4.0
3.0
2.0
1.0
0.0
Elevation (ft NGVD29)
-10.0
-5.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
Station (ft)- Relative to Benchmark for Cross-Section


Cross Section "F"
As Built
Year 1
Year 2
Year 3
5.0
4.0
3.0
2.0
1.0
0.0
Elevation (ft NGVD29)
-10.0
-5.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
Station (ft)- Relative to Benchmark for Cross-Section


Cross Section "G"
As Built
Year 1
Year 2
Year 3
5.0
4.0
3.0
2.0
1.0
0.0
Elevation (ft NGVD29)
-10.0
-5.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
Station (ft)- Relative to Benchmark for Cross-Section


Cross Section "H"
As Built
Year 1
Year 2
Year 3
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
Elevation (ft NGVD29)
-10.0
-5.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
Station (ft)- Relative to Benchmark for Cross-Section

APPENDIX C:

VEGETATION PLOT DATA

YEAR THREE VEGETATION REPORT - 2016

Restoration Site - 2016

Q-A Rest

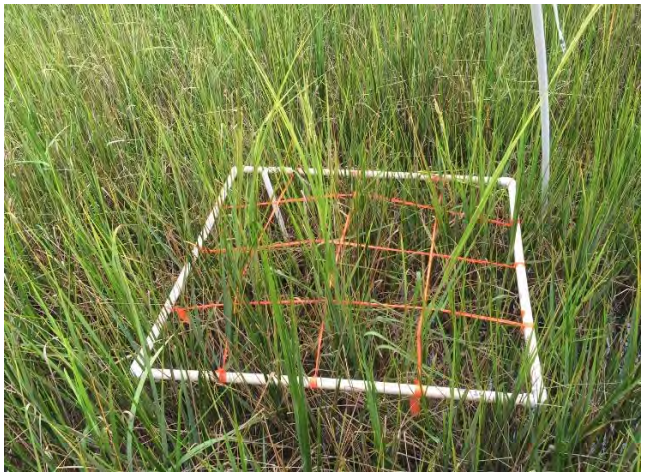
Species: *Spartina alterniflora*

Overall Percent Cover: 97

Percent Bare Ground: 3

Representative Plant Height (inches): 28

Sub-quadrat	Stem Count
14	12
16	15
2	11
5	9



Q-B Rest

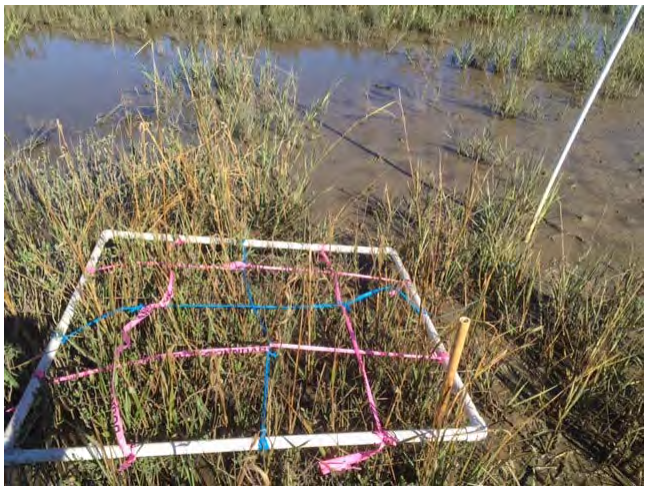
Species: *Salicornia virginica, Spartina alterniflora*

Overall Percent Cover: 45

Percent Bare Ground: 55

Representative Plant Height (inches): 22

Sub-quadrat	Stem Count (*Spartina*)	Stem Count (*Salicornia*)
4	17	0
7	8	0
8	12	0
2	7	0



Q-C Rest

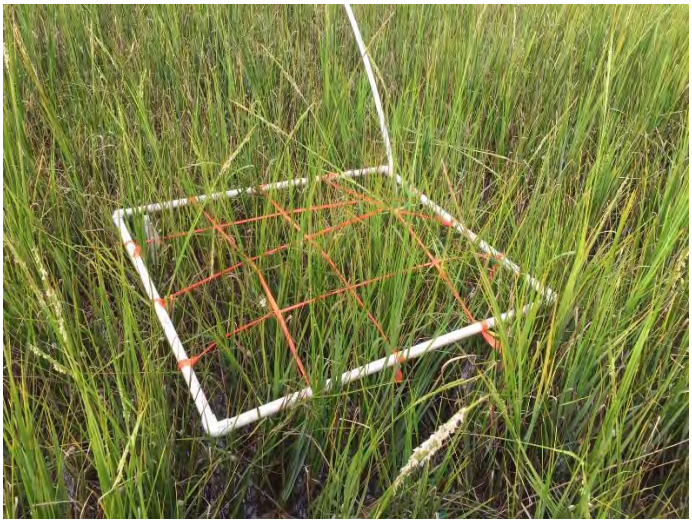
Species: *Spartina alterniflora*

Overall Percent Cover: 85

Percent Bare Ground: 15

Representative Plant Height (inches): 27

Sub-quadrat	Stem Count
12	19
4	9
1	15
2	18



Q-D Rest

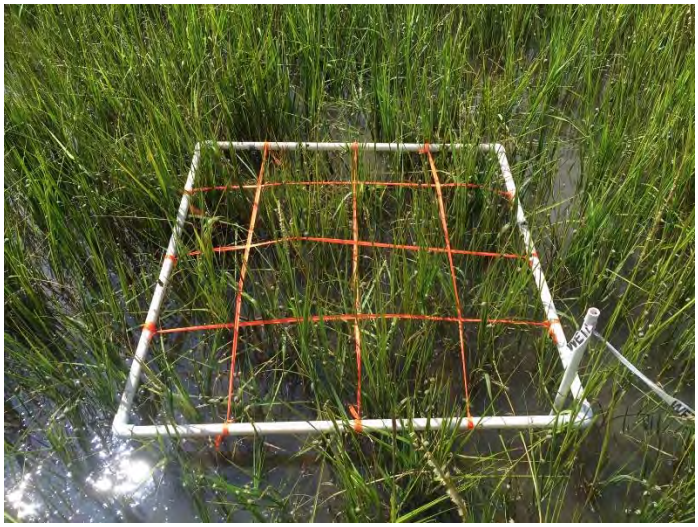
Species: *Spartina alterniflora*

Overall Percent Cover: 85

Percent Bare Ground: 15

Representative Plant Height (inches): 18

Sub-quadrat	Stem Count
7	15
14	12
8	17
3	19



30m Line Transects

Transect	Species	Sum of Intercept Length (cm)	% Relative Coverage
T-A Rest	*Salicornia virginica*	228	19
	Iva frutescens	12	1
	Spartina alterniflora	561.6	46.8
	Borrichia frutescens	540	45
T-B Rest	*Borrichia frutescens*	852	71
	Spartina alterniflora	780	65
	Salicornia virginica	108	9

T-A Rest

T-B Rest

Reference Site - 2016

Q-A Ref

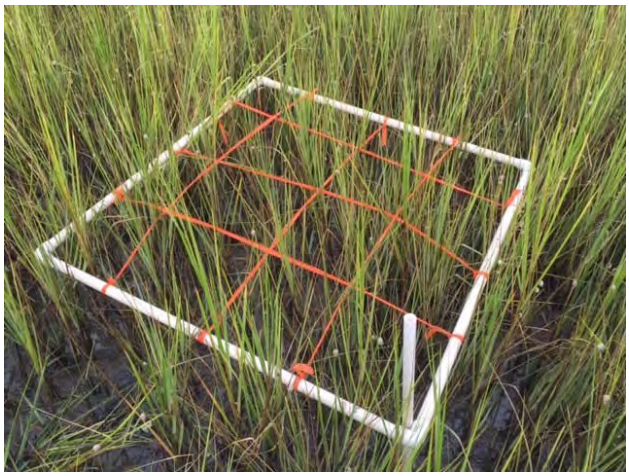
Species: *Spartina alterniflora*

Overall Percent Cover: 45

Percent Bare Ground: 55

Representative Plant Height (inches): 30

Sub-quadrat	Stem Count
6	13
8	14
2	13
11	18



Q-C Ref

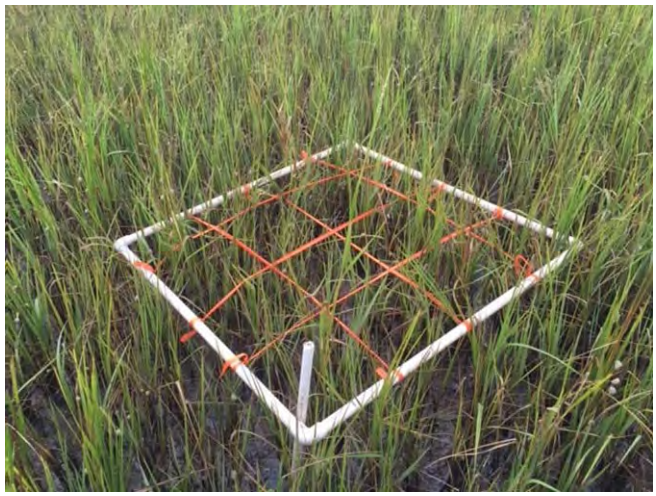
Species: *Spartina alterniflora*

Overall Percent Cover: 85

Percent Bare Ground: 15

Representative Plant Height (inches): 40

Sub-quadrat	Stem Count
9	17
11	16
4	17
12	15



Q-E Ref

Species: *Spartina alterniflora*

Overall Percent Cover: 75

Percent Bare Ground: 25

Representative Plant Height (inches): 25

Sub-quadrat	Stem Count
2	17
10	17
15	21
13	9

Q-F Ref

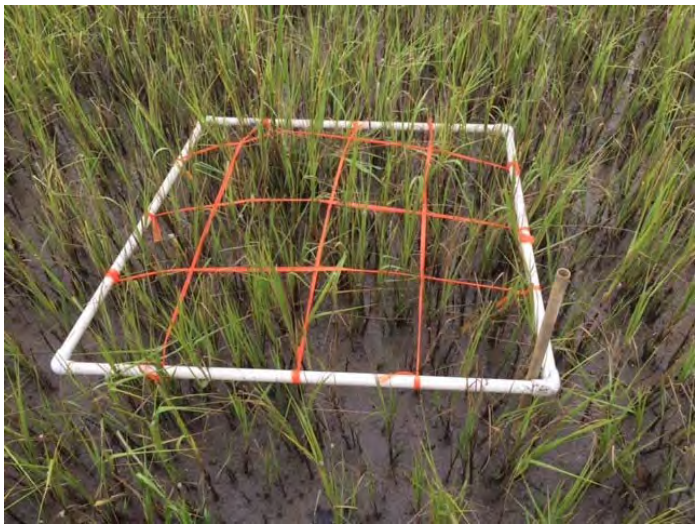
Species: *Spartina alterniflora*

Overall Percent Cover: 50

Percent Bare Ground: 50

Representative Plant Height (inches): 18

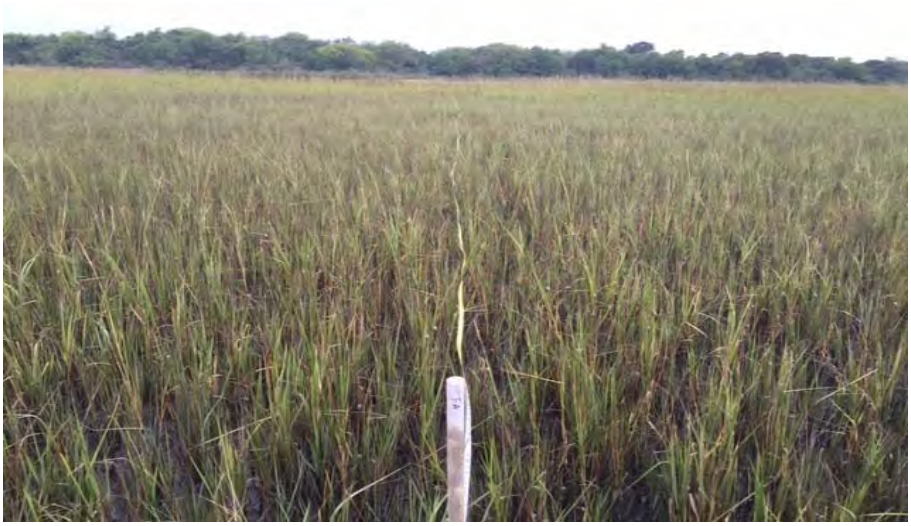
Sub-quadrat	Stem Count
15	37
3	27
1	15
13	16



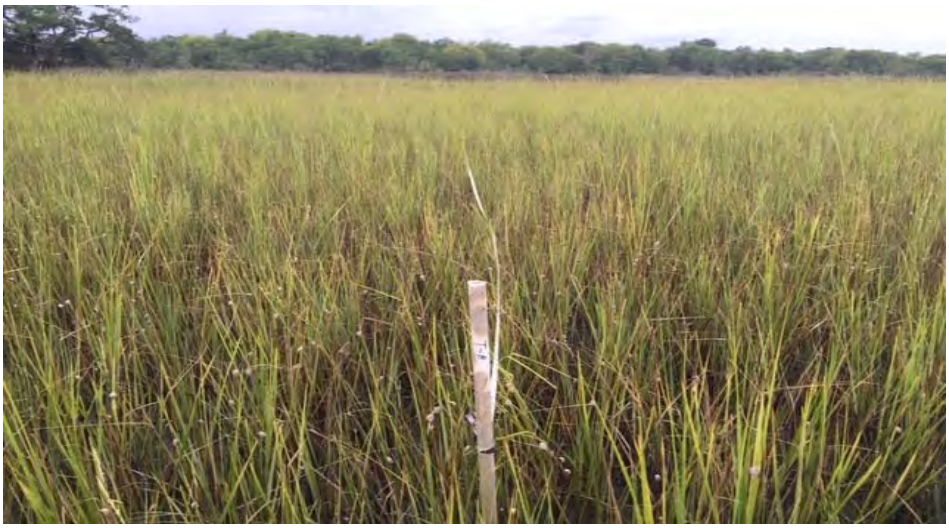
30m Line Transects

Transect	Species	Sum of Intercept Length (cm)	% Relative Coverage
T-A Ref	*Spartina alterniflora*	2750	92
T-B Ref	*Spartina alterniflora*	2790	93
T-C Ref	*Spartina alterniflora*	2740	89
T-D Ref	*Spartina alterniflora*	2377	78
	Borrichia frutescens	518.2	12
	Iva frutescens	30.5	1
	Spartina bakeri	944.8	31

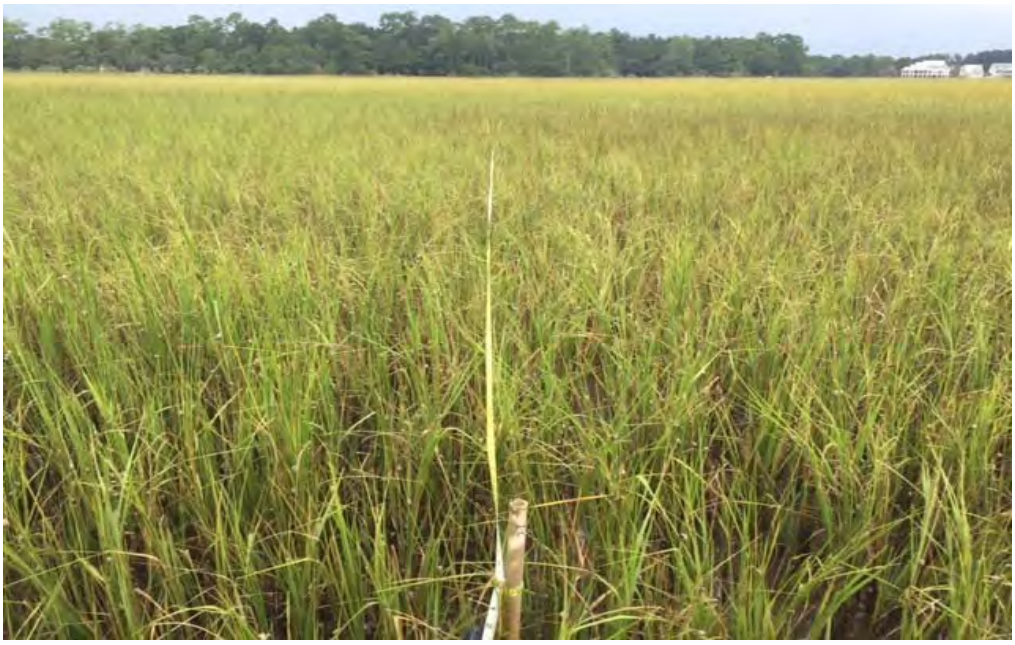
T-A Ref



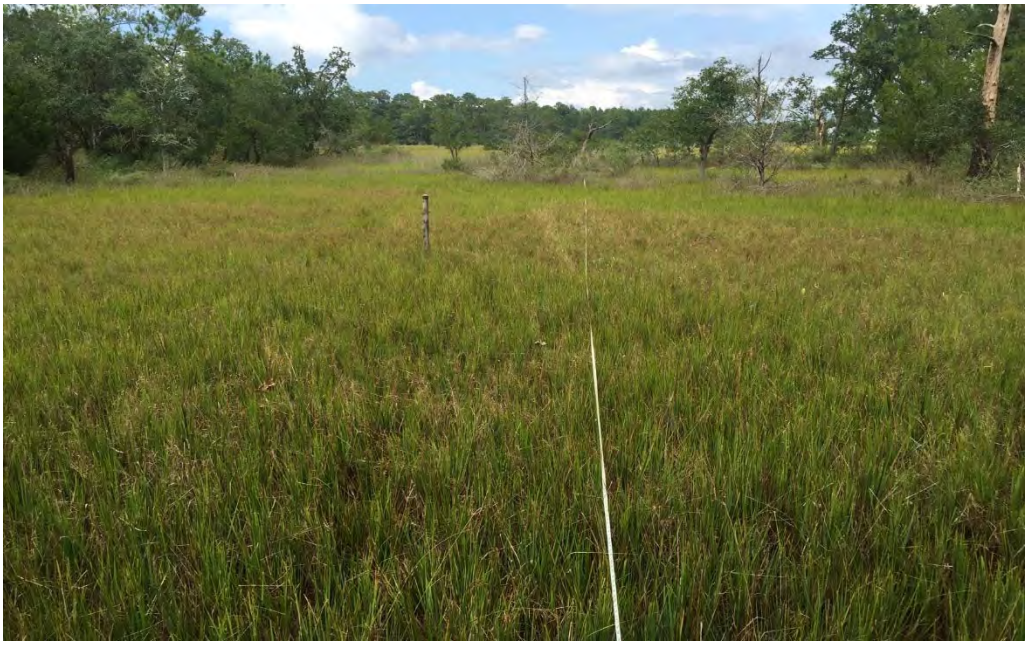
T-B Ref



T-C Ref

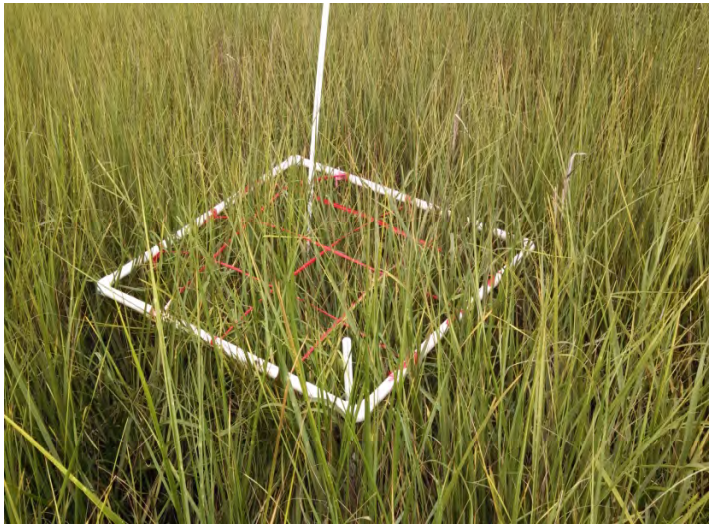


T-D Ref



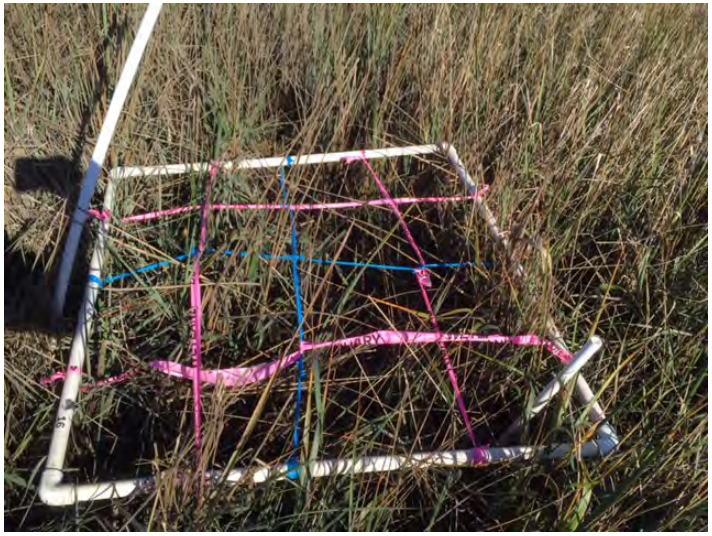
Restoration Site – Quadrat A

Baseline



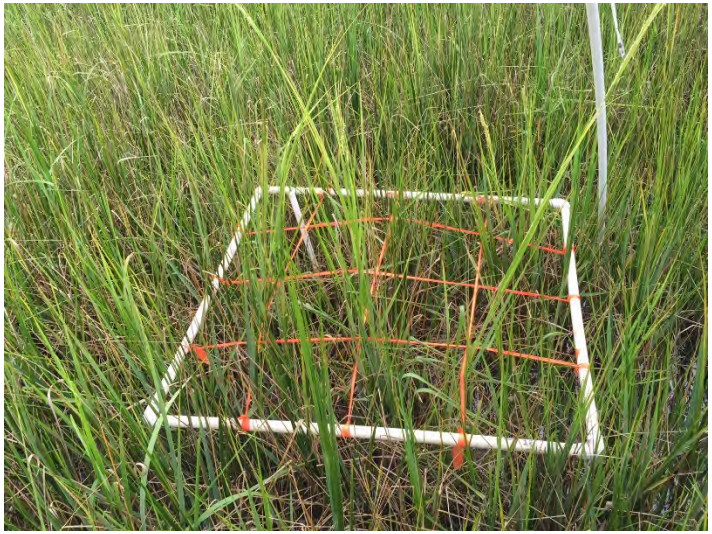
Time Zero

Year 1



Year 2

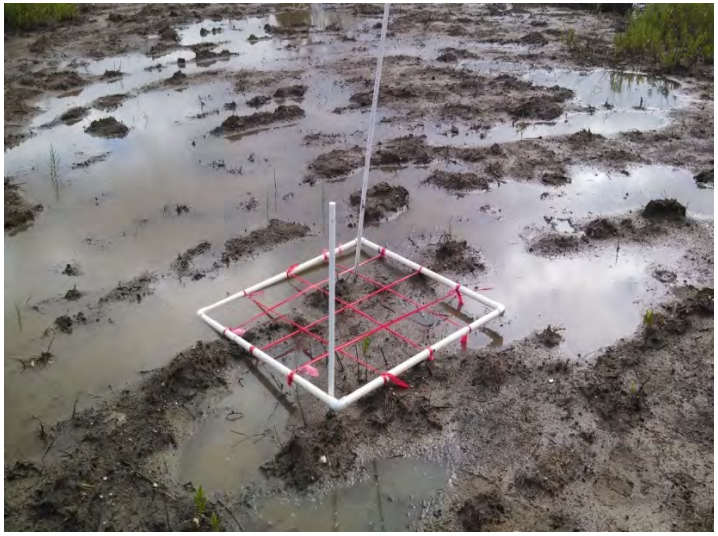
Restoration Site – Quadrat A



Year 3

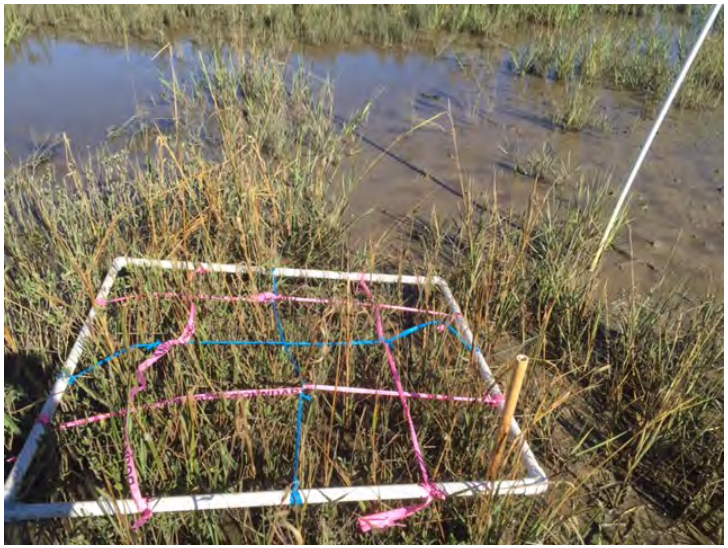
Restoration Site – Quadrat B

Baseline



Time Zero

Year 1



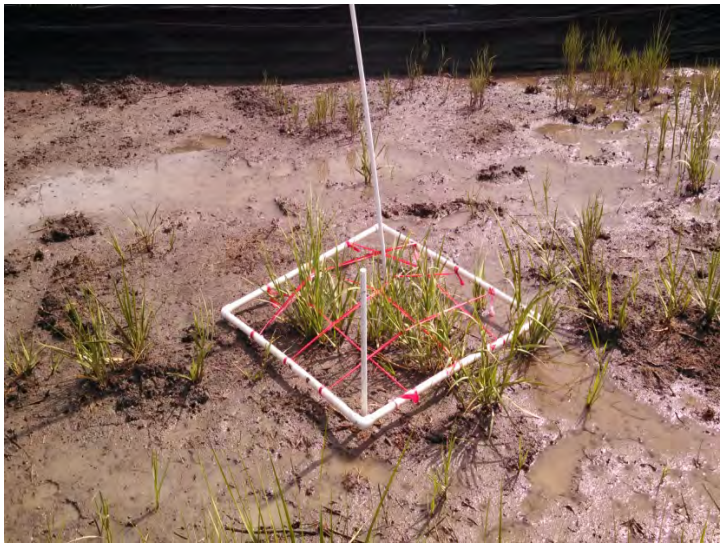
Year 2

Restoration Site – Quadrat B

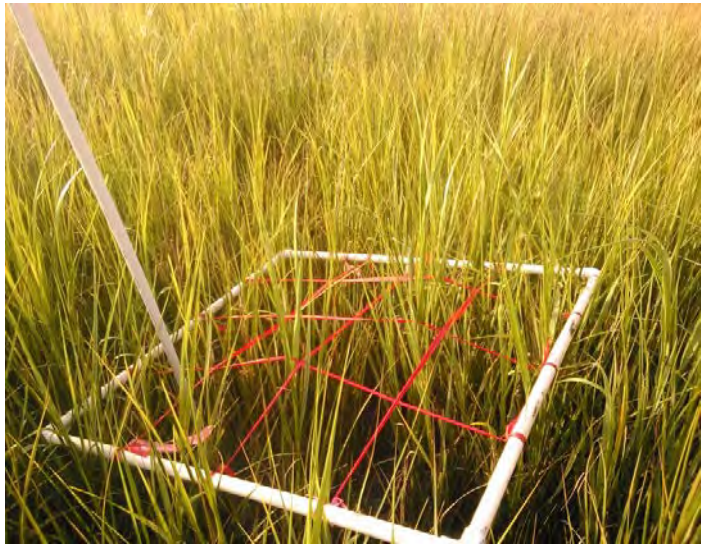
Year 3

Restoration Site – Quadrat C

Baseline



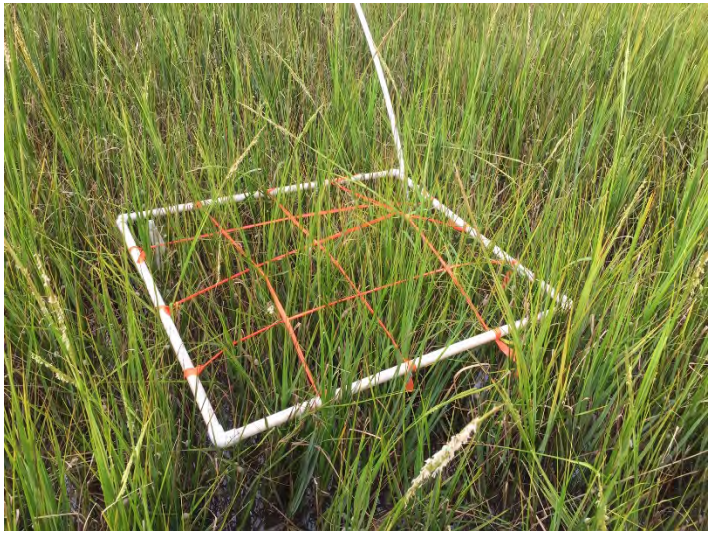
Time Zero



Year 1

Year 2

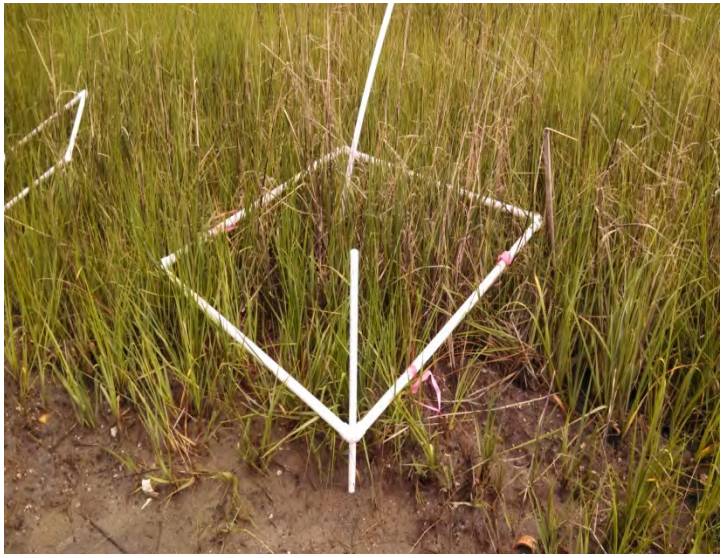
Restoration Site – Quadrat C



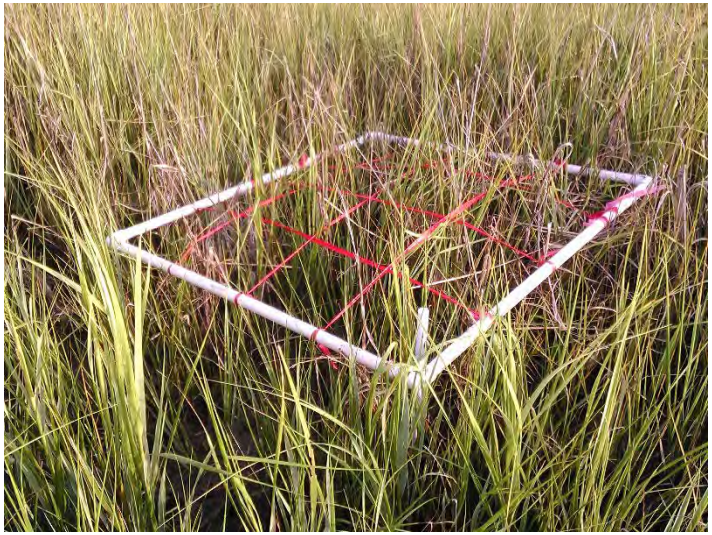
Year 3

Restoration Site – Quadrat D

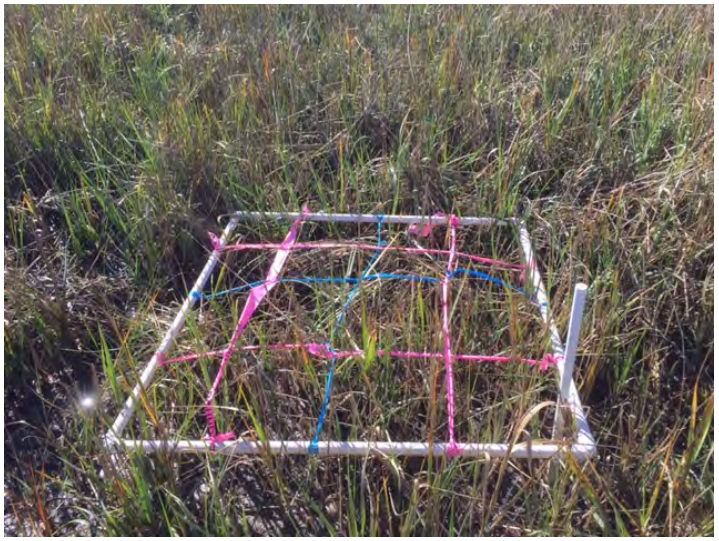
Baseline



Time Zero

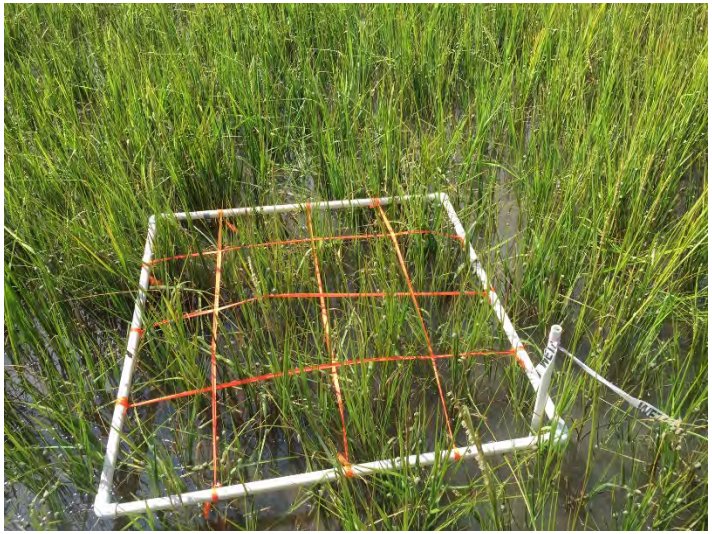


Year 1



Year 2

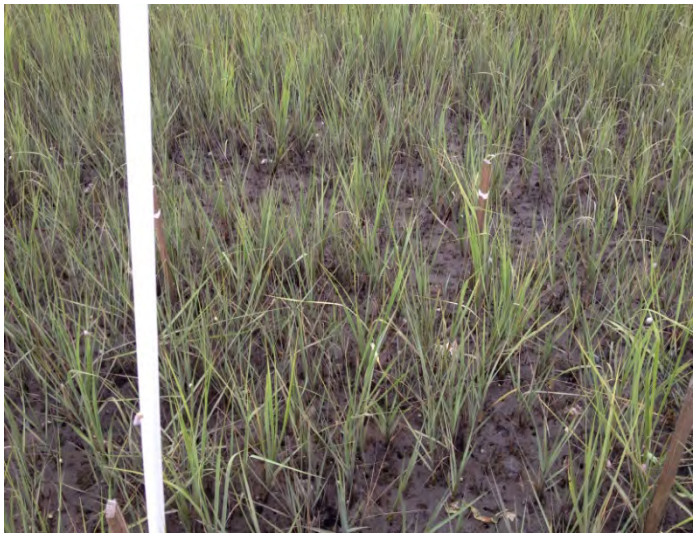
Restoration Site – Quadrat D



Year 3

Reference Site – Quadrat A

Baseline

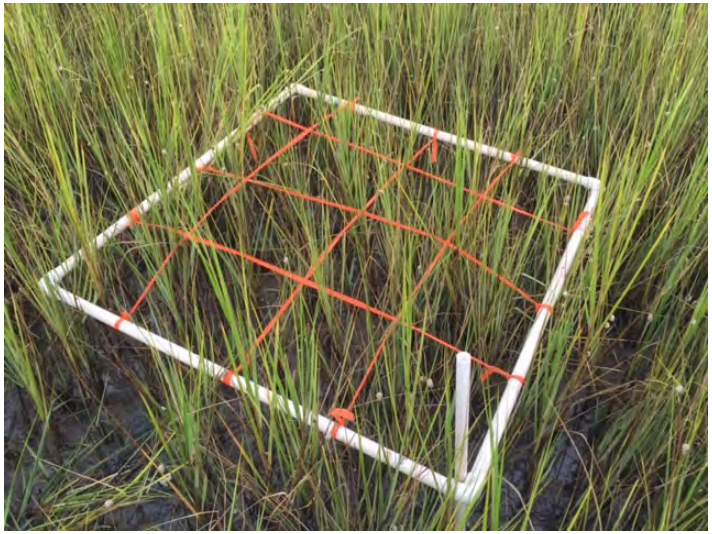


Time Zero

Year 1

Year 2

Reference Site – Quadrat A



Year 3

Reference Site – Quadrat B

Baseline

Time Zero

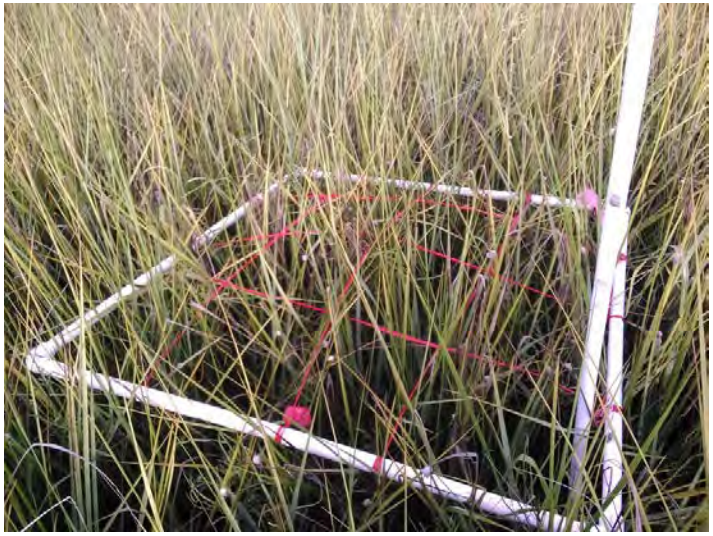
Year 1

Year 2 – NO LONGER USED

Reference Site – Quadrat C

Baseline

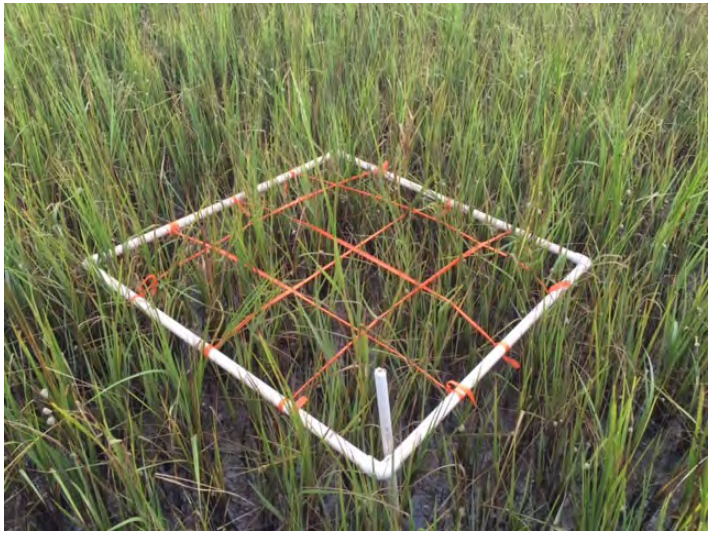
Time Zero



Year 1

Year 2

Reference Site – Quadrat C

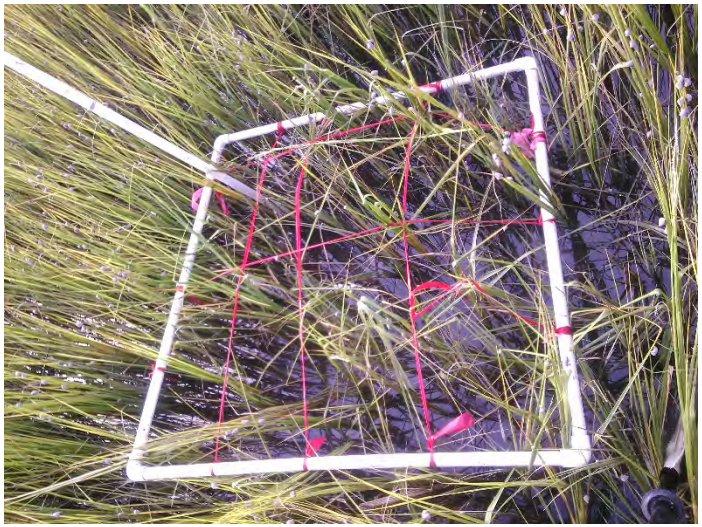


Year 3

Reference Site – Quadrat D

Baseline

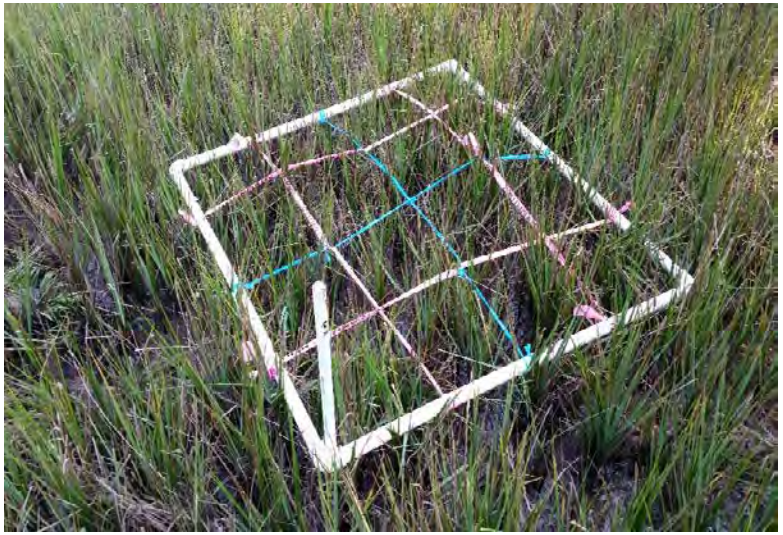
Time Zero



Year 1

Year 2 – NO LONGER USED

Reference Site – Quadrat E

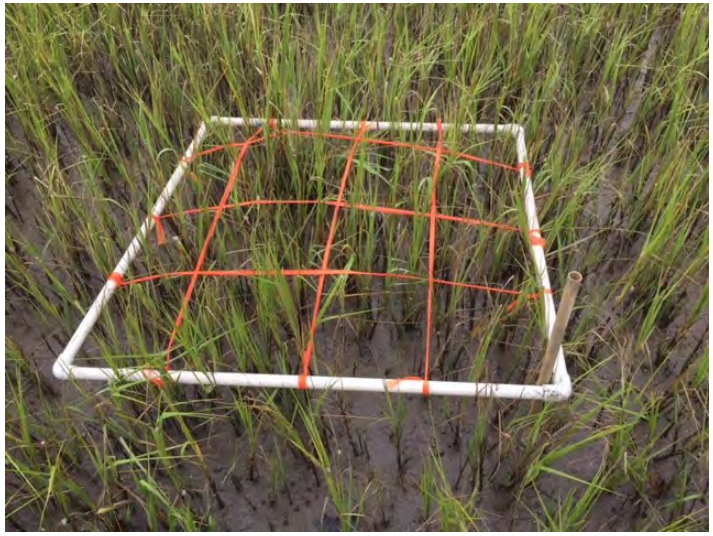


Year 2

Year 3

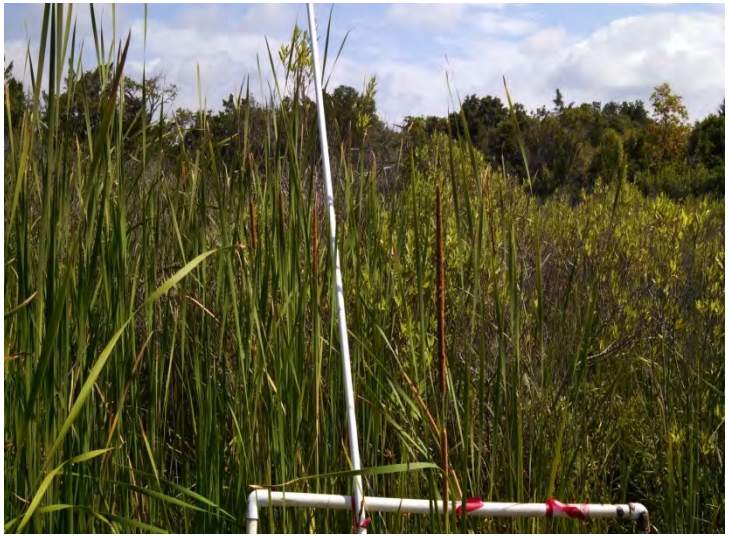
Reference Site – Quadrat F

Year 2



Year 3

Restoration Site – Transect A



Time Zero

Year 1

Year 2

Year 3

Restoration Site – Transect B

Time Zero

Year 1

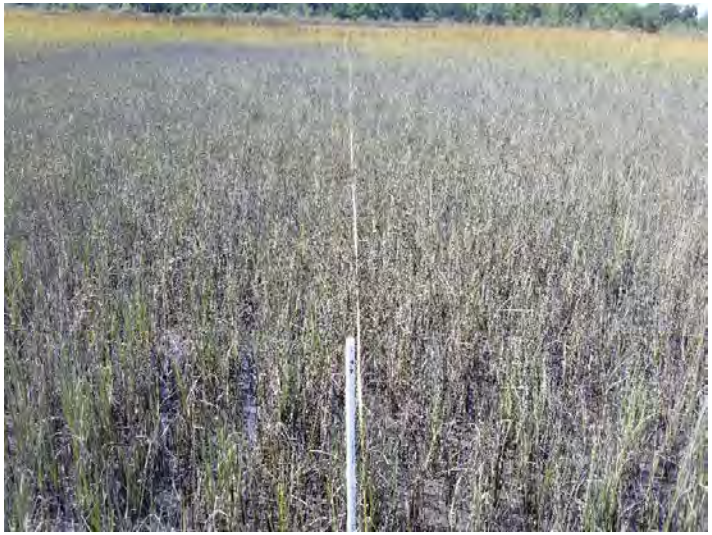
Year 2

Year 3

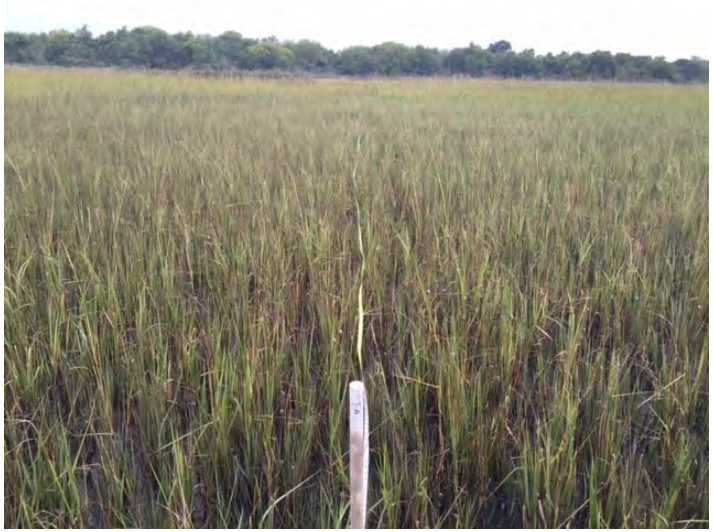
Reference Site – Transect A

Time Zero

Year 1



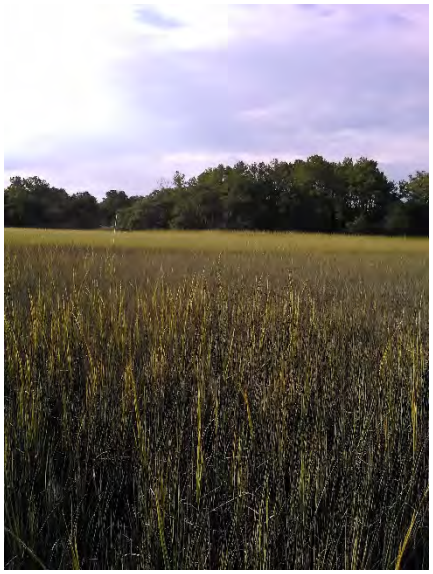
Year 2



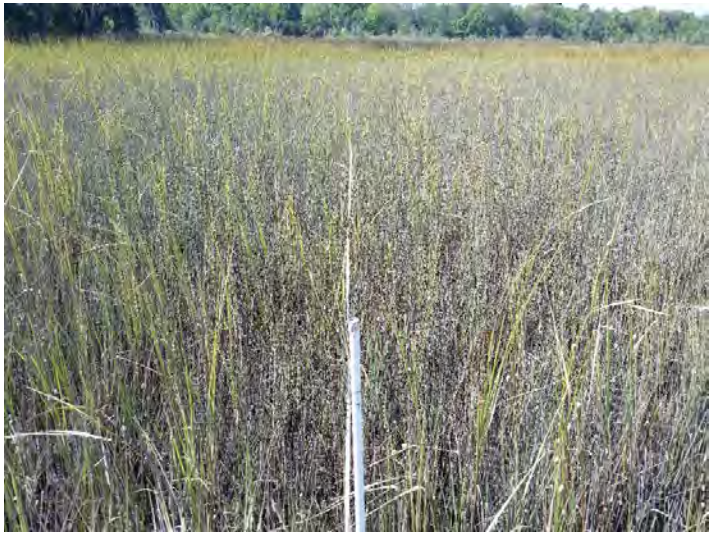
Year 3

Reference Site – Transect B

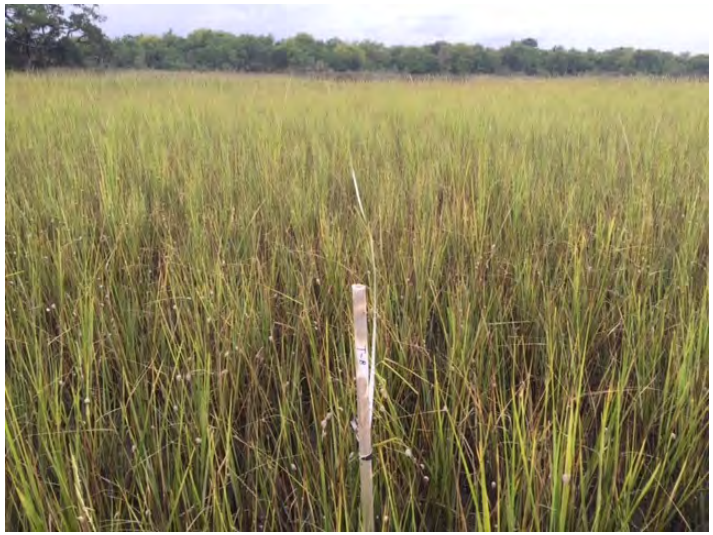
Time Zero



Year 1

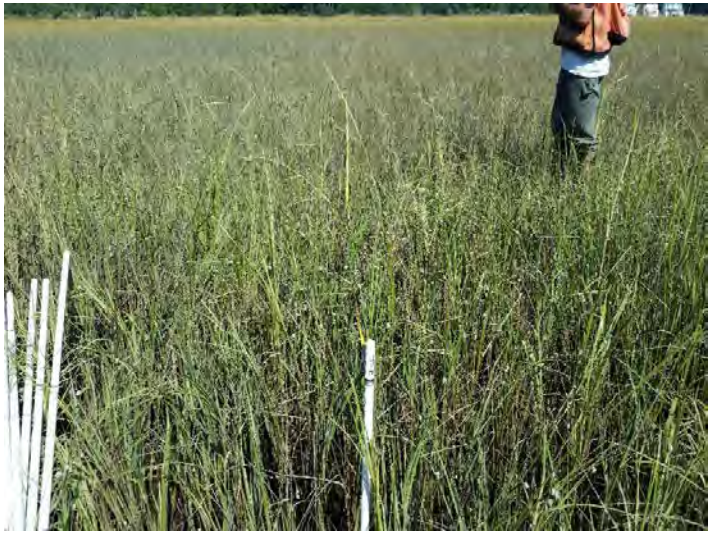


Year 2

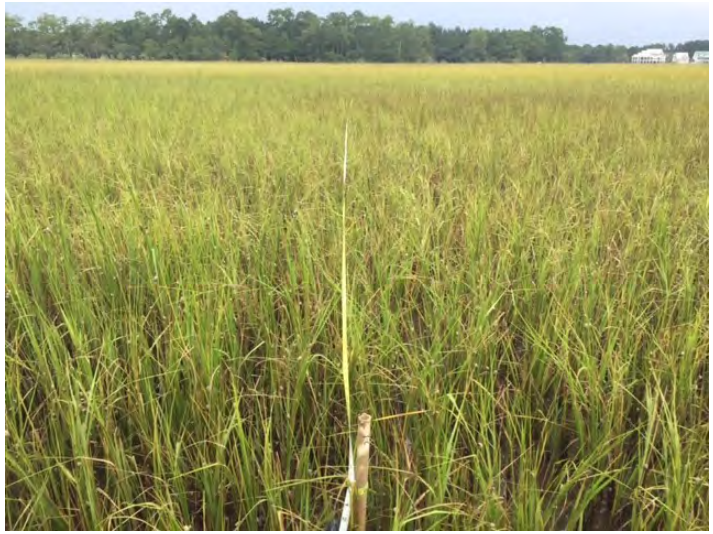


Year 3

Reference Site – Transect C

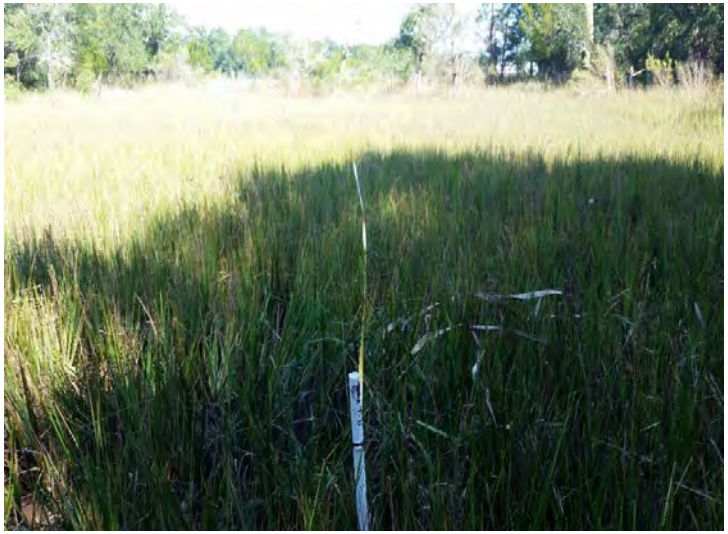


Year 2



Year 3

Reference Site – Transect D



Year 2

Year 3

Permanent Photograph Station Location 1:
at High Tide (2016)

Permanent Photograph Station Location 2
at High Tide (2016)

Permanent Photograph Station Location 1

March 2013

March 2014

Photo not available

2015

October 2016

Permanent Photograph Station Location 2

March 2013

March 2014

Photo not available

2015

October 2016

APPENDIX D:

MANN–WHITNEY U-TEST

T-Test to compare signficant difference between restoration and reference site
Comparison of randomly selected 0.0625-m² subquadrats located within a 1-m² quadrat

Includes Spartina alterniflora

Quad Label	Restoration Site	Reference Site
Q-A	12	13
Q-A	15	14
Q-A	11	13
Q-A	9	18
Q-B	17	
Q-B	8	
Q-B	12	
Q-B	7	
Q-C	19	17
Q-C	9	16
Q-C	15	17
Q-C	18	15
Q-D	15	
Q-D	12	
Q-D	17	
Q-D	19	
Q-E		17
Q-E		17
Q-E		21
Q-E		9
Q-F		37
Q-F		27
Q-F		15
Q-F		16
Mean Stem Count	**13.44**	**15.38**

F-Test

p = 0.070601

$p < 0.05$

Variances are not equal

T-Test

p = 0.035076 (2-sample t-test for equal variances)

$p > 0.05$

The 2 groups are not signficantly different in stem counts.

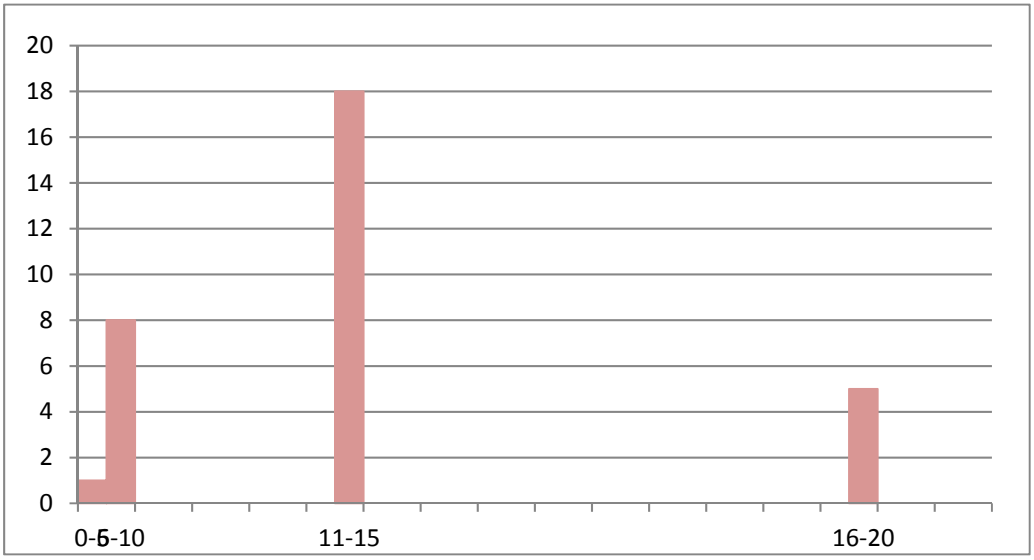
F test is used to determin if the data is skewed right (see if it has a normal distribution in the next tab). If not, then a T-test is used.

T-Test to compare signficant difference between restoration and reference site
Comparison of randomly selected 0.0625-m² subquadrats located within a 1-m² quadrat

Includes Spartina alterniflora

	Restoration Site
	Reference Site

Quad Label	Stem Count	Interval	Frequency
Q-C Rest	5	0-5	1
Q-D Rest	6		
Q-C Rest	6		
Q-A Rest	7		
Q-E Ref	8	6-10	8
Q-E Ref	9		
Q-D Rest	9		
Q-A Rest	9		
Q-F Ref	9		
Q-C Ref	11		
Q-E Ref	11		
Q-A Rest	12		
Q-B Rest	12		
Q-D Rest	12		
Q-A Ref	12		
Q-C Ref	12		
Q-A Rest	13		
Q-B Rest	13	11-15	18
Q-C Rest	13		
Q-B Rest	13		
Q-C Ref	13		
Q-B Rest	14		
Q-A Ref	14		
Q-C Ref	14		
Q-E Ref	14		
Q-A Ref	15		
Q-C Rest	15		
Q-F Ref	16		
Q-F Ref	17		
Q-D Rest	17	16-20	5
Q-F Ref	17		
Q-A Ref	20		
		>20	0


20
18
16
14
12
10
8
6
4
2
0
0-5-10
11-15
16-20

Mann Whitney U-Test (Non-parametric alternative) to compare restoration and reference site
Comparison of randomly selected 0.0625-m² subquadrats located within a 1-m² quadrat

Using Method II

Directional hypothesis: Group B (Reference Site) will have higher stem counts than Group A (Restoration Site).
Expect the Raw-Measure ratings of stem counts to be higher in Group B than in Group A
Expect Group B to have higher ranks

Restoration Site	(Q-X Rest)	A
Reference Site	(Q-Y Ref)	B

Count	Raw Measure	Rank	Sample Group
1	5	1	Q-C Rest
2	6	2	Q-D Rest
3	6	2	Q-C Rest
4	7	4	Q-A Rest
5	8	5	Q-E Ref
6	9	6	Q-E Ref
7	9	6	Q-D Rest
8	9	6	Q-A Rest
9	9	6	Q-F Ref
10	11	10	Q-C Ref
11	11	10	Q-E Ref
12	12	12	Q-A Rest
13	12	12	Q-B Rest
14	12	12	Q-D Rest
15	12	12	Q-A Ref
16	12	12	Q-C Ref
17	13	17	Q-A Rest
18	13	17	Q-B Rest
19	13	17	Q-C Rest
20	13	17	Q-B Rest
21	13	17	Q-C Ref
22	14	22	Q-B Rest
23	14	22	Q-A Ref
24	14	22	Q-C Ref
25	14	22	Q-E Ref
26	15	26	Q-A Ref
27	15	26	Q-C Rest
28	16	28	Q-F Ref
29	17	29	Q-F Ref
30	17	29	Q-D Rest
31	17	29	Q-F Ref
32	20	32	Q-A Ref

NOT COMPLETED FOR YEAR 2

Mann Whitney U-Test (Non-parametric alternative) to compare restoration and reference site
Comparison of randomly selected 0.0625-m² subquadrats located within a 1-m² quadrat

Using Method II

Raw Measures		Ranked Measures		
Restoration (A)	**Reference (B)**	**Restoration (A)**	**Reference (B)**	
5	8	1	5	
6	9	2	6	
6	9	2	6	
7	11	4	10	
9	11	6	10	
9	12	6	12	
12	12	12	12	
12	13	12	17	
12	14	12	22	
13	14	17	22	
13	14	17	22	
13	15	17	26	
13	16	17	28	
14	17	22	29	
15	17	26	29	
17	20	29	32	**Combined**
	SUM of Ranks (T)	202	288	490
	Mean Ranks	12.6	18.0	15.3
	μ_T	264.0	264.0	
	T_{max}	392	392	
	U	190	104	294
	U (Null Hypothesis)	128.0	128.0	
	Check of Null Hypothesis	128.0	128.0	

n_a	16
n_b	16
N	32

Critical Values for U with designated n_a and n_b values

	Level of Significance for a:		
	Directional Test		
	0.05	0.025	0.01
	Non-Directional Test		
	-	0.05	0.02
Lower Limit	83	75	66
Upper Limit	173	181	190

Mann Whitney U-Test (Non-parametric alternative) to compare restoration and reference site
Comparison of randomly selected 0.0625-m² subquadrats located within a 1-m² quadrat

Using Method II

Directional hypothesis: Group B (Reference Site) will have higher stem counts than Group A (Restoration Site).

Expect the Raw-Measure ratings of stem counts to be higher in Group B than in Group A	**NO**
Expect Group B to have higher ranks; hence $T_B > T_A$ and $U_A > U_B$	**NO**

Because both U values fall within the 83-173 limits, there is no significant difference at p=0.05

Notes & Assumptions:

Stem Counts include *Spartina alterniflora*

Assumptions:

1. that the two samples are randomly and independently drawn;
2. that the dependent variable is intrinsically continuous, capable in principle, if not in practice, of producing measures carried out to the n^{th} decimal place; and
3. that the measures within the two samples have the properties of at least an ordinal scale of measurement, so that it is meaningful to speak of "greater than," "less than," and "equal to."

Mann Whitney U-Test (Non-parametric alternative) to compare restoration and reference site
Comparison of visually estimated percent coverage within a 1-m² quadrat

Using Method II

Directional hypothesis: Group B (Reference Site) will have higher percent coverage than Group A (Restoration Site).
Expect the Raw-Measure ratings of percent coverage to be higher in Group B than in Group A
Expect Group B to have higher ranks

Restoration Site	A
Reference Site	B

Count	Raw Measure	Rank	Sample Group
1	39	1	Restoration (A)
2	41	2	Restoration (A)
3	42	3	Reference (B)
4	44	4	Restoration (A)
5	50	5	Reference (B)
6	52	6	Restoration (A)
7	59	7	Reference (B)
8	61	8	Reference (B)

Mean % Coverage	44	**Reference Site**
	53	**Restoration Site**

Raw Measures		Ranked Measures		
Restoration (A)	**Reference (B)**	**Restoration (A)**	**Reference (B)**	
39	42	1	3	
41	50	2	5	
44	59	4	7	
52	61	6	8	**Combined**
	SUM of Ranks (T)	13	23	36
	Mean Ranks	3.3	5.8	4.5
	μ_T	18.0	18.0	
	T_{max}	26	26	
	U	13	3	16
	U (Null Hypothesis)	8.0	8.0	
	Check of Null Hypothesis	8.0	8.0	

n_a	4
n_b	4
N	8

Mann Whitney U-Test (Non-parametric alternative) to compare restoration and reference site
Comparison of visually estimated percent coverage within a 1-m² quadrat

Using Method II

Critical Values for U with designated n_a and n_b values

	Level of Significance for a:		
	Directional Test		
	0.05	0.025	0.01
	Non-Directional Test		
	0.1	0.05	0.025
Lower Limit	N/A	N/A	N/A
Upper Limit	13	15	16

Directional hypothesis: Group B (Reference Site) will have higher percent coverage than Group A (Restoration Site).

Expect the Raw-Measure ratings of percent cover to be higher in Group A than in Group B **No**

Expect Group B to have higher ranks; hence $T_B > T_A$ and $U_A > U_B$ **No**

Because both U values fall within the 0-13 limits, there is no significant difference at p=0.1

Assumptions:

1. that the two samples are randomly and independently drawn;
2. that the dependent variable is intrinsically continuous, capable in principle, if not in practice, of producing measures carried out to the n^{th} decimal place; and
3. that the measures within the two samples have the properties of at least an ordinal scale of measurement, so that it is meaningful to speak of "greater than," "less than," and "equal to."