Post Hurricane Monitoring Report

Rockefeller Refuge Gulf Shoreline Stabilization Project

HDR Engineering, Inc.
State Project Number ME-0018
HDR Project Number 10270651

Cameron Parish, Louisiana
August 18, 2021

STATE OF LOUISIANA
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Executive Summary

The Rockefeller Refuge Gulf Shoreline Stabilization Project (State Project No. ME-0018) is a 4-mile lightweight aggregate core (LWAC) breakwater along the Gulf of Mexico coastline in Cameron Parish, Louisiana. The project was designed in 2014 to reduce erosion along the western portion of Rockefeller Wildlife Refuge's shoreline and had the following design objectives:

- Prevent beach erosion for up to Category 1 hurricane conditions, which were estimated to have a return interval of about 10 years at the project site.
- Be designed, constructed, monitored, and maintained over a 20-year design life.
- Where practicable, the protection should remain stable for more severe storm conditions up to an event having a 100-year return period. Note that a 100-year return period storm has an 18.2% probability of occurring within a given 20-year period.

Studies at the time of design indicated as much as 46 feet per year (USGS 2013) of coastal erosion. It was determined that erosion of 900 feet over 20 years would be expected near the Refuge without stabilizing this portion of the coastline. This rate is equivalent to over 300 acres of Louisiana's coastal wetlands lost to erosion within the project area. The Louisiana Coastal Protection and Restoration Authority (CPRA) teamed with the National Marine Fisheries Service (NMFS) to implement the project. Construction was completed in May 2020.

Two hurricanes significantly impacted the southwest Louisiana coast during the 2020 hurricane season. Hurricane Laura made landfall in Cameron, Louisiana on August 27 as a category 4 hurricane and is the strongest storm to strike southwest Louisiana in recorded history. Hurricane Delta made landfall as a category 2 hurricane near Creole, Louisiana on October 9, causing further damage to the already devastated area.

To isolate the effects of the uncharacteristically active 2020 hurricane season on the ME-0018 project area, a topographic and bathymetric Post-Hurricane Monitoring (Monitoring) survey was conducted from December 29, 2020 through March 30, 2021 by HydroTerra Technologies, LLC (HydroTerra). The Monitoring survey spanned a three month time period due to challenges surveying near the breakwater structure and inclement weather conditions. LIDAR data was collected on December 29, 2020. Data collected during the Monitoring survey was compared to the As-Built survey data collected in May 2020 by Patriot Construction and Industrial (Patriot) to quantify and assess the soil volume change, shoreline change, settlement plate elevation change, breakwater elevation change, and toe scour, if any, at the project site.

The project area was divided into 5 Analysis Groups by which the data was analyzed. A Control Group was also designated to the east of the site. Results at the Control location were compared to results at the Analysis Group sites to understand how the breakwater affected the results relative to the nearby unprotected shoreline. Over the total project length of 4 miles, approximately 426,000 cubic yards of soil was lost between the As-Built and Monitoring survey events. The average elevation change landward and offshore of the breakwater was -1.2 feet. The data showed that the shoreline behind the breakwater eroded an average of 62.58 ft since construction of the project, with the worst erosion being recorded on the western end of the project area. However, the Control Group experienced 165.18 ft of shoreline erosion. Comparing these values shows that the breakwater has mitigated erosion of the area as designed.

Elevation change along the breakwater was compared to settlement plate data to assess the potential for losses of armor stone material and settlement of the structure. Settlement plate elevation data was analyzed and compared to predicted rates of settlement, and no settlement plates were found to have

settled more than originally anticipated. Elevation change along the breakwater was generally higher than the elevation change of the settlement plates, however a review of the survey data did not indicate any major issues with the cross section of the breakwater.

Scour on the seaward side of the breakwater was assessed to determine whether the seaward toe of the breakwater is at risk. A statistical analysis of elevation change (i.e., scour or accretion) up to 300 feet offshore of the breakwater was conducted. No substantial scour adjacent to the breakwater seaward toe was observed.

Compared to the Control Group, the breakwater is mitigating erosion of the shoreline as designed. A significantly greater amount of shoreline change was measured at the Control location than at the 5 Analysis Group locations between the As-Built surveys and the recent monitoring surveys. Future monitoring will determine whether the project continues to reduce shoreline change.

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Acronyms, Abbreviations, and Nomenclature

CPRA	Coastal Protection and Restoration Authority
CWPPRA	Coastal Wetlands Planning, Protection and Restoration Act
DSAS	Digital Shoreline Analysis System (version 4.0)
ft	feet
HDR	HDR Engineering, Inc.
HydroTerra	HydroTerra Technologies, LLC
LIDAR	Light Detection and Ranging
LWAC	Lightweight Aggregate Core
m	meter
MHW	Mean High Water
Monitoring Survey	Post-Hurricane Monitoring Survey
NAD83 (2011)	North American Datum of 1983 (2011 adjustment)
NAVD88	North American Vertical Datum of 1988
NOAA	National Oceanic and Atmospheric Administration
NMFS	National Marine Fisheries Service
NSM	Net Shoreline Movement
Patriot	Patriot Construction and Industrial
Refuge	Rockefeller Wildlife Refuge
sUAS	Small unmanned aerial system
TIN	Triangular Irregular Network
yr	year

1 Introduction

1.1 Purpose

This report describes the results and analysis of monitoring surveys for the Rockefeller Refuge Gulf Shoreline Stabilization Project (ME-0018) in Cameron Parish, Louisiana after the 2020 hurricane season.

1.2 Background

ME-0018 is a 4-mile long breakwater with a lightweight aggregate core (LWAC) in Cameron Parish, Louisiana along the Gulf of Mexico shoreline of Rockefeller Wildlife Refuge (Refuge), west of Joseph's Harbor Canal as shown in Figure 1-1. The project's intent is to mitigate coastal erosion at the Refuge. The project was designed with the following objectives:

- Prevent beach erosion for up to Category 1 hurricane conditions, which were estimated to have a return interval of about 10 years at the project site.
- Be designed, constructed, monitored, and maintained over a 20-year design life.
- Where practicable, the protection should remain stable for more severe storm conditions up to an event having a 100-year return period. Note that a 100-year return period storm has an 18.2% probability of occurring within a given 20-year period.

At the time of design, studies showed as much as 46 feet per year (USGS 2013) of coastal erosion at the project site. It was determined that erosion of 900 feet over 20 years would be expected near the Refuge without stabilizing this portion of the coastline. This is equivalent to more than 300 acres of Louisiana's coastal wetlands lost to erosion. The Coastal Protection and Restoration Authority (CPRA) teamed with the National Marine Fisheries Service (NMFS) to implement ME-0018 through the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) program. The project was constructed from east to west between April 2018 to final acceptance from CPRA on May 27, 2020. Two breakwater demonstration projects were previously constructed within the project shoreline and were incorporated into the ME-0018 layout: the ME-0018 demonstration project completed in December 2009 and the LA-0008 project completed in April 2012 (see Section 3.1).

After construction completion in May 2020, the project experienced near-direct impacts from two major hurricanes. Hurricane Laura made landfall in Cameron, Louisiana on August 27 as a category 4 hurricane and is the strongest storm to strike southwest Louisiana in recorded history. As the area was still recovering, Hurricane Delta made landfall as a category 2 hurricane near Creole, Louisiana on October 9.

While accretion landward of the breakwater was observed after construction, shoreline erosion was visually observed after these storms, causing concerns for the structural integrity and performance of the breakwater. Topographic and bathymetric surveying were conducted from December 29, 2020 through March 30, 2021 to assess the breakwater width and elevation, Gulf bottom elevation, and beach and marsh dimensions. LIDAR data was collected on December 29, 2020. The data collected during this Post-Hurricane Monitoring (Monitoring) survey was analyzed to evaluate the condition and performance of the breakwater and to determine whether corrective action would be necessary.

1.3 Datum

Unless stated otherwise, all coordinates in this report are relative to the 2011 adjustment of North American Datum of 1983 (NAD83 (2011)), State Plane Coordinate System, Louisiana South Zone. All elevations are relative to the North American Vertical Datum of 1988 (NAVD88) GEOID12B.

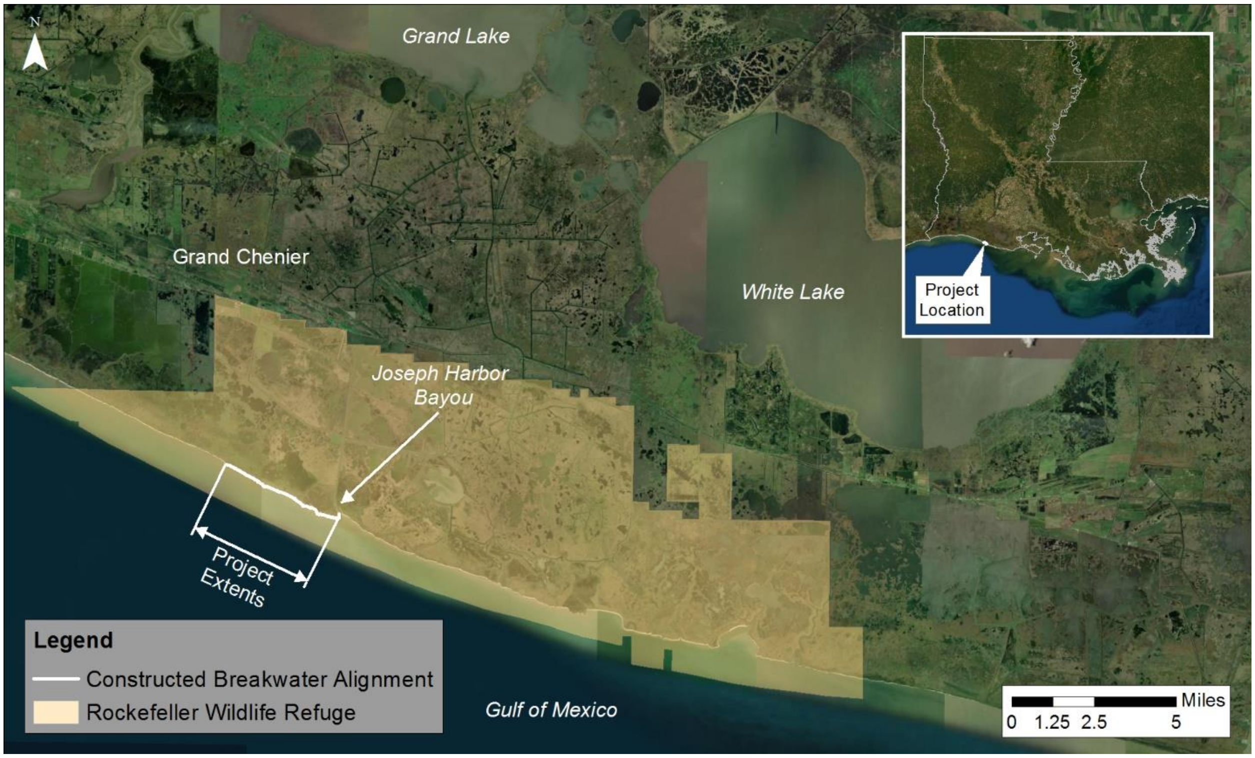

Figure 1-1. Project Location

2 Survey Data Collection

2.1 Topography and Bathymetry

Monitoring topographic and bathymetric elevation surveys of the ME-0018 project site were conducted by HydroTerra Technologies, LLC (HydroTerra) from January 26, 2021 through March 30, 2021. The survey consisted of 113 transects intersecting the LWAC breakwater and adjacent shoreline, with maximum 250-ft spacing between transects. As-Built survey data collected in June 2020 by Patriot Construction and Industrial (Patriot), the construction contractor, was available for 87% of the Monitoring transects. The Monitoring survey also included 10 topographic and bathymetric transects at an unprotected shoreline control site east of Joseph Harbor with similar transect spacing. The Monitoring survey limits were extended further inshore than the As-Built survey to more adequately capture the transition elevations into vegetated marsh. Figure 2-1 shows the As-Built and Monitoring survey locations.

The Monitoring survey transects extended approximately 350 ft seaward of the toe of the breakwater to approximately 200 ft inland to survey into the marsh and at least 25 ft beyond the sand over wash from hurricane deposition. A closer view of the landward and seaward transect extents is shown in Figure 2-1. Seaward of the breakwater, survey shots were taken along the transects at all significant grade breaks and at contours (i.e. -4-ft contour, -5-ft contour), with a maximum horizontal spacing of 25 ft. Survey shots of certain topographic features were also taken along the transects, including the end of continuous vegetation from the marsh, top of berm, Mean High Water (MHW) elevation, and breakwater toe. Shots were also taken at the locations of all significant grade breaks of the water bottom and structure features (toes and crest). All shots of the breakwater and landward were taken at a maximum horizontal spacing of 10 ft along transects.

Substrate characteristics were classified for each survey point collected on the breakwater or landward. Seven substrate classifications were used to delineate geomorphic transition along coastal gradient:

- Marsh – Typically herbaceous vegetation (grasses such as Spartina spp., sedges, rushes, whips)
- Marsh Pond – Enclosed water body within the marsh
- Shrub – Shrub or bushes typically occurs between Marsh and Sand/Shell Hash.
- Sand/Shell Hash – Sand or shell hash between the Marsh and Old Marsh Platform. May contain a dune, berms, and beach face.
- Old Marsh Platform – Typically intertidal and unvegetated but may be supratidal. Old Marsh Platform may have some isolated vegetation from old rhizomes and typically ends with a sharp drop-off at subtidal end.
- Water Bottom/Bathy – Area between Old Marsh Platform and Structure, and seaward of Structure, which typically remains underwater.
- Structure – In addition to 10-ft sampling interval, points were collected for shoreward toe, shoreward crest, gulfward crest, and gulfward toe of structure.

If substrate classifications co-occurred, both classifications were documented. For visual purposes, Marsh classification was given priority when co-occurring with another classification type (primarily with Marsh and Sand/Shell Hash) in the figures shown in Appendix A.

Settlement plates were installed at 21 locations along the breakwater during construction. Elevations were collected at the top of the pipes and at the grade elevation of the rocks at these locations.

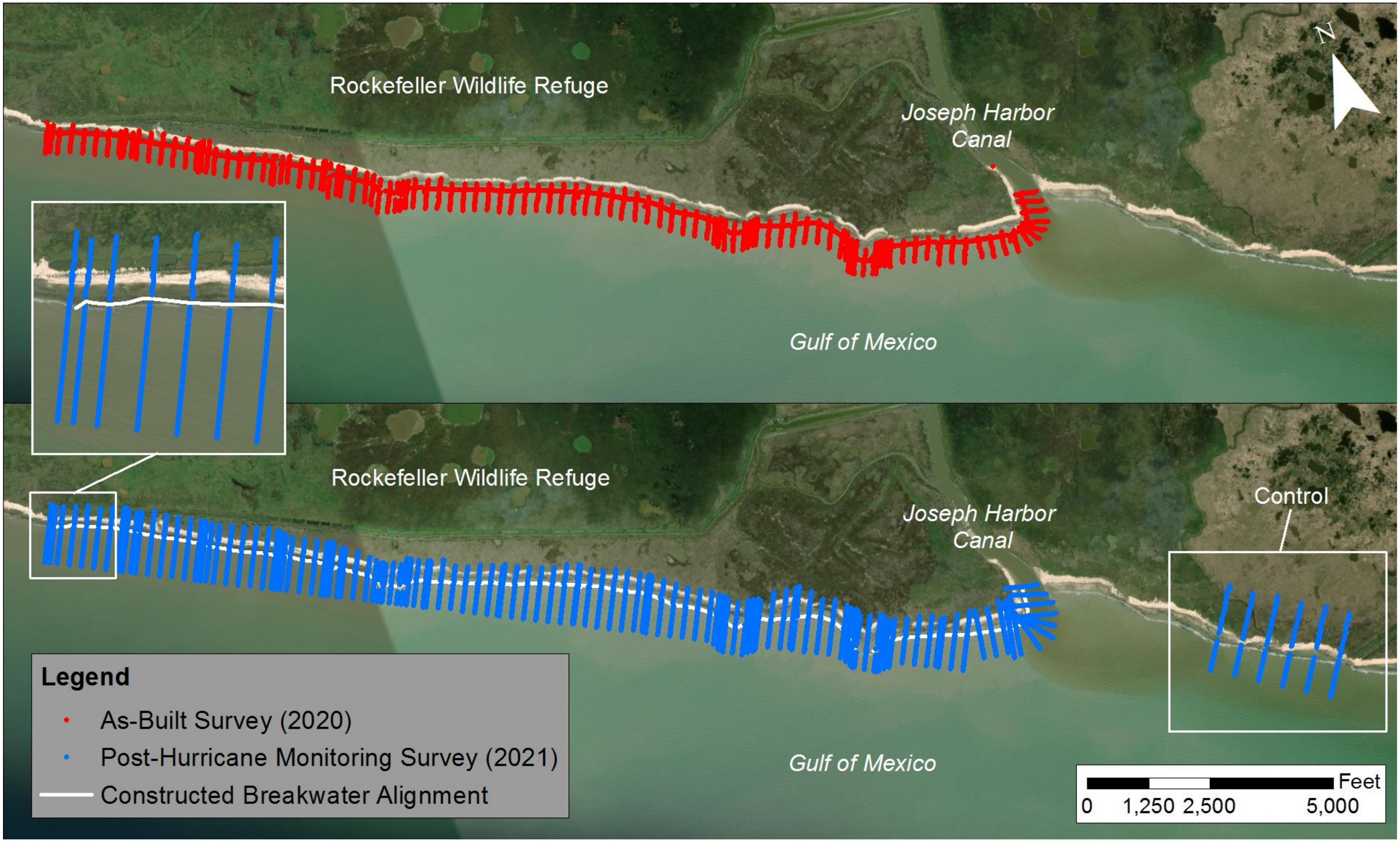

Figure 2-1. As-Built and Post-Hurricane Monitoring Survey Locations

2.2 LIDAR

LIDAR data was collected on December 29, 2020 at shoreline locations behind the breakwater without dense vegetation. LIDAR was also used to survey the breakwater centerline elevation at a maximum horizontal spacing of 10 ft.

3 Data Analysis

3.1 Analysis Groups

The project area was divided into 5 Analysis Groups as shown in Figure 3-1.

Group 1 (Mouth of Joseph Harbor Bayou) is the easternmost portion of the study area. It is located west of the mouth of Joseph Harbor Bayou (Joseph Harbor) and includes 2,700 ft of shoreline. This area was selected to capture the influence of Joseph Harbor on shoreline movement within the project area. This analysis group also includes 350 ft of shoreline north of the breakwater structures with open exposure to Joseph Harbor.

Group 2 (ME-0018 Demonstration Sections) spans 5,700 ft of shoreline which includes the area of the two demonstration sections completed in December 2009 and the more recently constructed breakwater structures in the vicinity. The demonstration areas differ from other construction locations in the study area in two ways: 1) the pre-construction shoreline extended into the Gulf relative to the remainder of the study area that had a relatively flat or linear shoreline geomorphology and 2) the breakwater alignment was updated during construction to accommodate the change in shoreline and bathymetry due to the demonstration features and to incorporate the demonstration features into the overall system.

Group 3 (Middle Typical) is the center-most analysis group and includes 4,400 ft of shoreline. This analysis group is generally characterized by the typical linear shoreline geomorphology and breakwater construction technique.

Group 4 (LA-0008) spans 3,500 ft of shoreline and includes the LA-08 demonstration project which was constructed in April 2012. This analysis group is functionally similar to Group 2 in that the shoreline had been influenced by another structure before construction of ME-0018.

Group 5 (Western Typical) is the westernmost analysis group and includes 5,300 ft of shoreline. Like Group 3, this analysis group is generally characterized by the typical linear shoreline geomorphology and breakwater construction technique.

The Control Group was established 3,650 east of Joseph Harbor along 2,950 ft of shoreline without a breakwater system. This shoreline is directly exposed to waves and currents from the open Gulf of Mexico including high tides, storms, and hurricane events. Longshore transport in this region of the Gulf of Mexico generally moves from east to west, meaning that the Control Group is generally considered to be outside the area of influence from the constructed structures to the west, including the jetty at the mouth of Joseph Harbor. The Control Group area has a similar pre-construction shoreline geomorphology as the typical shoreline segments. The beaches are composed of similar soft marine clays and crushed shell and are both backed by similarly vegetated marshland. Although the Control Group was not included in the As-Built survey, it will be compared to Analysis Groups 1 through 5 to quantify future sedimentation behind the breakwater and to measure project performance over its 20-year design life.

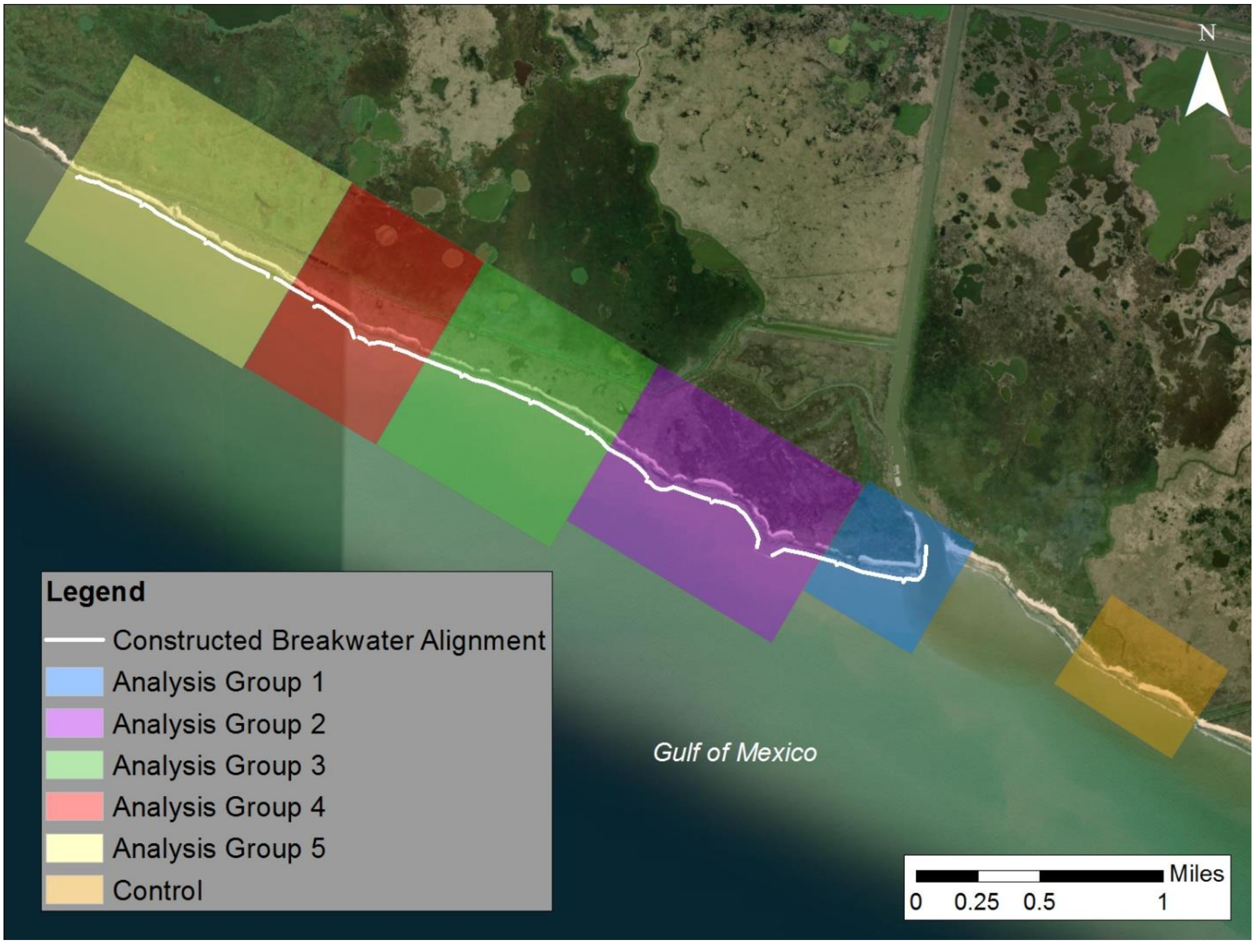

Figure 3-1. Analysis Groups

3.2 Shoreline Change

Net shoreline movement (NSM) was calculated between the As-Built and Monitoring surveys to determine the shoreline movement associated with the 2020 hurricane season. NSM was calculated using aerial imagery ESRI ArcMap 10.7.1, and the Digital Shoreline Analysis System (DSAS) version 5.0, which is an ArcMap application. For the purposes of this analysis, shoreline was defined as the continuous marsh vegetation boundary. A desktop assessment and field survey data were used to delineate continuous marsh in areas divided by borrow ponds and marsh trenasse (Figure 1-5 in Appendix B). Strips of marsh separated from continuous marsh by ponds and sand/shell hash were generally not included as continuous shoreline. The DSAS baseline was drawn approximately parallel to the shoreline and breakwater. Transects were perpendicular to the baseline and spaced 2 m apart. Transects were edited as necessary to accurately represent the shoreline change profile. For example, the transects were truncated to capture the front of the continuous marsh vegetation shoreline in areas where the shoreline “doubled back” with erosion taking place behind a line of continuous marsh.

As-Built orthomosaic imagery was collected by Patriot on May 28, 2020 for the ME-0018 project area (Analysis Groups 1-5) using drone/sUAS (small unmanned aerial system) technology. However, this survey did not capture the Control location, so the nearest available aerial imagery of the control area from February 2, 2020 was used (World Imagery basemap layer from ESRI and its contributors). Where available, the February 2020 imagery was used to create a shoreline for both the Control and the Analysis Groups as a means for comparison between the two imagery dates. When comparing the February 2020 and May 2020 shorelines in the Analysis Groups, there was no significant discernable difference in shoreline location between the two imagery dates. Therefore the May 2020 shorelines were used for the Analysis Group locations for consistency with the timing of survey data and the February 2020 shoreline was used for the Control Site.

Aerial imagery from NOAA's Emergency Response Imagery program was used to create a post-hurricane shoreline location for October 10, 2020. This imagery is collected by the remote sensing division of NOAA as part of homeland security and emergency response requirements. The substrate classification data from the field topographic survey were used to check the shoreline location derived from post-hurricane imagery (Appendix A, Figures 1-1 through 1-6). The spatial distribution of shoreline movement by Analysis Group is illustrated in Appendix B, Figures 1-1 through 1-6. A summary of the change by Analysis Group is shown in Table 3-1 and Figure 3-2.

All transects in Analysis Group 1 experienced a net negative shoreline movement. Because of a lack of data from the As-Built survey, it is not clear what the sediment dynamics are at the mouth of Joseph Harbor (Analysis Group 1), but future samplings of the expanded survey area would allow for further investigation. While Analysis Groups 2-4 all experienced negative shoreline movement, Analysis Group 4 had the highest number of transects (10) and the highest percentage of transects (2.5%) with a positive shoreline movement of any analysis group in the study area. Even so, the positive shoreline movement values in Groups 2-4 were all near 0 ft, the highest value being 0.16 ft, which denotes no significant positive shoreline movement. Analysis Group 5 had the greatest shoreline movement variability of all analysis groups and had the greatest negative value for average shoreline movement. Since shoreline data reflect vegetated shoreline and did not include sand/shell hash (unvegetated) area, it is possible that areas of recent sand/shell deposition (as seen in Analysis Group 5) may experience positive shoreline movement in the future as these areas are recolonized by marsh vegetation. The Control Group experienced significantly higher values of negative shoreline movement than any of the analysis groups and did not contain any transects with a positive shoreline movement value.

Table 3-1. Net Shoreline Movement for Each Analysis Group

Analysis Group	Total number of Transects	Average Distance (ft)	St. Dev. (ft)	Transects with Negative Distance	Maximum Negative Distance (ft)	Transects with Positive Distance	Maximum Positive Distance (ft)
1	433	-82.91	35.08	433 (100.0%)	-184.71	0 (0.0%)	N/A[1]
2	611	-71.72	40.35	610 (99.8%)	-189.86	1 (0.2%)	0[2]
3	613	-48.16	19.25	612 (99.8%)	-108.14	1 (0.2%)	0[2]
4	394	-62.63	39.43	384 (97.5%)	-142.16	10 (2.5%)	0.16
5	764	-96.95	34.29	757 (99.1%)	-227.30	7 (0.9%)	79.40
1-5 Combined	2815	-98.09	38.52	2796 (99.3%)	-227.30	19 (0.7%)	79.40
Control	452	-165.22	43.90	452 (100.0%)	-319.13	0 (0.0%)	N/A[1]

[1]Analysis Group 1 and the Control Group had a negative distance value for all transects.
[2]DSAS classifies 0 as positive net shoreline movement distance value.

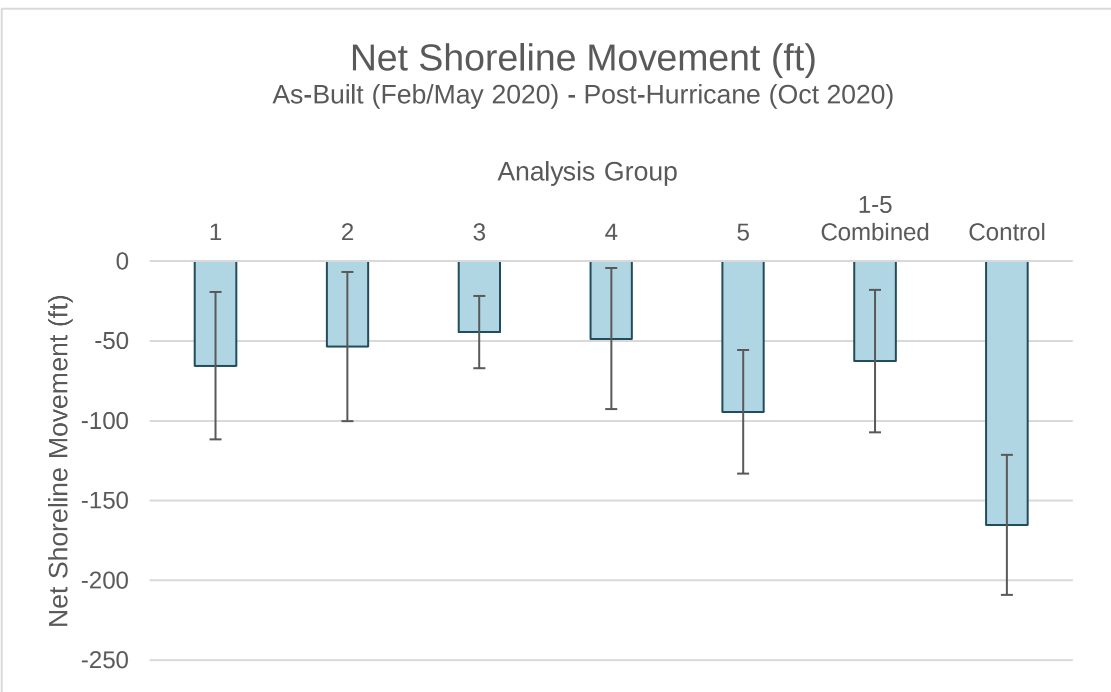

Figure 3-2. Net Shoreline Movement for Each Analysis Group

3.3 Soil Volume Change

A soil volume change assessment was conducted to understand the impacts of Hurricanes Laura and Delta by comparing the Monitoring survey to the As-Built survey. The topographic, bathymetric, and LIDAR data from the As-Built survey were provided to HDR relative to GEOID99 and were converted to GEOID12B to compare to the Monitoring survey data. All Monitoring data was clipped to the As-Built extents, meaning that this soil volume change analysis does not extend far inshore and does not include the Control area. However, the Hurricane Monitoring survey will be used as the baseline moving forward for future analyses.

The survey data was classified according to Analysis Group and location relative to breakwater (i.e., Inshore, Breakwater, and Offshore). Elevation data was spatially joined by station number with a 10-ft limit due to the density of the LIDAR data. The LIDAR survey data from the Monitoring survey was thinned to a grid interval of 10 ft or at elevation changes of 0.5 ft. Any LIDAR data located within 20 ft of topographic and bathymetric survey data points from the Monitoring survey were removed. This removal allowed the topographic and bathymetric data to have priority in creating the surface layers for data analysis.

To analyze the data, elevations from the Monitoring survey were interpolated to make a surface. This task was performed using the Natural Neighbor tool within ArcGIS. The resulting mosaic was then blended to create one continuous surface. Using the "Extract by Point" tool, elevations from the Monitoring survey surface were subsampled using the locations of As-Built point data to retrieve elevation values at the same coordinate for each surveying event. At each transect, As-Built and Monitoring profiles were then plotted (Appendix C). The soil volume change between surveys was then calculated using the average end area method for each Analysis Group. Because Analysis Groups have different coverage areas, a unit volume change in cubic yards per acre has been calculated. Table 3-2, Table 3-3, and Table 3-4 list the volume change for each Analysis Group and Location. The total volume of soil lost from the As-Built to the Monitoring survey for the Inshore and Offshore locations was 426,000 cy, which equates to an average unit volume change of -2,000 cy/acre. The total volume lost for the Inshore locations was 76,000 cy or -1,500 cy/acre. Eastern Analysis Groups (i.e., 1 and 2) showed the greatest inshore erosion while Western Analysis Groups (i.e., 4 and 5) showed the smallest inshore erosion.

Table 3-2. Volume Change Assessment for Inshore Locations

Analysis Group	Length Along Shoreline (ft)	Area (acre)	Volume Change (cy)	Unit Volume Change (cy/acre)	Average Elevation Change (ft)
1	2,502	2.7	-6,937	-2,569	-1.6
2	5,250	13.7	-25,168	-1,837	-1.1
3	4,250	10.7	-15,488	-1,447	-0.9
4	3,351	11.2	-12,261	-1,095	-0.7
5	5,100	13.1	-15,649	-1,195	-0.7
All Groups	**20,453**	**51.45**	**-75,552**	**-1,468**	**-0.9**

Table 3-3. Volume Change Assessment for Breakwater Locations

Analysis Group	Length Along Shoreline (ft)	Area (acre)	Volume Change (cy)	Unit Volume Change (cy/acre)	Average Elevation Change (ft)
1	2,502	4.0	-6,937	-1,734	-1.1
2	5,250	9.0	-16,133	-1,793	-1.1
3	4,250	6.8	-16,456	-2,420	-1.5
4	3,351	5.5	-9,196	-1,672	-1.0
5	5,100	8.5	-16,295	-1,917	-1.2
All Groups	**20,453**	**33.89**	**-65,291**	**-1,927**	**-1.2**

Table 3-4. Volume Change Assessment for Offshore Locations

Analysis Group	Length Along Shoreline (ft)	Area (acre)	Volume Change (acre-ft)	Unit Volume Change (cy/acre)	Average Elevation Change (ft)
1	2,502	20.1	-45,980	-2,288	-1.4
2	5,250	41.4	-73,891	-1,785	-1.1
3	4,250	36.1	-80,989	-2,243	-1.4
4	3,351	27.7	-60,823	-2,196	-1.4
5	5,100	41.0	-89,056	-2,172	-1.3
All Groups	**20,453**	**166.26**	**-350,593**	**-2,109**	**-1.3**

3.4 Settlement

Settlement plate elevation data obtained during the construction surveys, As-Built surveys, and Monitoring surveys were compared. Construction surveys conducted by Patriot captured the settlement plate elevation at the time of installation, periodically throughout construction, and for the As-Built survey. Two settlement values were calculated at each settlement plate location: 1) Settlement between the As-Built survey (May 2020) and Monitoring survey (January 2021); and 2) Settlement between installation (varies between July 2018 and May 2020) and the Monitoring survey (January 2021). The locations of the settlement plates along the constructed breakwater alignment are shown in Figure 3-3, and the computed settlement quantities are listed in Table 3-5. The calculated settlement at the breakwater transects between the As-Built and Monitoring surveys is summarized in Table 3-6.

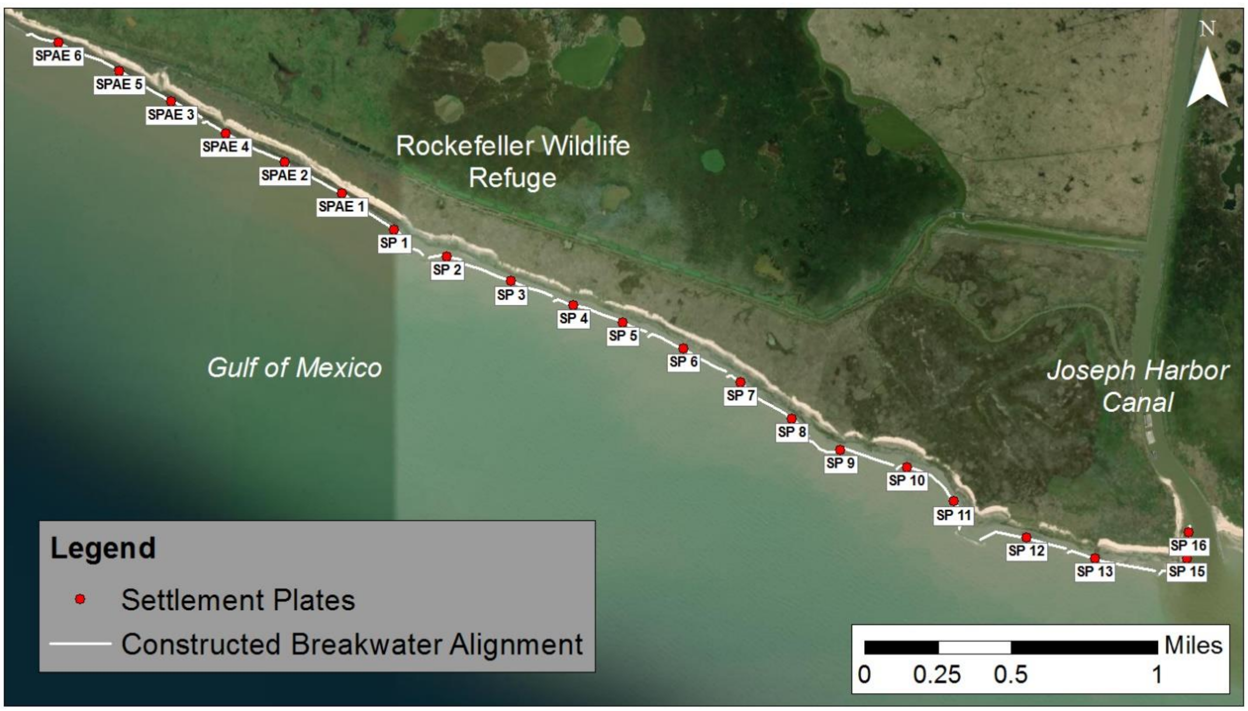

Figure 3-3. Settlement Plate Locations

Table 3-5. Observed Settlement at Settlement Plates

Station	Settlement Plate	Elevation Change Between As-Built and Monitoring Surveys (ft)	Elevation Change Between Installation and Monitoring Survey (ft)
317+41	SPAE 6	-0.86	-1.26
327+97	SPAE 5	-0.69	-1.3
337+32	SPAE 3	-0.72	-1.38

Table 3-5. Observed Settlement at Settlement Plates

Station	Settlement Plate	Elevation Change Between As-Built and Monitoring Surveys (ft)	Elevation Change Between Installation and Monitoring Survey (ft)
347+28	SPAE 4	-0.85	-1.65
357+47	SPAE 2	-0.48	-1.05
367+43	SPAE 1	N/A*	-2.66
377+57	SP 1	-1.09	-1.53
386+85	SP 2	+0.52	+0.11
397+55	SP 3	-0.53	-1.81
408+01	SP 4	-0.41	-1.75
416+09	SP 5	-0.51	-1.38
426+45	SP 6	-0.42	-1.42
436+76	SP 7	-0.49	-1.80
446+50	SP 8	-0.39	-1.33
455+58	SP 9	-0.51	-1.12
466+09	SP 10	-0.74	-1.78
474+98	SP 11	-0.42	-2.27
487+81	SP 12	-0.29	-2.46
498+78	SP 13	-0.54	-2.22
514+04	SP 15	-0.41	-1.61
518+02	SP 16	-0.48	-2.03

*Settlement plate was marked “disturbed” during As-Built survey.

Figure 3-4 shows the settlement between the As-Built and Monitoring surveys at each settlement plate and the corresponding breakwater elevation changes. One settlement plate showed no settlement, 18 settlement plates showed settlement between 0 and 1 ft, and two settlement plates showed settlement between 1 and 2 ft. The greatest amount of settlement experienced between the As-Built and Monitoring surveys was 1.09 ft at SP1.

In addition to using settlement plate data, the average elevation change along the breakwater extents of each transect was calculated. If the average breakwater elevation change is similar to nearby settlement values, the amount of riprap displaced from the breakwater is likely minimal.

Ninety-eight breakwater transects were surveyed. Of this total, 34 transects showed elevation change between 0 and -1 ft, 57 transects showed elevation change between -1 and -2 ft, and 6 transects showed elevation change exceeding -2 ft. One transect showed no elevation change. The maximum elevation change observed between the As-Built and Monitoring surveys was -2.64 ft at Station 415+01.The elevation change of the breakwater is generally higher than the settlement plate elevation change which indicates there may have been some minimal movement of riprap. Since the majority of the structure appears to be intact, no corrective actions are recommended at this time. Future monitoring should continue to assess the structure integrity.

Table 3-6. Elevation Change at Breakwater

Station	Elevation Change (ft)	Station	Elevation Change (ft)	Station	Elevation Change (ft)
313+00	-1.30	379+01	-1.24	457+01	-0.94
314+50	-1.85	382+51	-1.95	457+51	-0.81
317+00	-1.79	385+01	-2.17	460+01	-1.30
319+50	-0.98	386+01	-0.20	462+51	-0.85
322+00	-1.31	390+01	-0.02	465+01	-0.87
324+50	-1.02	392+51	-1.18	467+51	-1.16
326+79	-1.26	395+01	-0.55	470+01	-0.95
327+87	-1.66	397+51	-1.53	472+51	-0.40
329+48	-1.33	400+01	-2.13	475+01	-1.79
330+50	-1.33	402+51	-1.00	476+01	-1.03
333+00	-0.29	405+01	-1.93	478+00	-0.53
335+50	-2.26	407+51	-0.60	480+01	-1.43
338+00	-1.12	410+01	-1.68	482+02	-1.33
340+50	-1.62	414+51	-1.42	483+01	-0.70
343+30	-0.74	415+01	-2.64	484+01	-2.01
343+80	1.29	417+51	-1.62	485+01	-1.95
345+00	-0.80	422+51	-2.19	487+51	-1.25
346+50	-0.22	425+01	-1.47	490+01	-1.61
349+00	-1.36	427+51	-0.53	492+51	-1.25
351+50	-1.38	430+01	-0.91	495+01	-1.39
354+00	-1.16	432+51	-0.98	497+51	-1.33
356+50	-1.12	435+01	-1.60	500+01	-1.30
358+32	-1.35	437+51	-1.82	502+50	-1.16
360+20	-1.27	440+01	-1.43	505+00	-1.05
361+50	-0.89	442+51	-0.84	507+50	-0.88
364+00	-1.10	445+01	-0.84	510+00	-1.02
366+50	-1.60	447+51	-0.96	511+46	-1.92
368+55	-0.77	449+01	-1.77	512+17	-1.40

Table 3-6. Elevation Change at Breakwater

Station	Elevation Change (ft)	Station	Elevation Change (ft)	Station	Elevation Change (ft)
371+71	-0.22	450+01	-1.32	512+63	-1.63
372+51	-0.86	451+02	-0.75	513+10	-0.78
375+01	-1.44	453+03	-0.94	515+35	-0.19
377+51	-0.89	455+01	-1.12	517+53	-0.70
378+51	-1.58	456+01	-1.40		

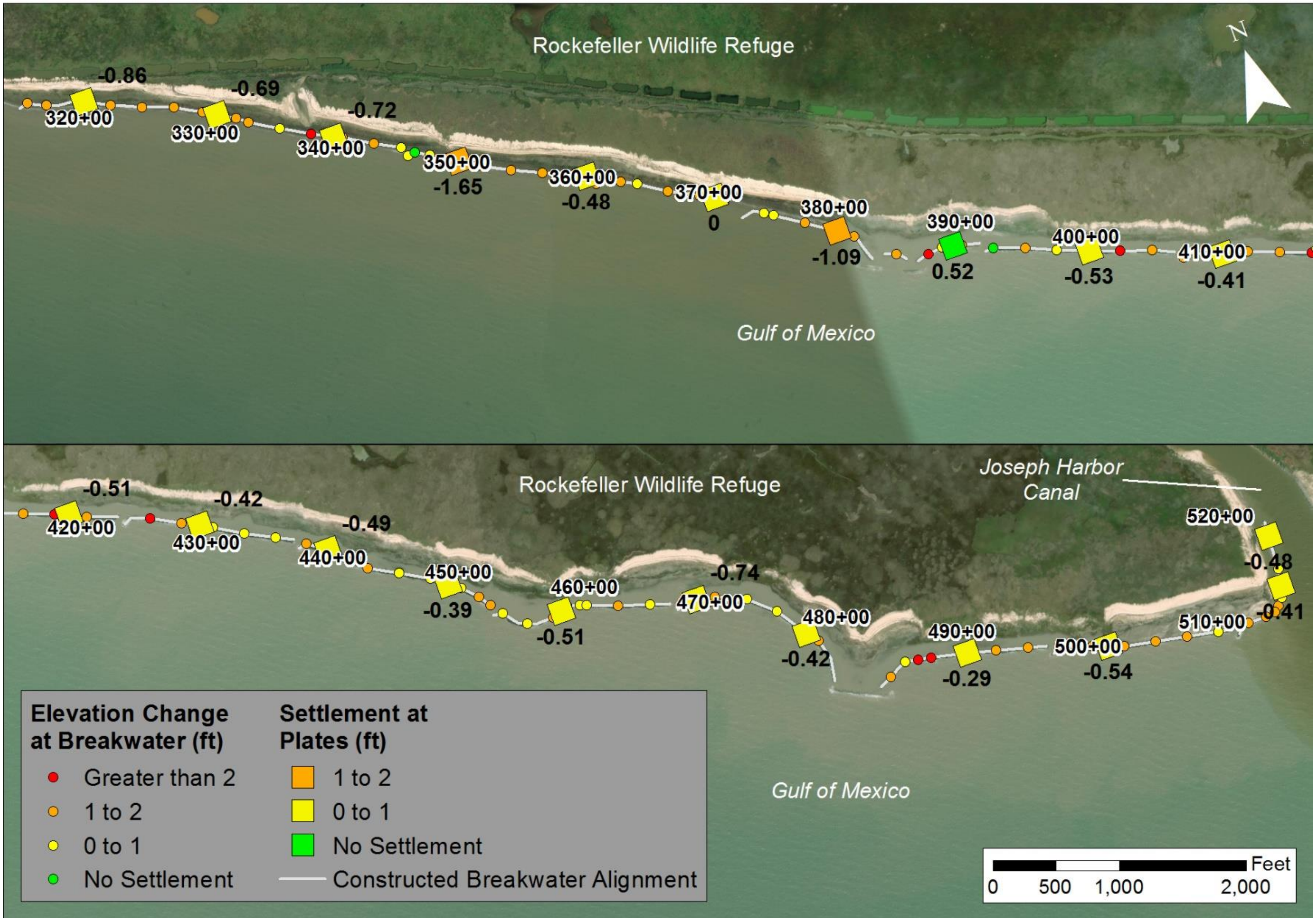

Figure 3-4. Elevation Change at Breakwater vs. Settlement at Settlement Plates (ft)

A demonstration project which included a LWAC breakwater was constructed at the site in April 2010 before the full ME-0018 project was constructed. HDR performed geotechnical analyses on the demonstration project settlement plate data in October 2011 and April 2014. The results indicated an average settlement of 2.7 ft at the demonstration project over the 4 years from installation to the 2014 analysis. The full ME-0018 project was constructed between July 2018 and January 2020 with settlement plates installed throughout that timeframe as the breakwater was constructed. Each of the settlement plates from the full ME-0018 project were surveyed again in January 2021 as part of the current monitoring providing a range of settlement data from 12 to 30 months, depending on installation time. Figure 3-5 shows the maximum and minimum measured settlement values as shades for both the demonstration project and the full ME-0018 project relative to time since settlement plate installation. Also included is the predicted settlement curve used during design over the project's 20-yr design life. All settlement plates installed during the full ME-0018 construction project and all breakwater transects compared between the As-Built and Monitoring surveys show less settlement than what was estimated during design. This indicates that the breakwater is settling as anticipated, or better than anticipated.

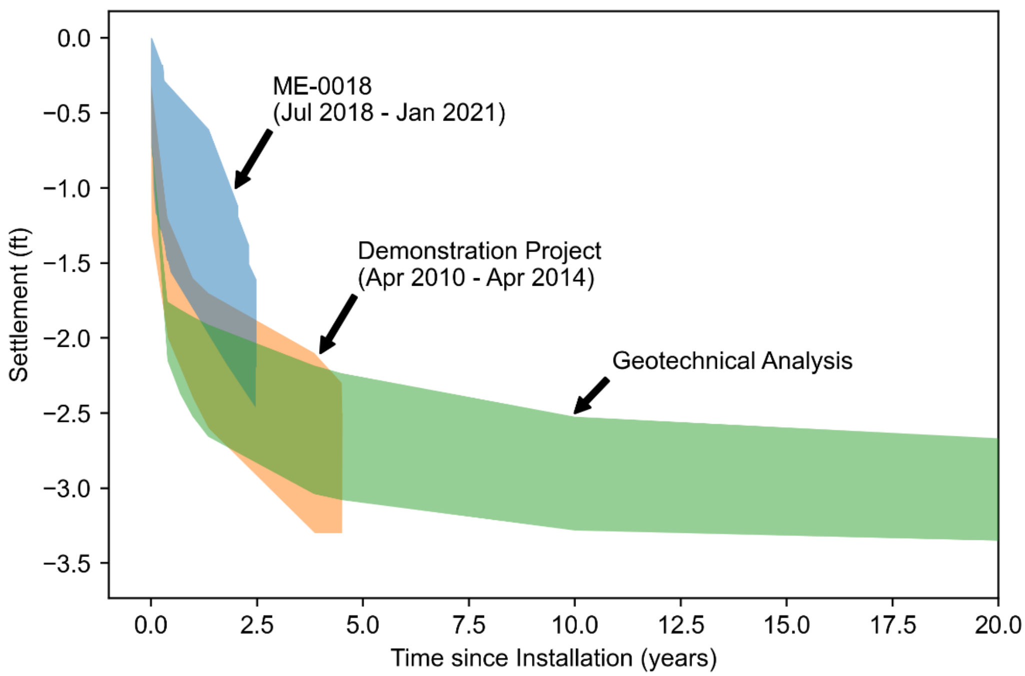

Figure 3-5. Settlement at ME-0018 compared to the LWAC demonstration project and geotechnical analysis.

3.5 Toe Scour Assessment

A toe scour assessment was performed. The offshore As-Built and Monitoring survey lines at each transect were sampled at 1 ft horizontal spacings and the elevation change was calculated at each sampled point. The standard deviation of the offshore elevation change values at each transect was then computed. A high standard deviation indicates that the elevation change values along a transect are spread out over a wider range, suggesting the presence of noticeable erosion or deposition relative to the mean offshore elevation change.

Figure 3-6 shows the standard deviation of each transect. The transects with the highest standard deviations (i.e., greater than 0.8 ft) mostly lie at the mouth of Joseph Harbor Canal where offshore erosion (away from breakwater toe within the canal) has been observed. Transects toward the center of the breakwater segments typically showed lower standard deviation values due to the greater protection from erosion with values ranging from 0 to 0.8 ft. Review of the transects did not indicate any significant toe scour near the breakwater. See Appendix C for As-Built and Monitoring Transect Plots.

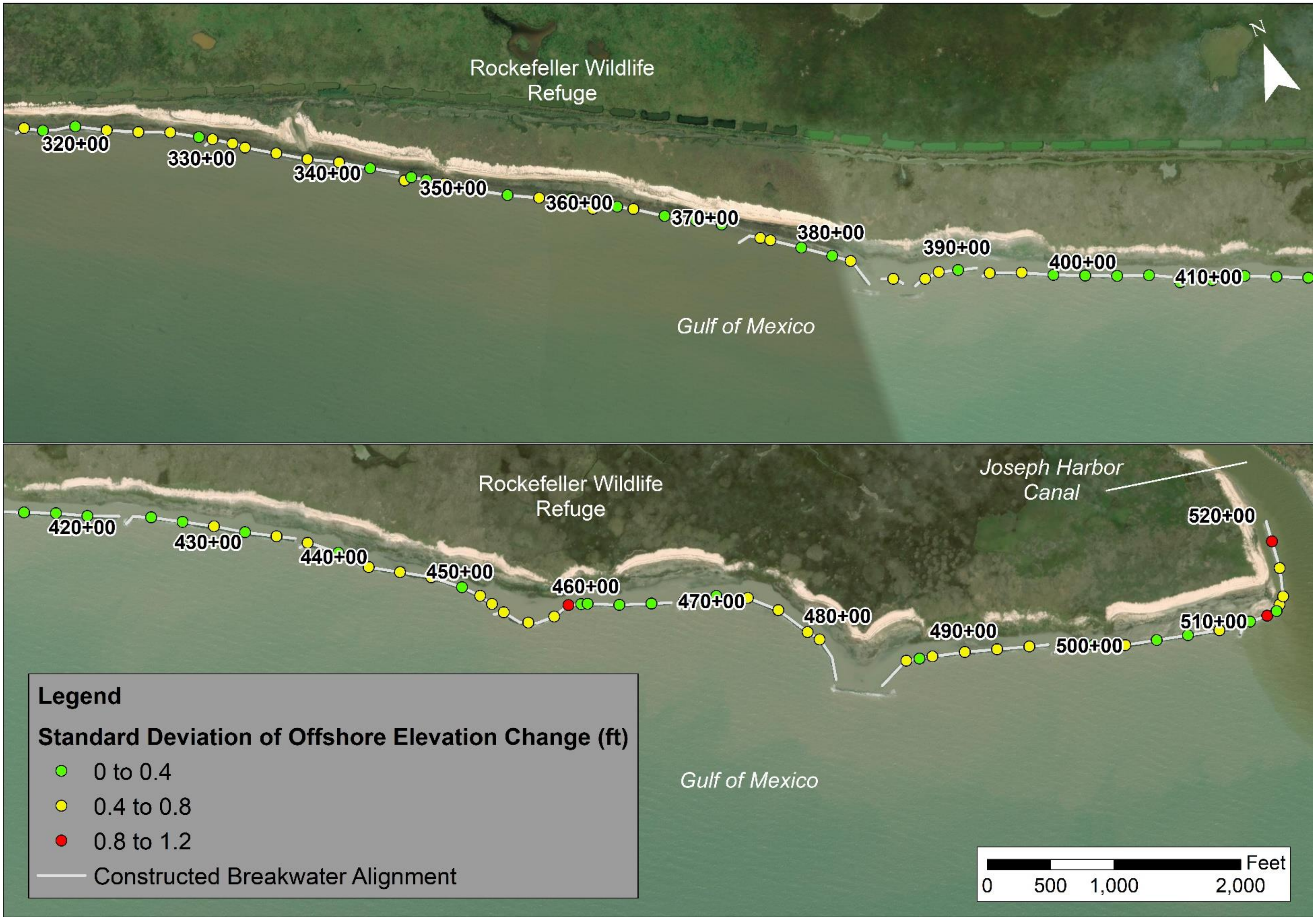

Figure 3-6. Standard Deviation of Offshore Scour (ft)

4 Conclusions and Recommendations

Based on the results of the Post-Hurricane Monitoring analysis, no major structural defects (i.e., excessive settlement, detrimental erosion, and noticeable movement of riprap) has been observed. Therefore, no structural corrective action is currently recommended. The breakwater performed as intended despite being impacted by two major hurricanes within two months. The Control Group experienced considerable shoreline and soil volume loss relative to the project location. This result indicates that the coastline would have experienced a much higher amount of erosion without the ME-0018 project. It is recommended that the lighted daybeacons that were damaged during Hurricanes Laura and Delta be repaired or replaced as needed. Monitoring of the condition of the breakwater, warning signs, and lighted daybeacons after all major storm events is recommended.

5 References

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Himmelstoss, E.A., Henderson, R.E., Kratzmann, M.G., and Farris, A.S., 2018, Digital Shoreline Analysis System (DSAS) version 5.0 user guide: U.S. Geological Survey Open-File Report 2018–1179, 110 p., https://doi.org/10.3133/ofr20181179.

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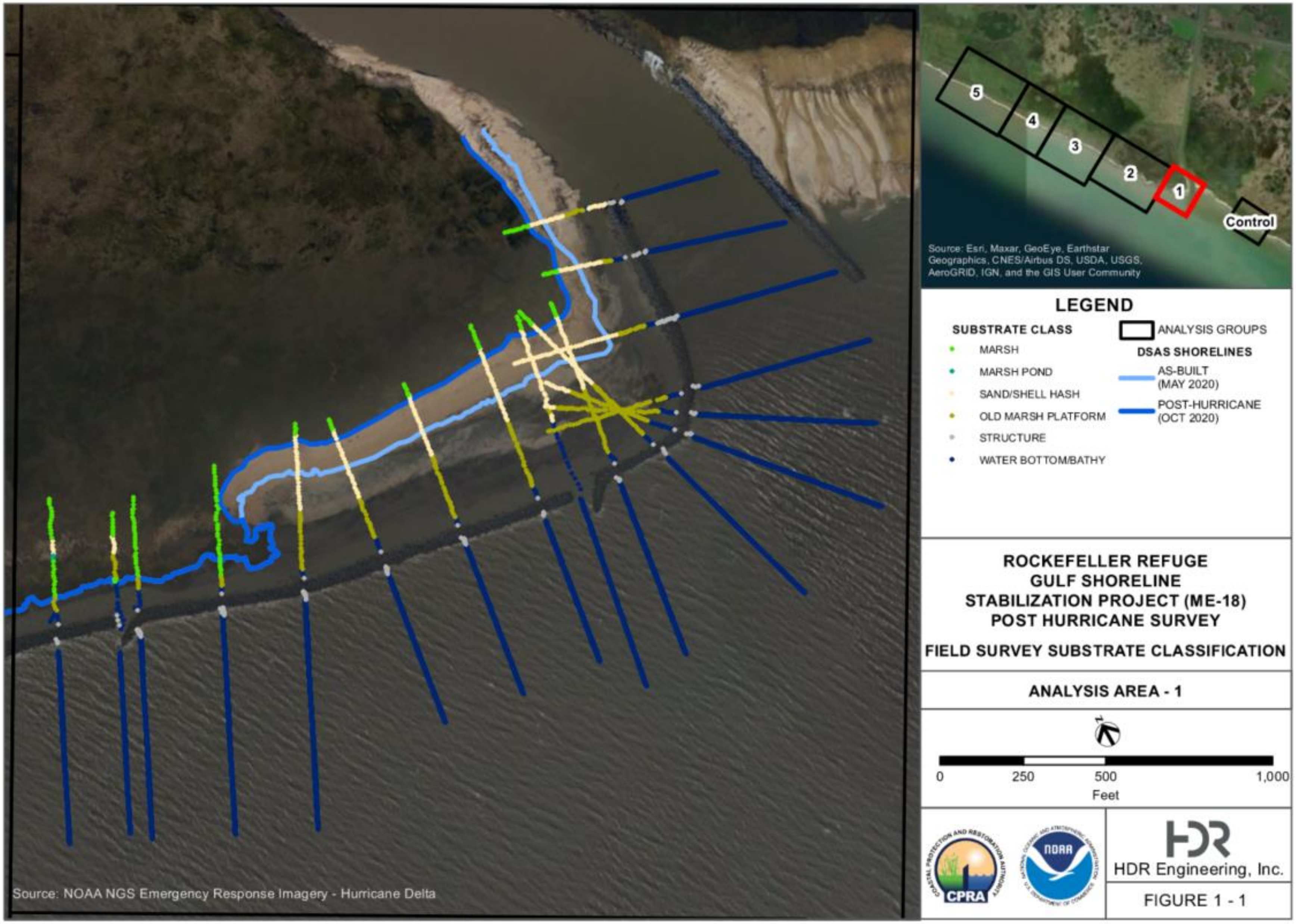
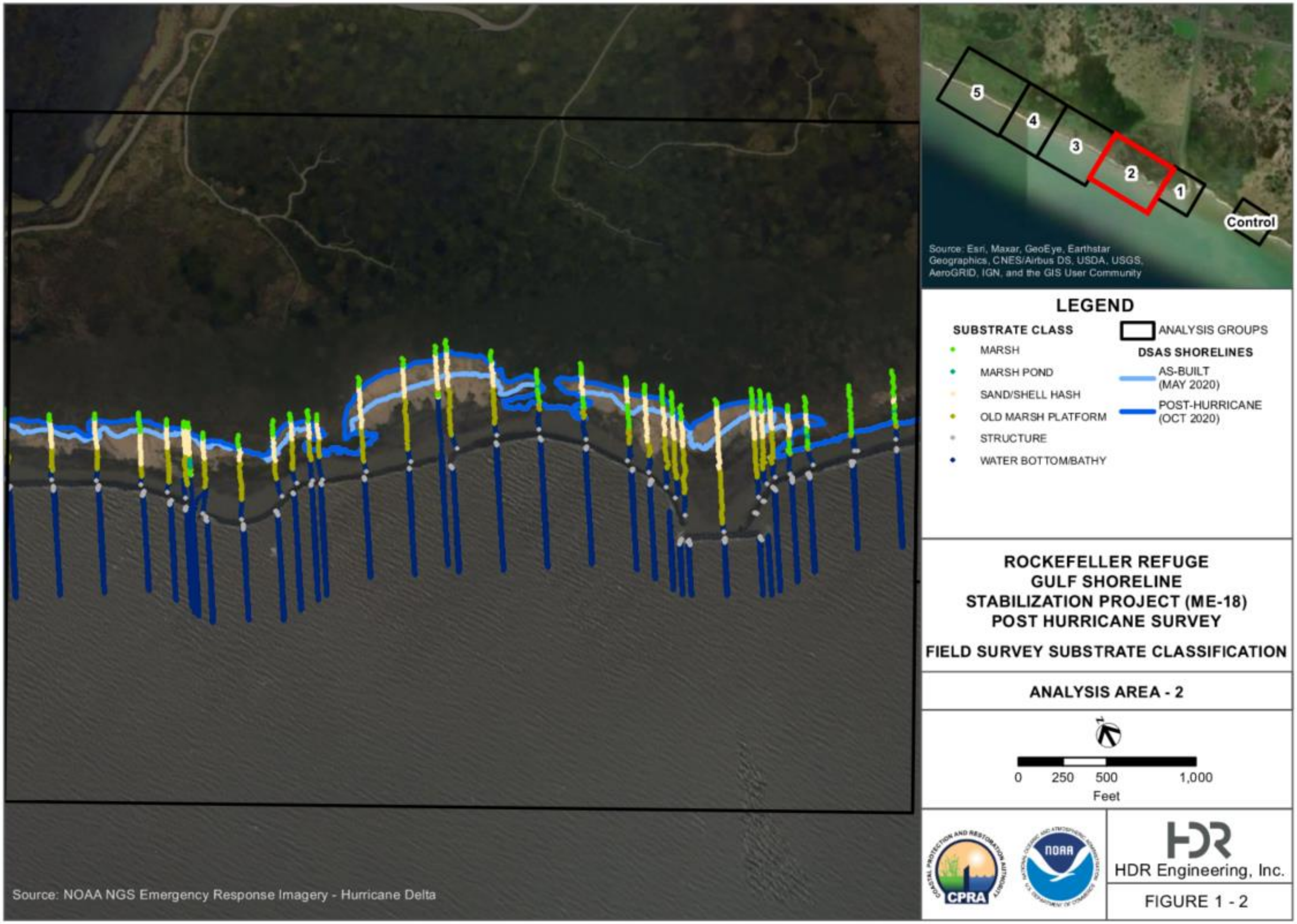
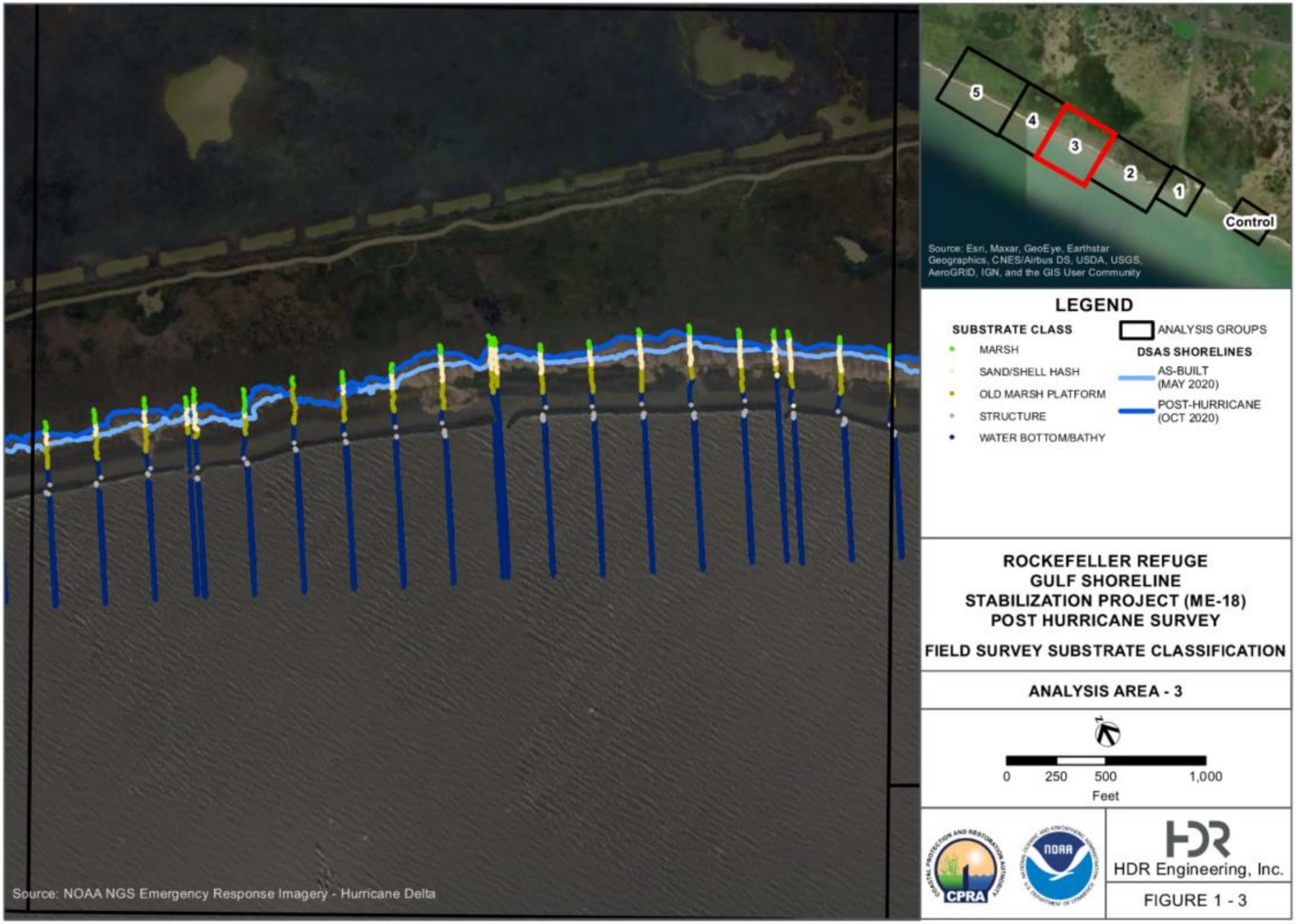
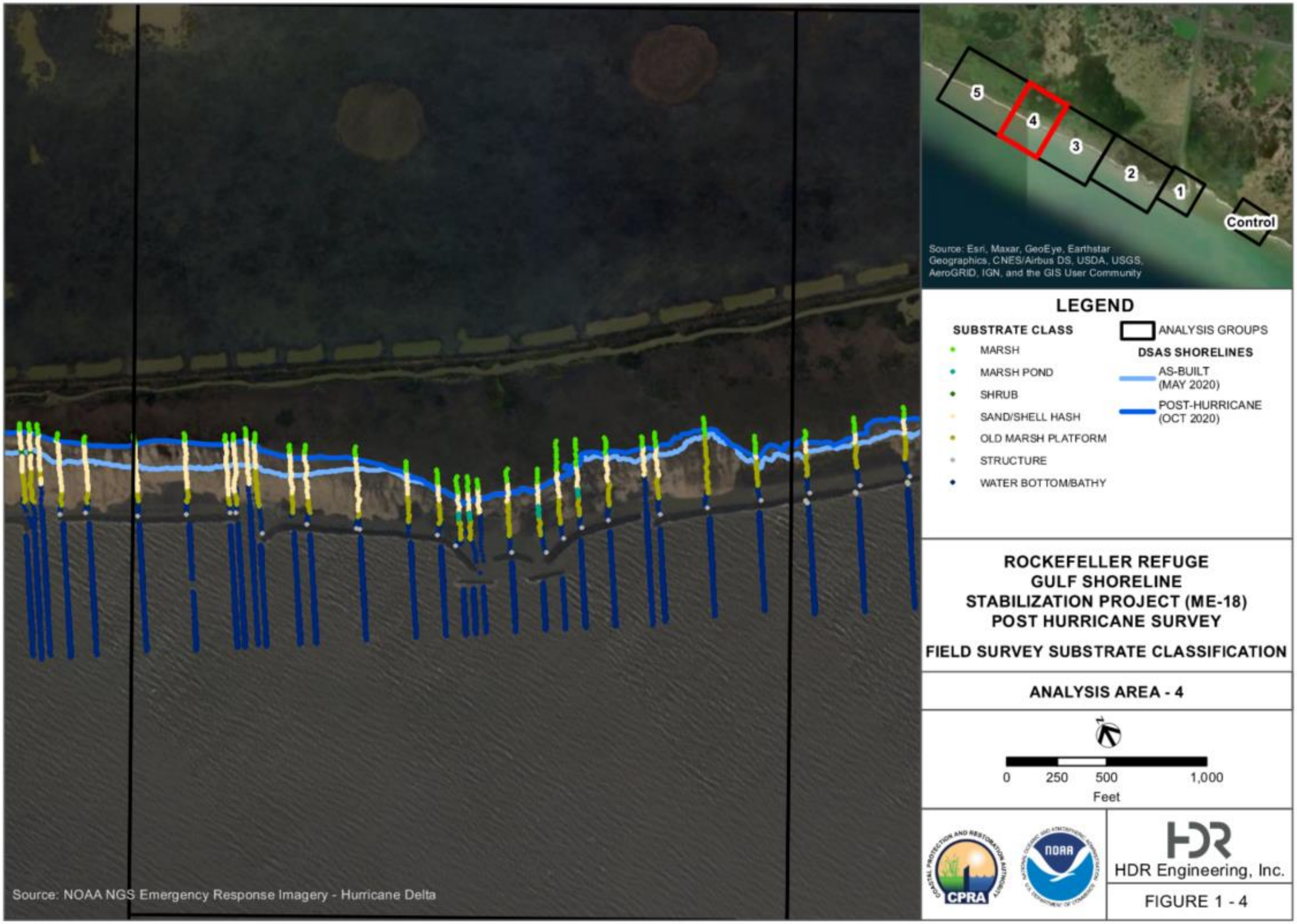
USGS, 2013. Rockefeller Refuge Gulf Shoreline Stabilization (ME-18), Shoreline Change Rate from 1998 to 2010. (Map Date April 1, 2013).

Appendix A. Field Survey Substrate Classification Figures


Source: NOAA NGS Emergency Response Imagery - Hurricane Delta
5
4
3
2
1
Control
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
LEGEND
SUBSTRATE CLASS
MARSH
MARSH POND
SAND/SHELL HASH
OLD MARSH PLATFORM
STRUCTURE
WATER BOTTOM/BATHY
ANALYSIS GROUPS
DSAS SHORELINES
AS-BUILT (MAY 2020)
POST-HURRICANE (OCT 2020)
ROCKEFELLER REFUGE GULF SHORELINE STABILIZATION PROJECT (ME-18) POST HURRICANE SURVEY
FIELD SURVEY SUBSTRATE CLASSIFICATION
ANALYSIS AREA - 1
0
250
500
1,000
Feet
HDR Engineering, Inc.
FIGURE 1 - 1


5
4
3
2
1
Control
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
LEGEND
SUBSTRATE CLASS
MARSH
MARSH POND
SAND/SHELL HASH
OLD MARSH PLATFORM
STRUCTURE
WATER BOTTOM/BATHY
ANALYSIS GROUPS
DSAS SHORELINES
AS-BUILT (MAY 2020)
POST-HURRICANE (OCT 2020)
ROCKEFELLER REFUGE
GULF SHORELINE
STABILIZATION PROJECT (ME-18)
POST HURRICANE SURVEY
FIELD SURVEY SUBSTRATE CLASSIFICATION
ANALYSIS AREA - 2
0 250 500 1,000
Feet
CPRA
NOAA
HDR Engineering, Inc.
FIGURE 1 - 2
Source: NOAA NGS Emergency Response Imagery - Hurricane Delta


Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
5
4
3
2
1
Control
LEGEND
SUBSTRATE CLASS
MARSH
SAND/SHELL HASH
OLD MARSH PLATFORM
STRUCTURE
WATER BOTTOM/BATHY
ANALYSIS GROUPS
DSAS SHORELINES
AS-BUILT (MAY 2020)
POST-HURRICANE (OCT 2020)
ROCKEFELLER REFUGE GULF SHORELINE STABILIZATION PROJECT (ME-18) POST HURRICANE SURVEY
FIELD SURVEY SUBSTRATE CLASSIFICATION
ANALYSIS AREA - 3
0
250
500
1,000
Feet
HDR Engineering, Inc.
FIGURE 1 - 3
Source: NOAA NGS Emergency Response Imagery - Hurricane Delta


5
4
3
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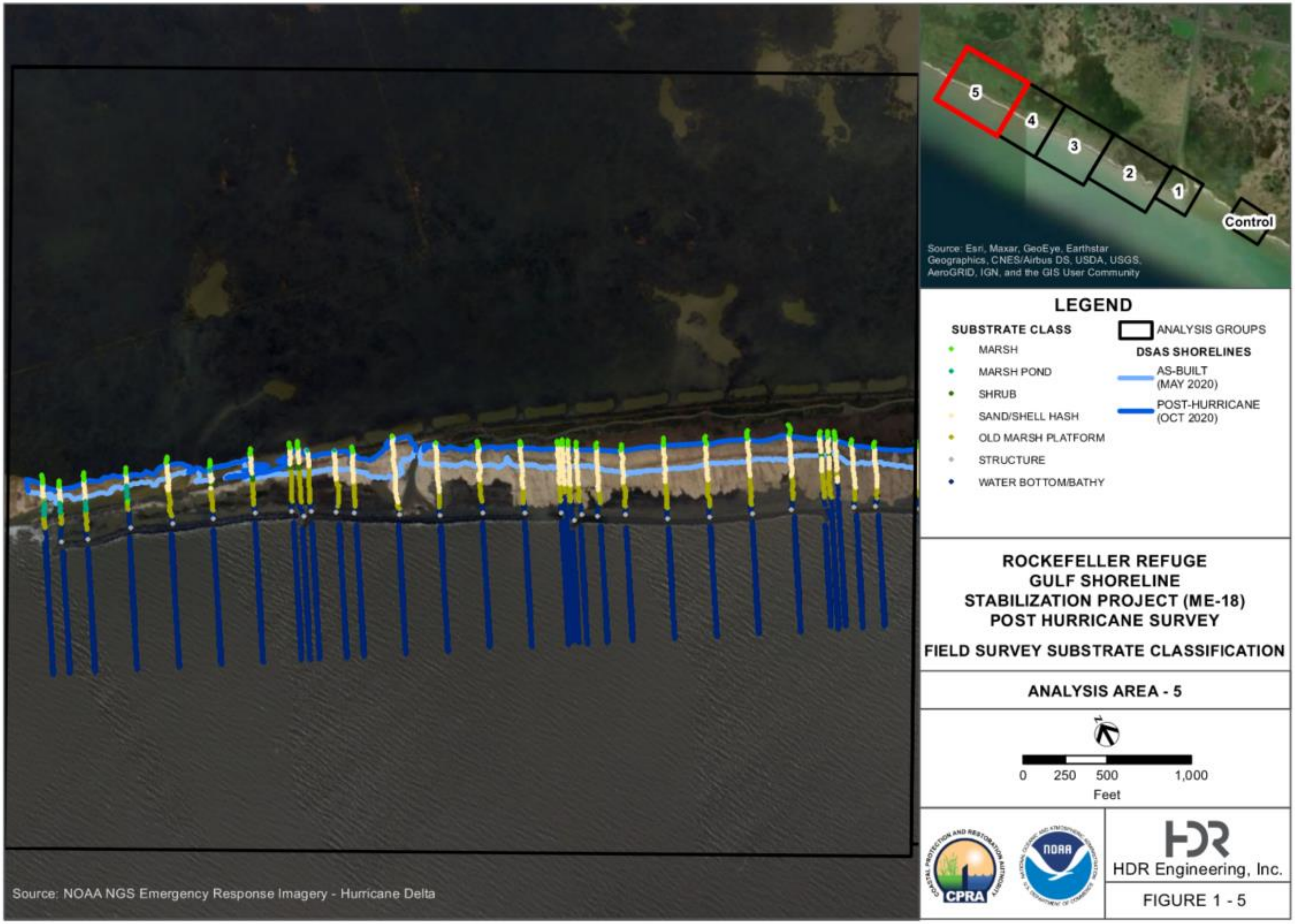
1
Control
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
LEGEND
SUBSTRATE CLASS
MARSH
MARSH POND
SHRUB
SAND/SHELL HASH
OLD MARSH PLATFORM
STRUCTURE
WATER BOTTOM/BATHY
ANALYSIS GROUPS
DSAS SHORELINES
AS-BUILT (MAY 2020)
POST-HURRICANE (OCT 2020)
ROCKEFELLER REFUGE GULF SHORELINE STABILIZATION PROJECT (ME-18) POST HURRICANE SURVEY
FIELD SURVEY SUBSTRATE CLASSIFICATION
ANALYSIS AREA - 4
0 250 500 1,000
Feet
CPRA
NOAA
HDR Engineering, Inc.
FIGURE 1 - 4
Source: NOAA NGS Emergency Response Imagery - Hurricane Delta


5
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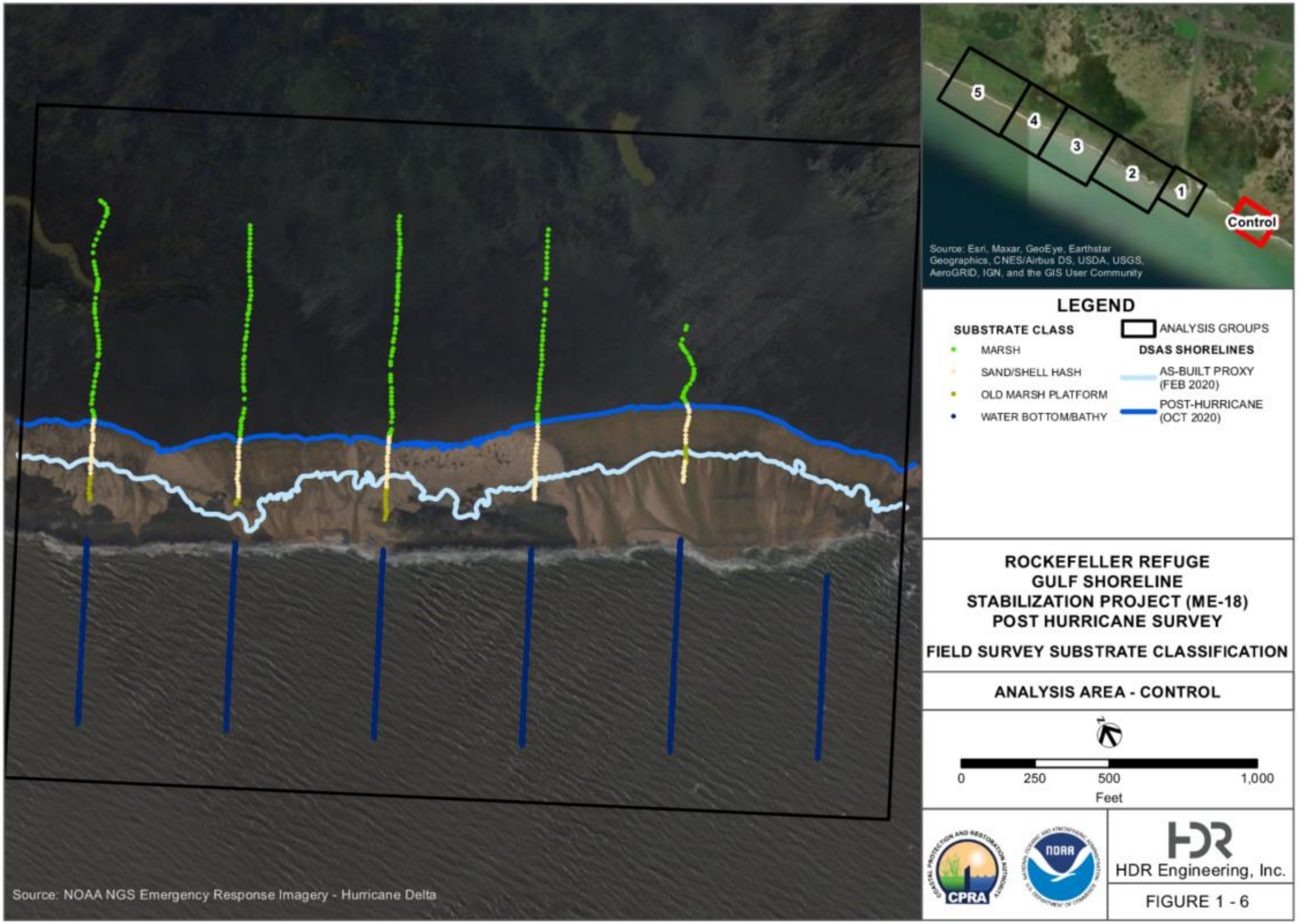
Control
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
LEGEND
SUBSTRATE CLASS
MARSH
MARSH POND
SHRUB
SAND/SHELL HASH
OLD MARSH PLATFORM
STRUCTURE
WATER BOTTOM/BATHY
ANALYSIS GROUPS
DSAS SHORELINES
AS-BUILT (MAY 2020)
POST-HURRICANE (OCT 2020)
ROCKEFELLER REFUGE
GULF SHORELINE
STABILIZATION PROJECT (ME-18)
POST HURRICANE SURVEY
FIELD SURVEY SUBSTRATE CLASSIFICATION
ANALYSIS AREA - 5
0 250 500 1,000
Feet
CPRA
NOAA
HDR Engineering, Inc.
FIGURE 1 - 5
Source: NOAA NGS Emergency Response Imagery - Hurricane Delta


Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
5
4
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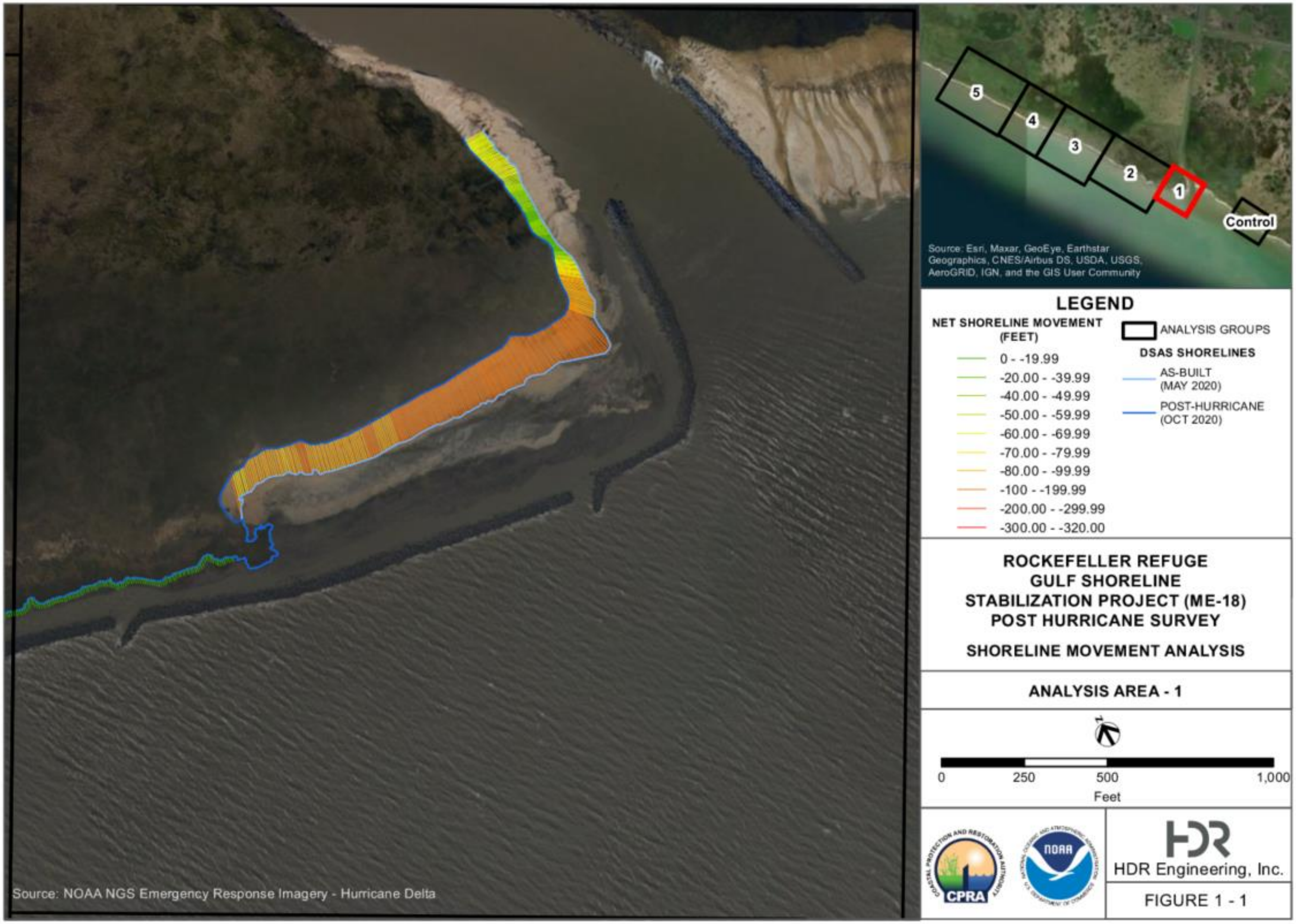
Control
LEGEND
SUBSTRATE CLASS
MARSH
SAND/SHELL HASH
OLD MARSH PLATFORM
WATER BOTTOM/BATHY
ANALYSIS GROUPS
DSAS SHORELINES
AS-BUILT PROXY (FEB 2020)
POST-HURRICANE (OCT 2020)
ROCKEFELLER REFUGE GULF SHORELINE STABILIZATION PROJECT (ME-18) POST HURRICANE SURVEY
FIELD SURVEY SUBSTRATE CLASSIFICATION
ANALYSIS AREA - CONTROL
0
250
500
1,000
Feet
CPRA
NOAA
HDR Engineering, Inc.
FIGURE 1 - 6
Source: NOAA NGS Emergency Response Imagery - Hurricane Delta

Appendix B. Shoreline Movement Analysis Figures


Source: NOAA NGS Emergency Response Imagery - Hurricane Delta
5
4
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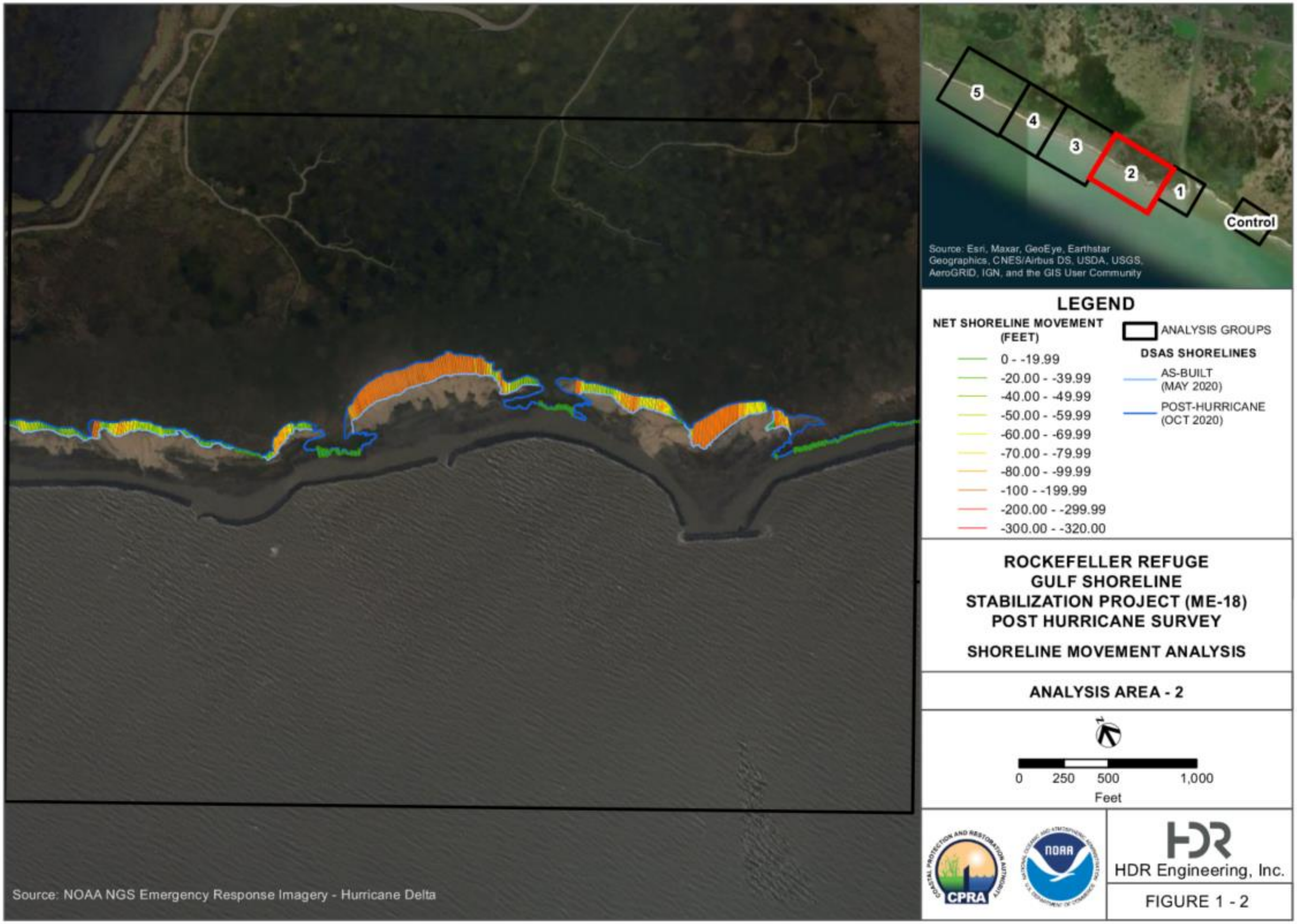
2
1
Control
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
LEGEND
NET SHORELINE MOVEMENT (FEET)
0 - -19.99
-20.00 - -39.99
-40.00 - -49.99
-50.00 - -59.99
-60.00 - -69.99
-70.00 - -79.99
-80.00 - -99.99
-100 - -199.99
-200.00 - -299.99
-300.00 - -320.00
ANALYSIS GROUPS
DSAS SHORELINES
AS-BUILT (MAY 2020)
POST-HURRICANE (OCT 2020)
ROCKEFELLER REFUGE GULF SHORELINE STABILIZATION PROJECT (ME-18) POST HURRICANE SURVEY
SHORELINE MOVEMENT ANALYSIS
ANALYSIS AREA - 1
N
0
250
500
1,000
Feet
CPRA
NOAA
HDR Engineering, Inc.

FIGURE 1 - 1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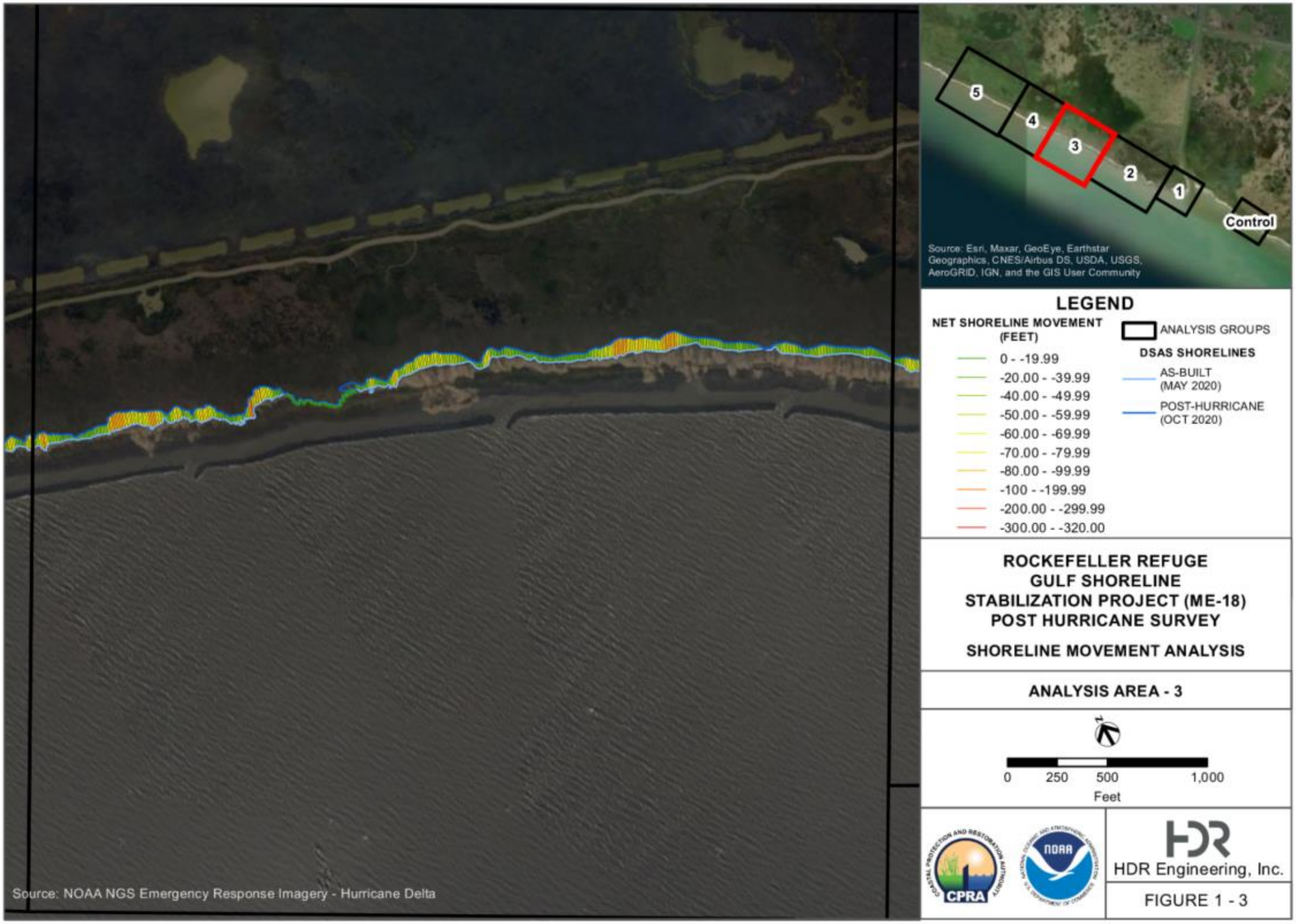
Control
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
LEGEND
NET SHORELINE MOVEMENT (FEET)
0 - -19.99
-20.00 - -39.99
-40.00 - -49.99
-50.00 - -59.99
-60.00 - -69.99
-70.00 - -79.99
-80.00 - -99.99
-100 - -199.99
-200.00 - -299.99
-300.00 - -320.00
ANALYSIS GROUPS
DSAS SHORELINES
AS-BUILT (MAY 2020)
POST-HURRICANE (OCT 2020)
ROCKEFELLER REFUGE GULF SHORELINE STABILIZATION PROJECT (ME-18) POST HURRICANE SURVEY
SHORELINE MOVEMENT ANALYSIS
ANALYSIS AREA - 2
0 250 500 1,000
Feet
CPRA
NOAA
HDR Engineering, Inc.
FIGURE 1 - 2
Source: NOAA NGS Emergency Response Imagery - Hurricane Delta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Control
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
LEGEND
NET SHORELINE MOVEMENT (FEET)
0 - -19.99
-20.00 - -39.99
-40.00 - -49.99
-50.00 - -59.99
-60.00 - -69.99
-70.00 - -79.99
-80.00 - -99.99
-100 - -199.99
-200.00 - -299.99
-300.00 - -320.00
ANALYSIS GROUPS
DSAS SHORELINES
AS-BUILT (MAY 2020)
POST-HURRICANE (OCT 2020)
ROCKEFELLER REFUGE GULF SHORELINE STABILIZATION PROJECT (ME-18) POST HURRICANE SURVEY
SHORELINE MOVEMENT ANALYSIS
ANALYSIS AREA - 3
0
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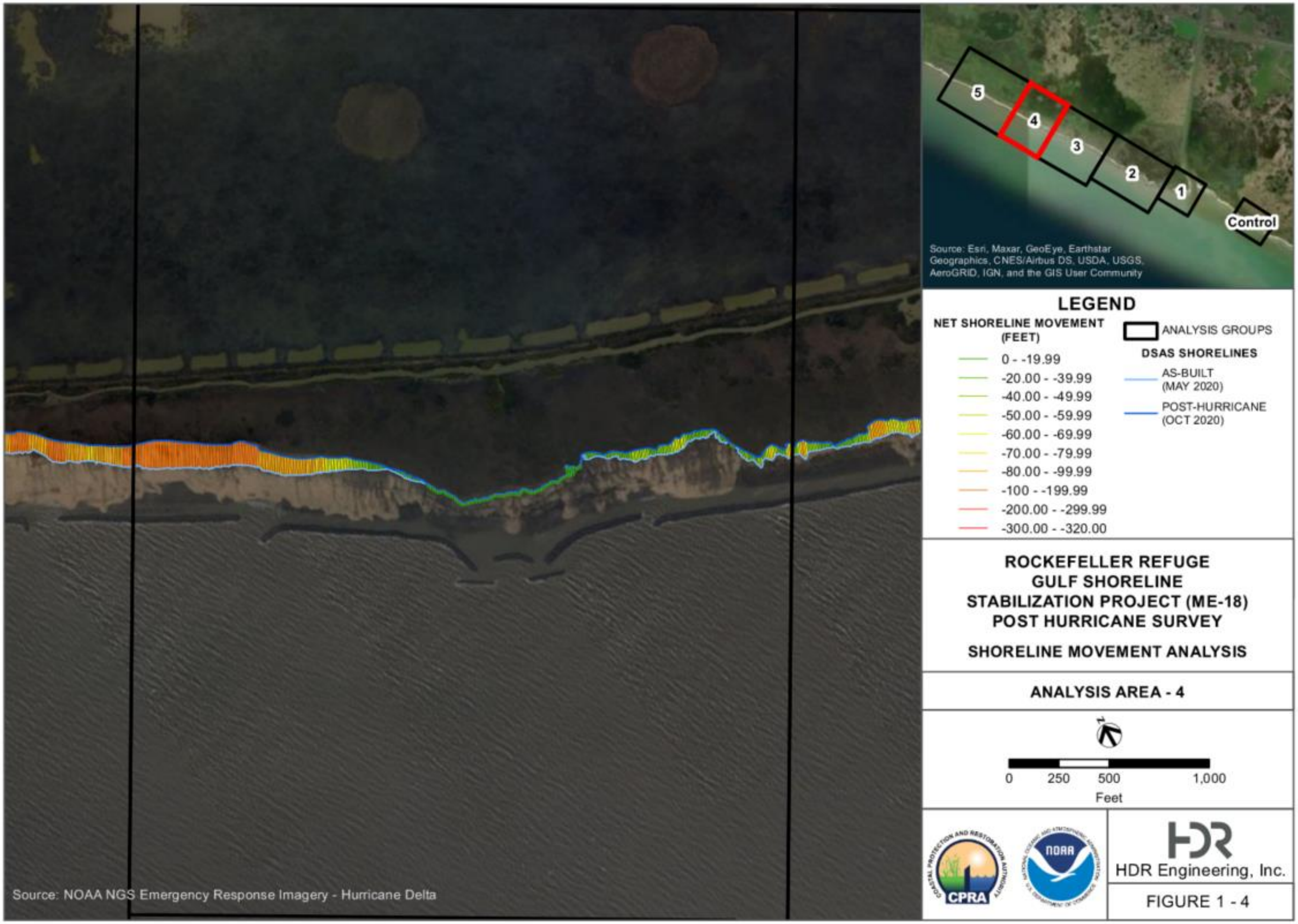
1,000
Feet
CPRA
NOAA
HDR Engineering, Inc.
FIGURE 1 - 3
Source: NOAA NGS Emergency Response Imagery - Hurricane Delta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Control
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
LEGEND
NET SHORELINE MOVEMENT (FEET)
0 - -19.99
-20.00 - -39.99
-40.00 - -49.99
-50.00 - -59.99
-60.00 - -69.99
-70.00 - -79.99
-80.00 - -99.99
-100 - -199.99
-200.00 - -299.99
-300.00 - -320.00
ANALYSIS GROUPS
DSAS SHORELINES
AS-BUILT (MAY 2020)
POST-HURRICANE (OCT 2020)
ROCKEFELLER REFUGE GULF SHORELINE STABILIZATION PROJECT (ME-18) POST HURRICANE SURVEY
SHORELINE MOVEMENT ANALYSIS
ANALYSIS AREA - 4
0
250
500
1,000
Feet
CPRA
NOAA
HDR Engineering, Inc.
FIGURE 1 - 4
Source: NOAA NGS Emergency Response Imagery - Hurricane Delta


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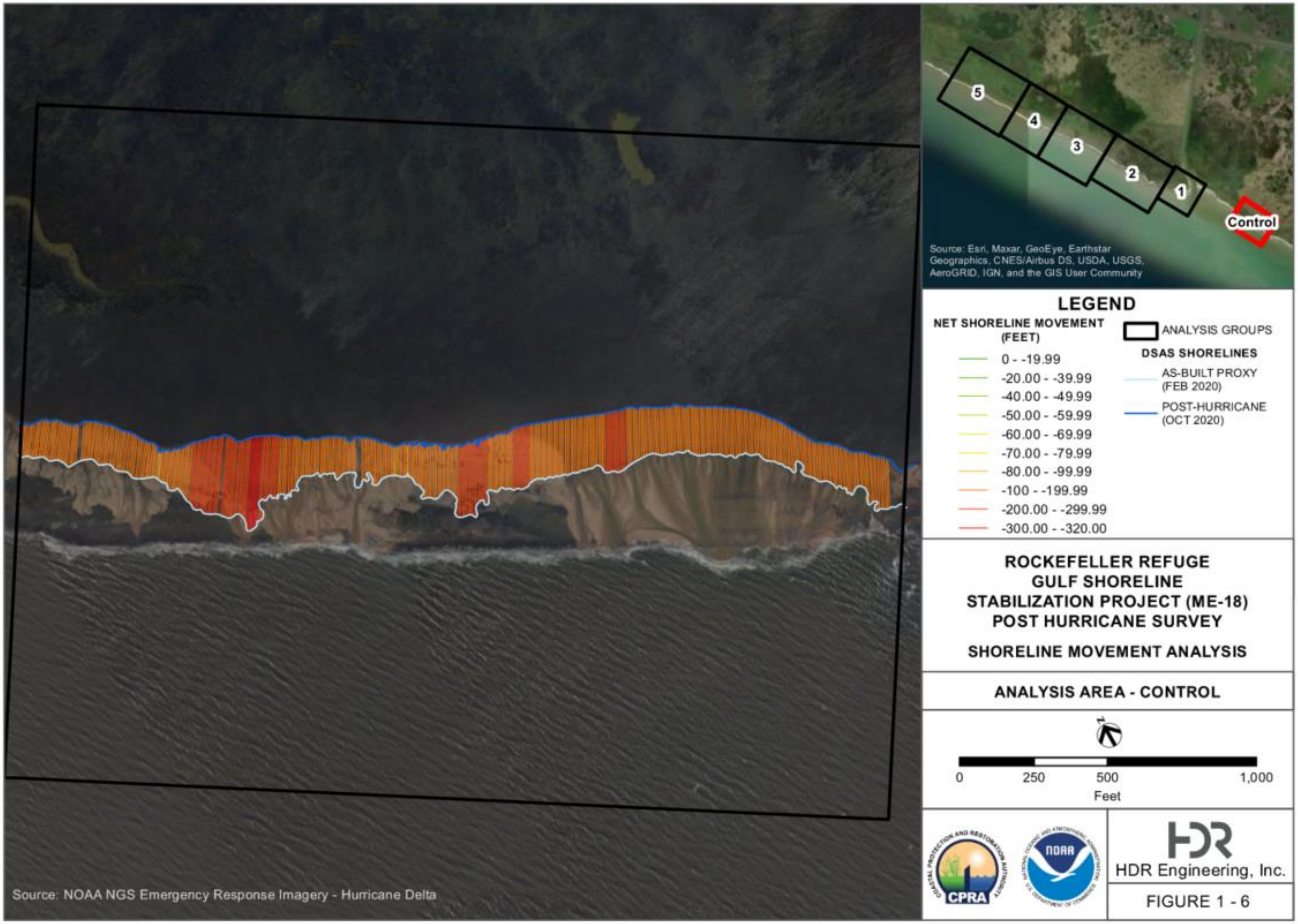
Control
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
LEGEND
NET SHORELINE MOVEMENT (FEET)
0 - -19.99
-20.00 - -39.99
-40.00 - -49.99
-50.00 - -59.99
-60.00 - -69.99
-70.00 - -79.99
-80.00 - -99.99
-100 - -199.99
-200.00 - -299.99
-300.00 - -320.00
ANALYSIS GROUPS
DSAS SHORELINES
AS-BUILT (MAY 2020)
POST-HURRICANE (OCT 2020)
ROCKEFELLER REFUGE
GULF SHORELINE
STABILIZATION PROJECT (ME-18)
POST HURRICANE SURVEY
SHORELINE MOVEMENT ANALYSIS
ANALYSIS AREA - 5
0 250 500 1,000
Feet
CPRA
NOAA
HDR Engineering, Inc.
FIGURE 1 - 5
Source: NOAA NGS Emergency Response Imagery - Hurricane Delta


5
4
3
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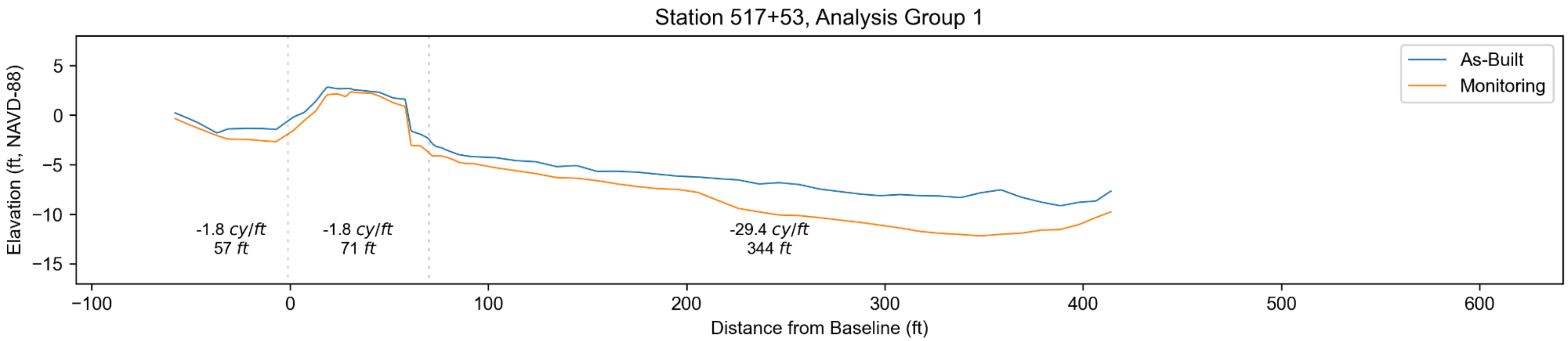
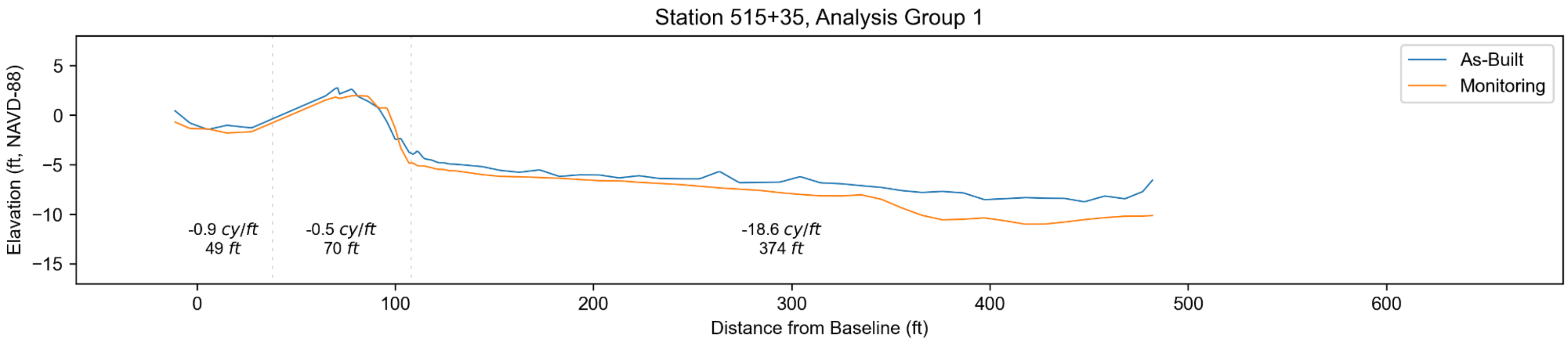
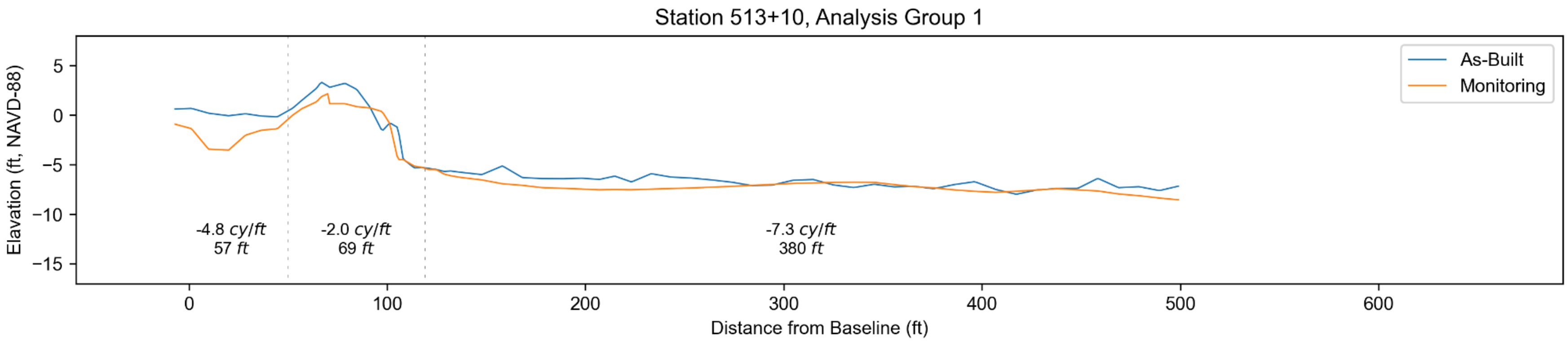
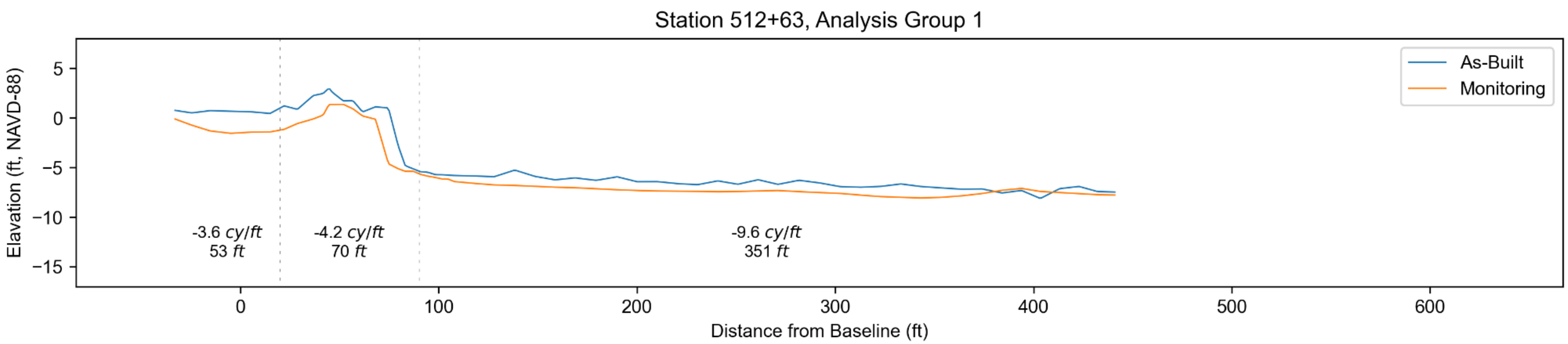
1
Control
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
LEGEND
NET SHORELINE MOVEMENT (FEET)
0 - -19.99
-20.00 - -39.99
-40.00 - -49.99
-50.00 - -59.99
-60.00 - -69.99
-70.00 - -79.99
-80.00 - -99.99
-100 - -199.99
-200.00 - -299.99
-300.00 - -320.00
ANALYSIS GROUPS
DSAS SHORELINES
AS-BUILT PROXY (FEB 2020)
POST-HURRICANE (OCT 2020)
ROCKEFELLER REFUGE GULF SHORELINE STABILIZATION PROJECT (ME-18) POST HURRICANE SURVEY
SHORELINE MOVEMENT ANALYSIS
ANALYSIS AREA - CONTROL
0
250
500
1,000
Feet
CPRA
NOAA
HDR Engineering, Inc.
FIGURE 1 - 6
Source: NOAA NGS Emergency Response Imagery - Hurricane Delta

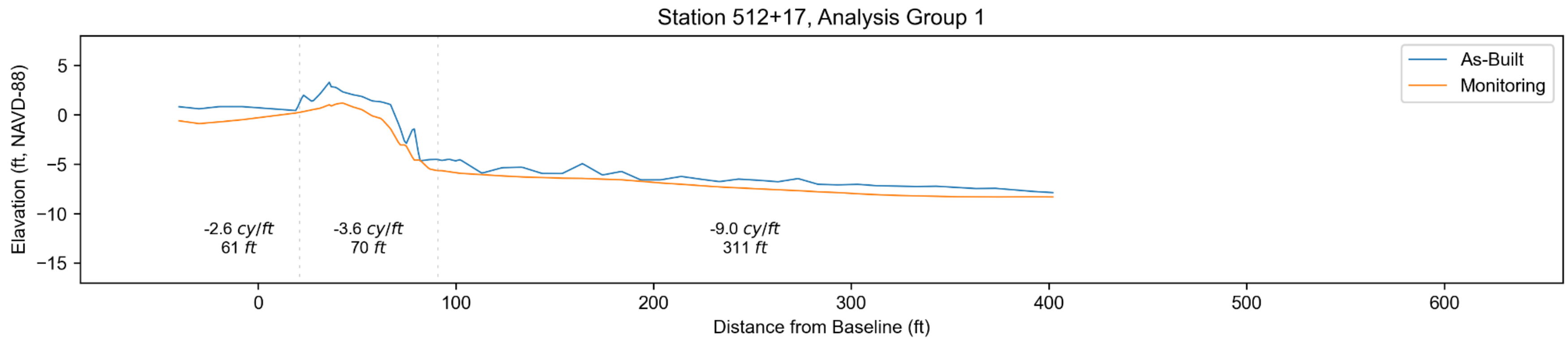
Appendix C. As-Built and Monitoring Transect Plots

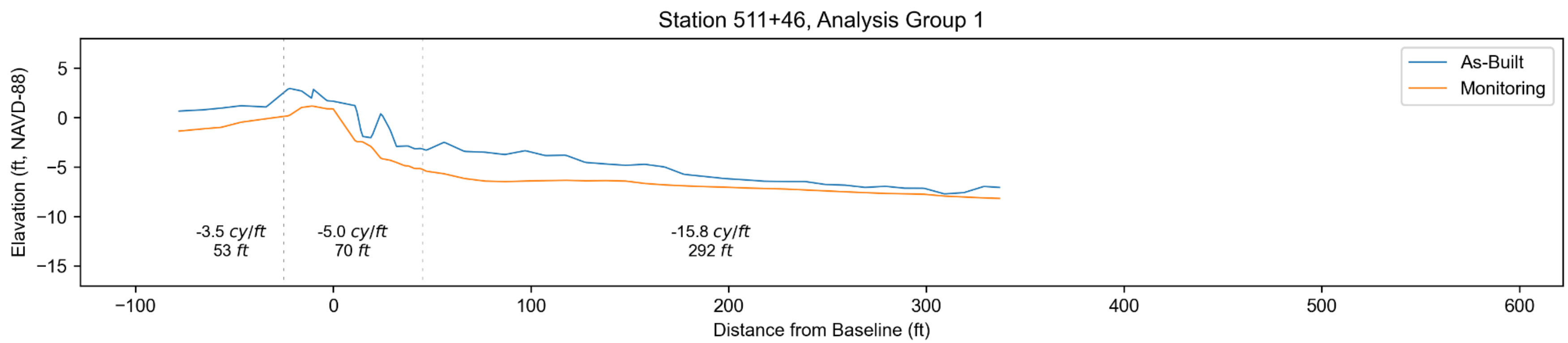

Station 517+53, Analysis Group 1
Elavation (ft, NAVD-88)
Distance from Baseline (ft)
As-Built
Monitoring
-1.8 cy/ft
57 ft
-1.8 cy/ft
71 ft
-29.4 cy/ft
344 ft

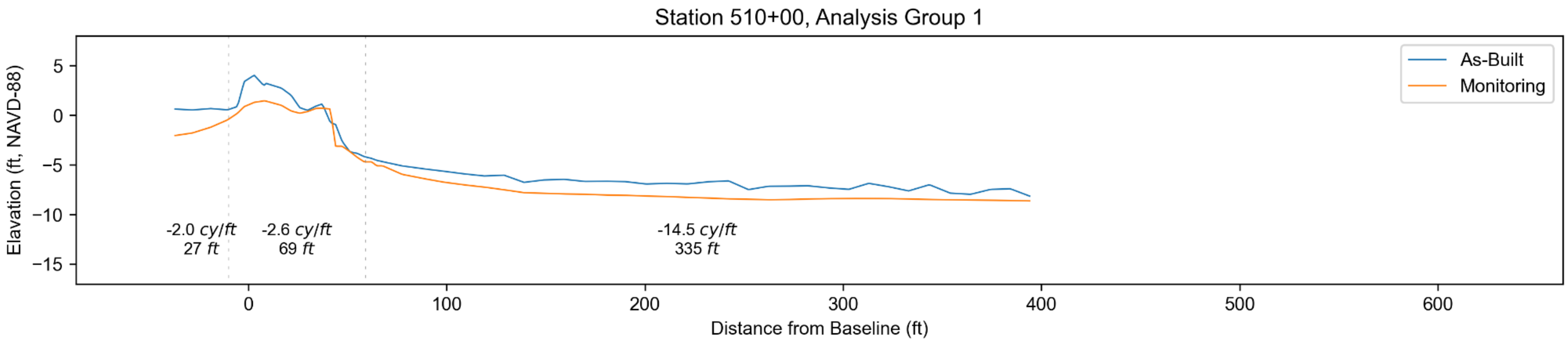

Station 515+35, Analysis Group 1
Elavation (ft, NAVD-88)
Distance from Baseline (ft)
As-Built
Monitoring
-0.9 cy/ft
49 ft
-0.5 cy/ft
70 ft
-18.6 cy/ft
374 ft

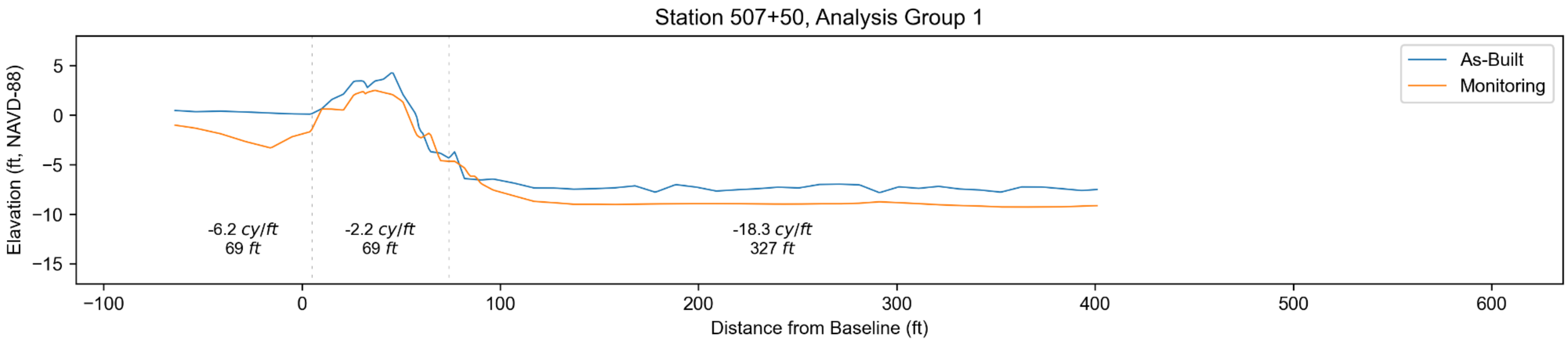

Station 513+10, Analysis Group 1
As-Built
Monitoring
Elavation (ft, NAVD-88)
-4.8 cy/ft
57 ft
-2.0 cy/ft
69 ft
-7.3 cy/ft
380 ft
Distance from Baseline (ft)

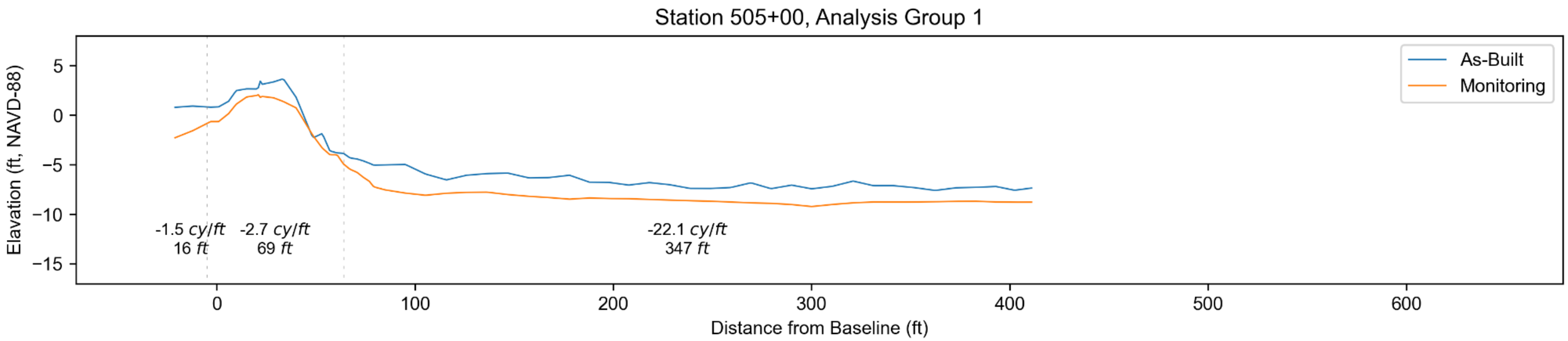

Station 512+63, Analysis Group 1
As-Built
Monitoring
Elavation (ft, NAVD-88)
-3.6 cy/ft
53 ft
-4.2 cy/ft
70 ft
-9.6 cy/ft
351 ft
Distance from Baseline (ft)

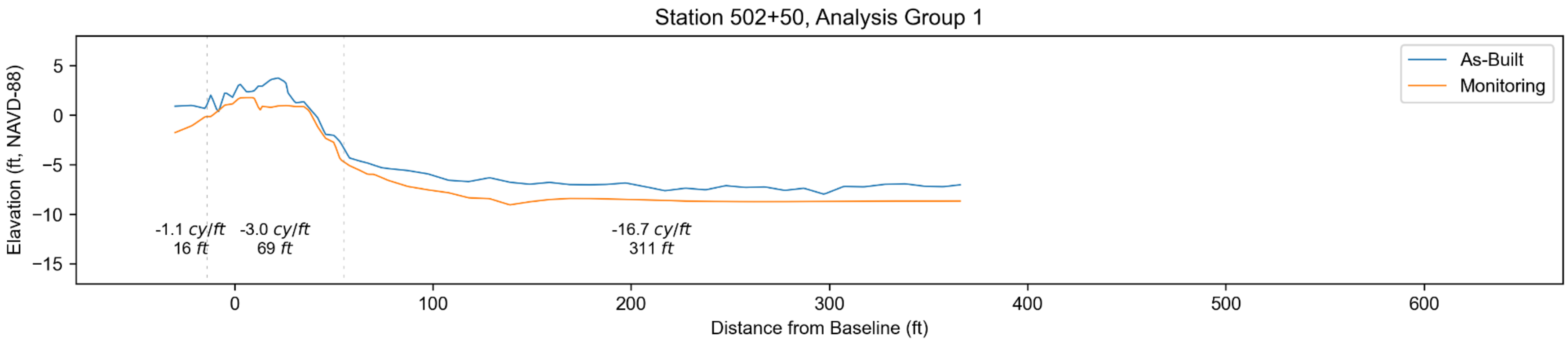

Station 512+17, Analysis Group 1
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-2.6 cy/ft
61 ft
-3.6 cy/ft
70 ft
-9.0 cy/ft
311 ft
0
100
200
300
400
500
600
Distance from Baseline (ft)

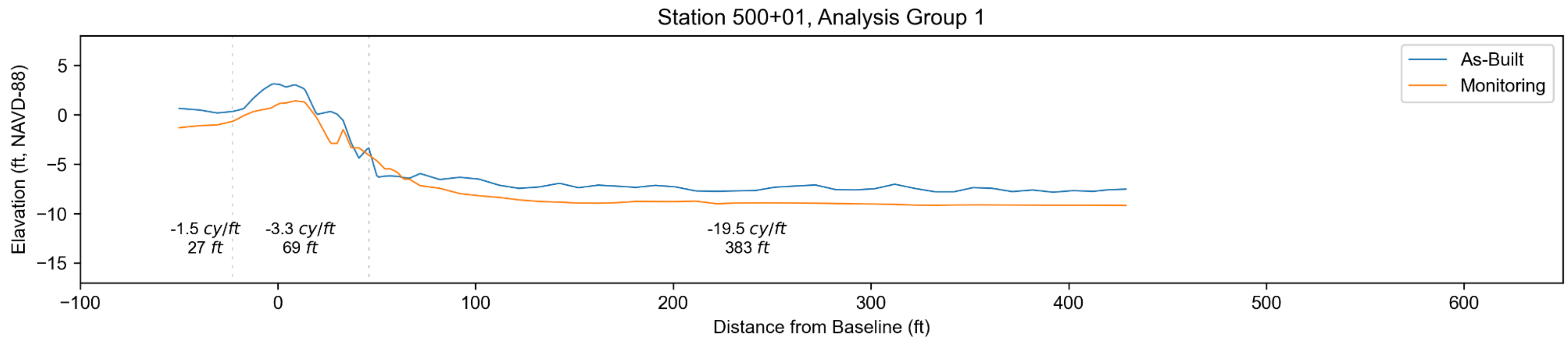

Station 511+46, Analysis Group 1
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-3.5 cy/ft
53 ft
-5.0 cy/ft
70 ft
-15.8 cy/ft
292 ft
−100
0
100
200
300
400
500
600
Distance from Baseline (ft)

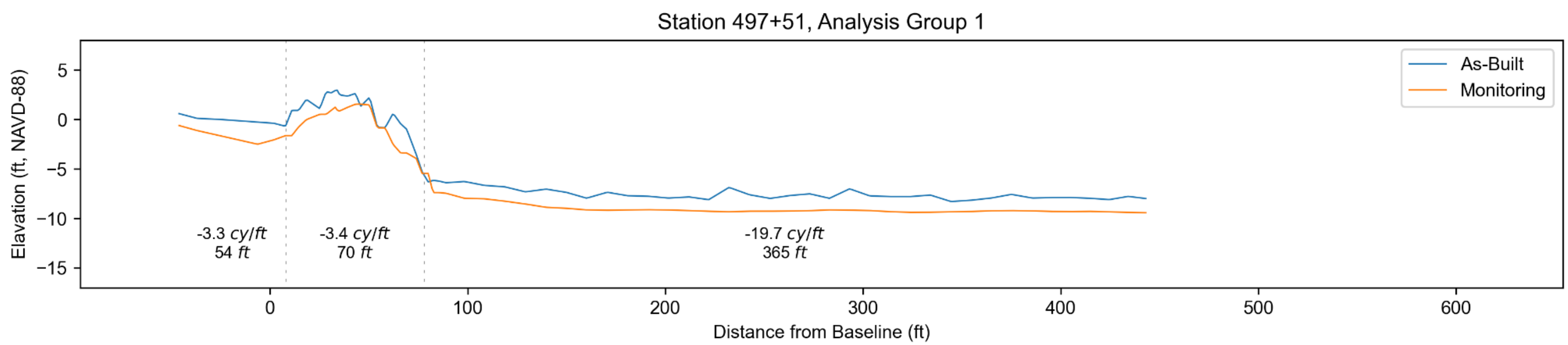

Station 510+00, Analysis Group 1
As-Built
Monitoring
Elavation (ft, NAVD-88)
-2.0 cy/ft
27 ft
-2.6 cy/ft
69 ft
-14.5 cy/ft
335 ft
Distance from Baseline (ft)

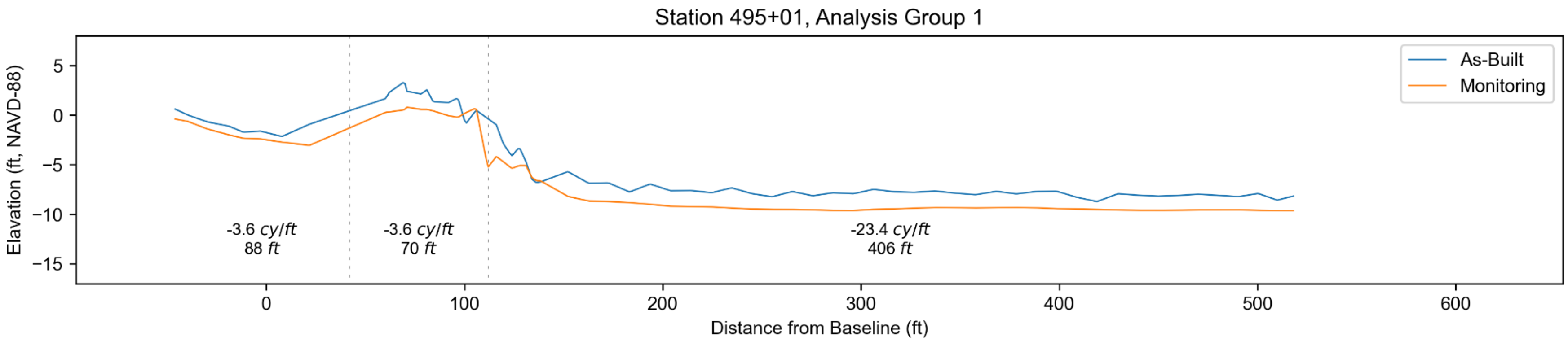

Station 507+50, Analysis Group 1
As-Built
Monitoring
Elavation (ft, NAVD-88)
-6.2 cy/ft
69 ft
-2.2 cy/ft
69 ft
-18.3 cy/ft
327 ft
Distance from Baseline (ft)

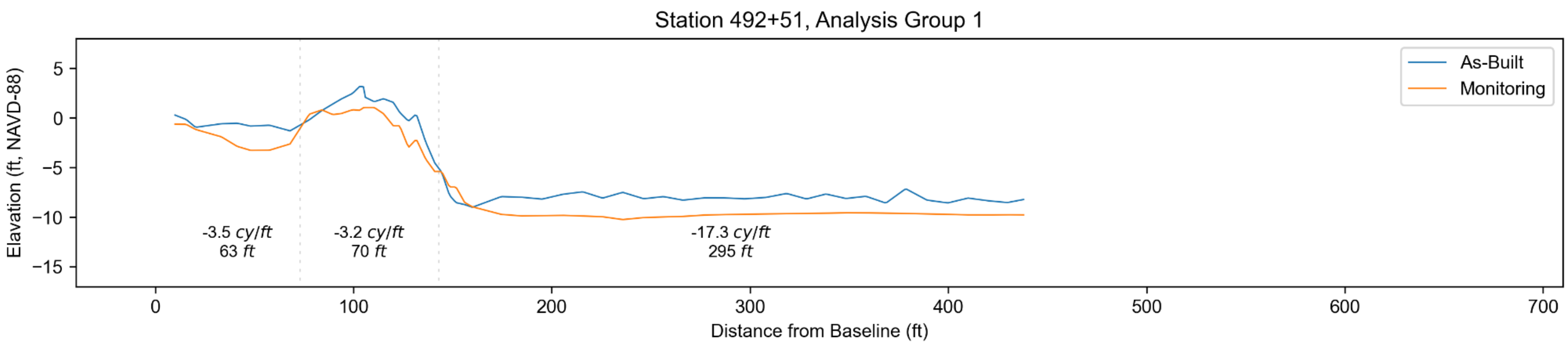

Station 505+00, Analysis Group 1
As-Built
Monitoring
Elevation (ft, NAVD-88)
-1.5 cy/ft
16 ft
-2.7 cy/ft
69 ft
-22.1 cy/ft
347 ft
Distance from Baseline (ft)

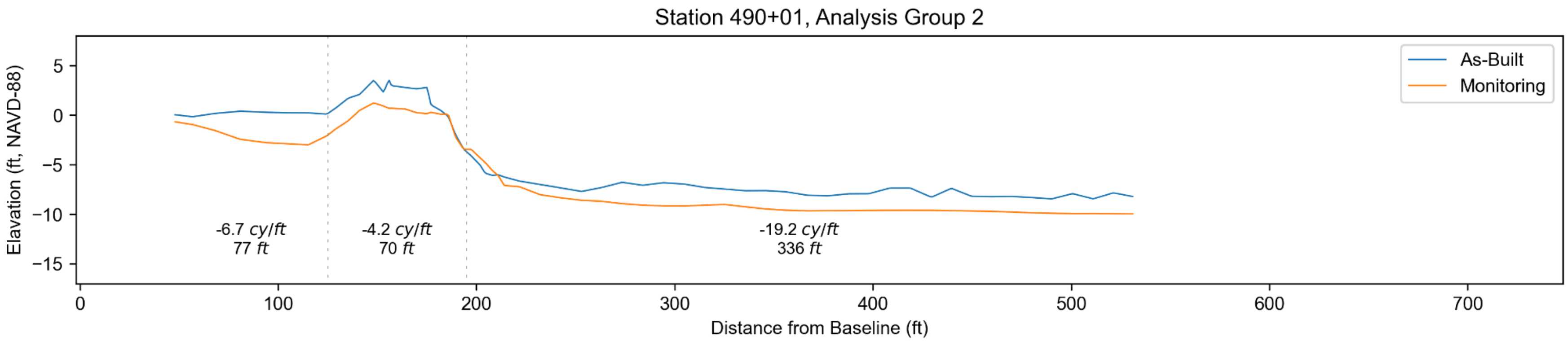

Station 502+50, Analysis Group 1
As-Built
Monitoring
Elavation (ft, NAVD-88)
-1.1 cy/ft
16 ft
-3.0 cy/ft
69 ft
-16.7 cy/ft
311 ft
Distance from Baseline (ft)

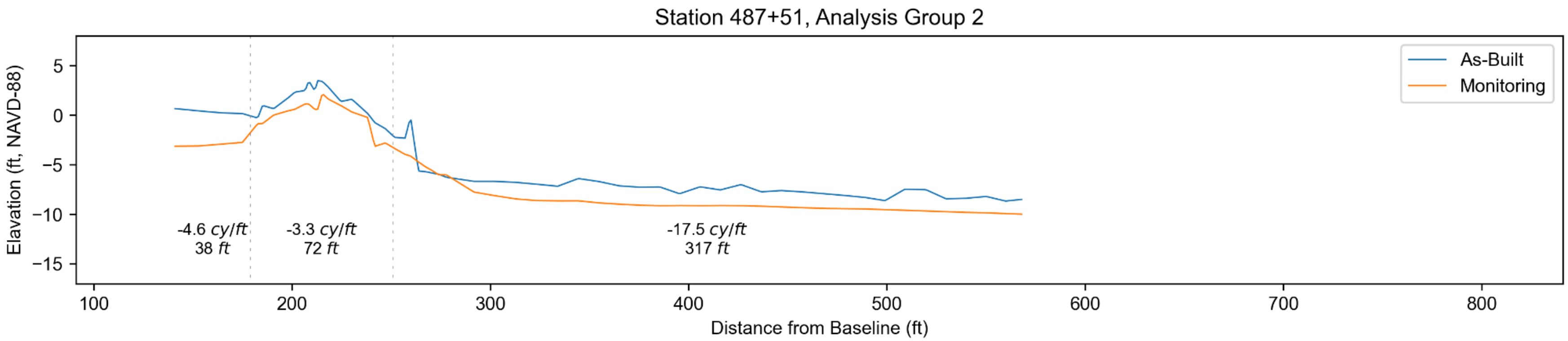

Station 500+01, Analysis Group 1
As-Built
Monitoring
Elavation (ft, NAVD-88)
-1.5 cy/ft
27 ft
-3.3 cy/ft
69 ft
-19.5 cy/ft
383 ft
Distance from Baseline (ft)

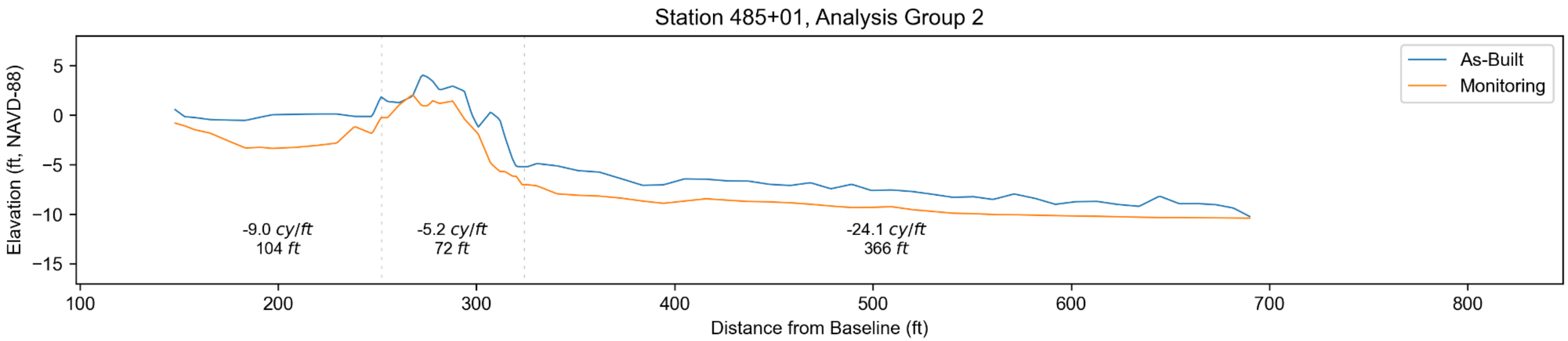

Station 497+51, Analysis Group 1
As-Built
Monitoring
Elavation (ft, NAVD-88)
-3.3 cy/ft
54 ft
-3.4 cy/ft
70 ft
-19.7 cy/ft
365 ft
Distance from Baseline (ft)

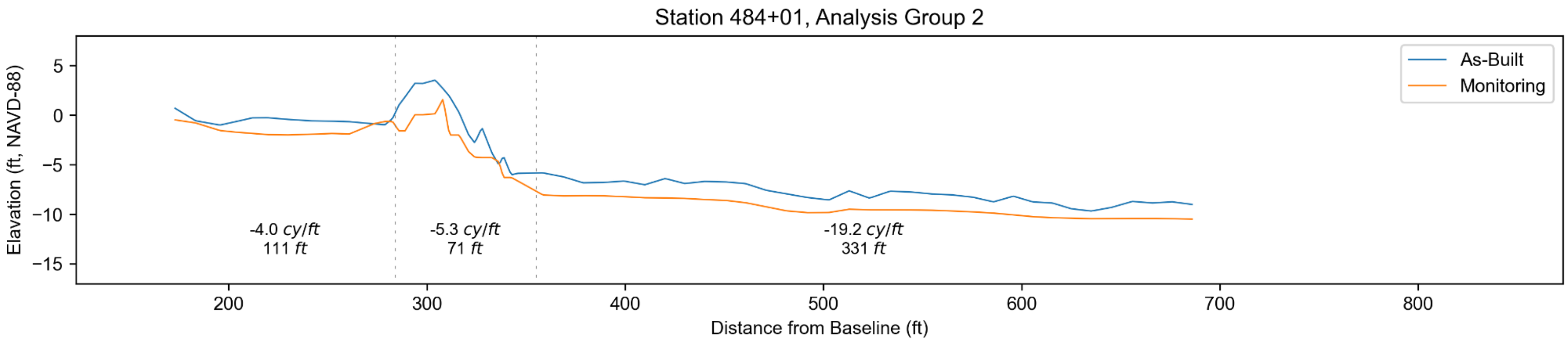

Station 495+01, Analysis Group 1
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-3.6 cy/ft
88 ft
-3.6 cy/ft
70 ft
-23.4 cy/ft
406 ft
0
100
200
300
400
500
600
Distance from Baseline (ft)

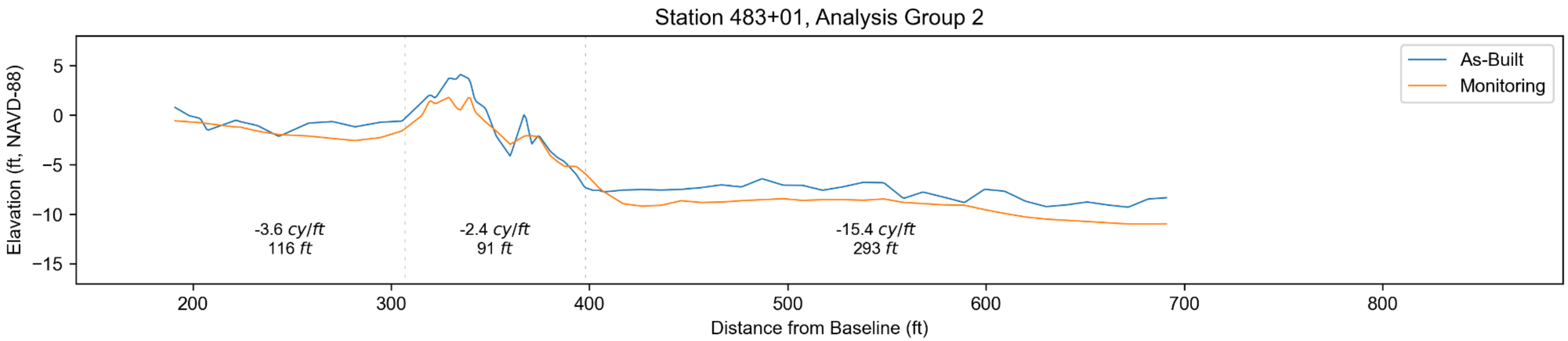

Station 492+51, Analysis Group 1
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-3.5 cy/ft
63 ft
-3.2 cy/ft
70 ft
-17.3 cy/ft
295 ft
0
100
200
300
400
500
600
700
Distance from Baseline (ft)

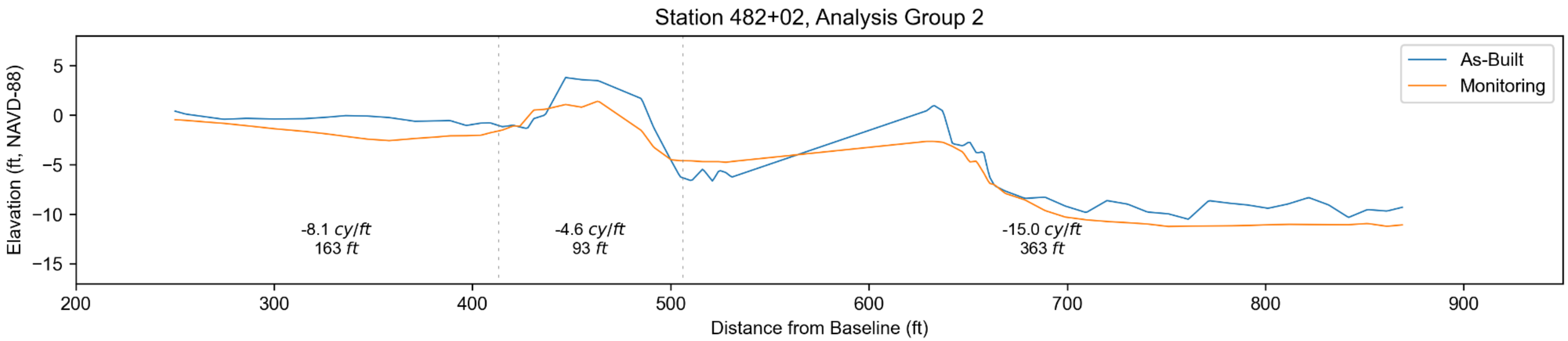

Station 490+01, Analysis Group 2
As-Built
Monitoring
Elavation (ft, NAVD-88)
-6.7 cy/ft
77 ft
-4.2 cy/ft
70 ft
-19.2 cy/ft
336 ft
Distance from Baseline (ft)

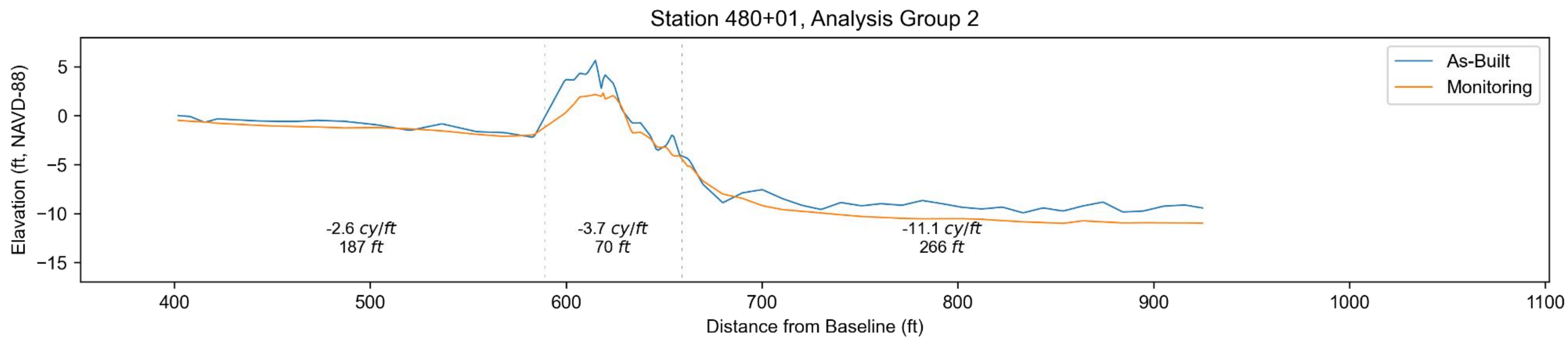

Station 487+51, Analysis Group 2
As-Built
Monitoring
Elavation (ft, NAVD-88)
-4.6 cy/ft
38 ft
-3.3 cy/ft
72 ft
-17.5 cy/ft
317 ft
Distance from Baseline (ft)

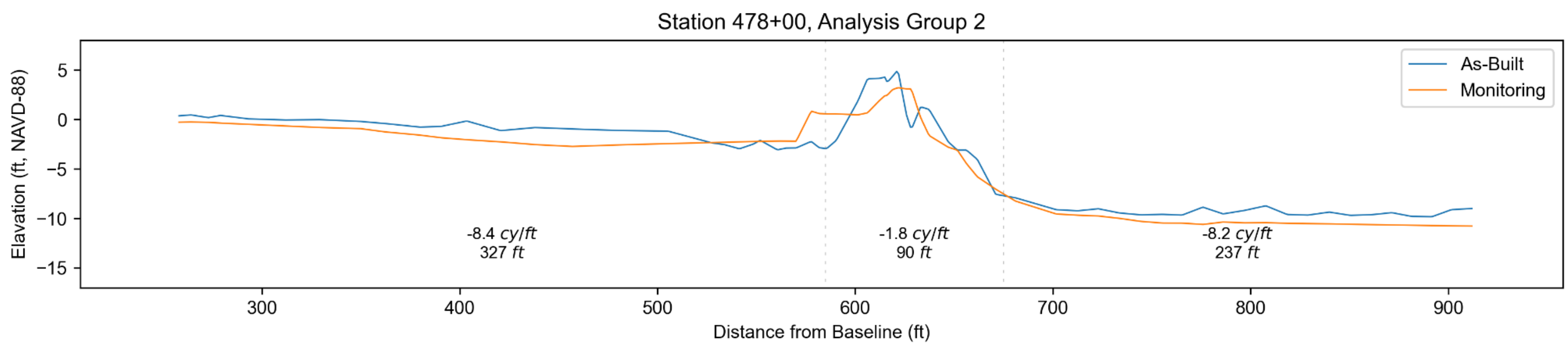

Station 485+01, Analysis Group 2
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-9.0 cy/ft
104 ft
-5.2 cy/ft
72 ft
-24.1 cy/ft
366 ft
100
200
300
400
500
600
700
800
Distance from Baseline (ft)

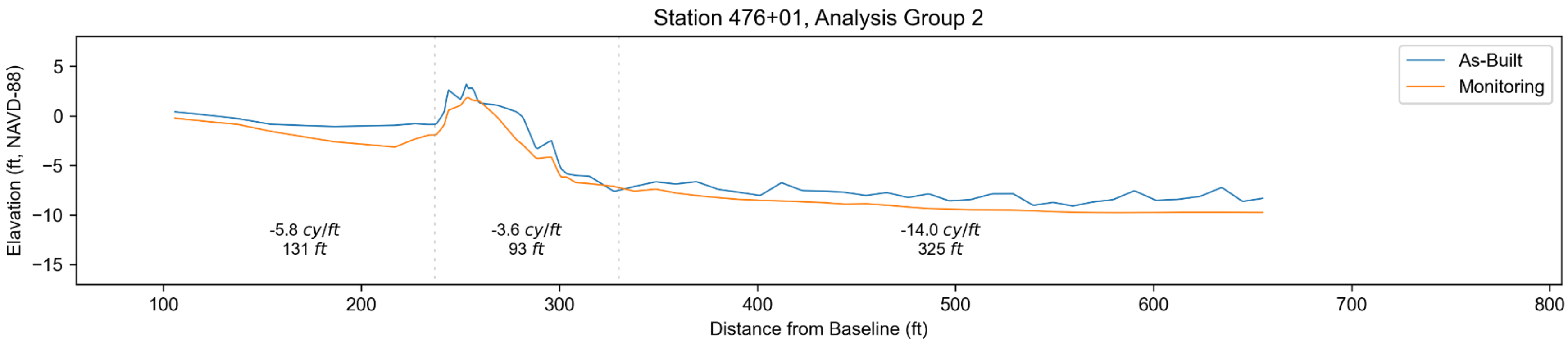

Station 484+01, Analysis Group 2
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-4.0 cy/ft
111 ft
-5.3 cy/ft
71 ft
-19.2 cy/ft
331 ft
200
300
400
500
600
700
800
Distance from Baseline (ft)

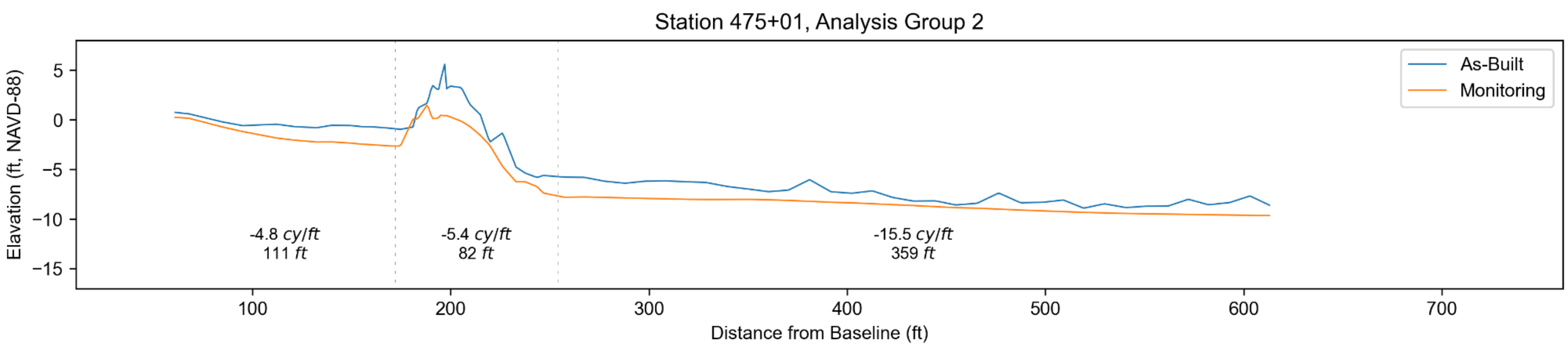

Station 483+01, Analysis Group 2
Elavation (ft, NAVD-88)
Distance from Baseline (ft)
As-Built
Monitoring
-3.6 cy/ft
116 ft
-2.4 cy/ft
91 ft
-15.4 cy/ft
293 ft

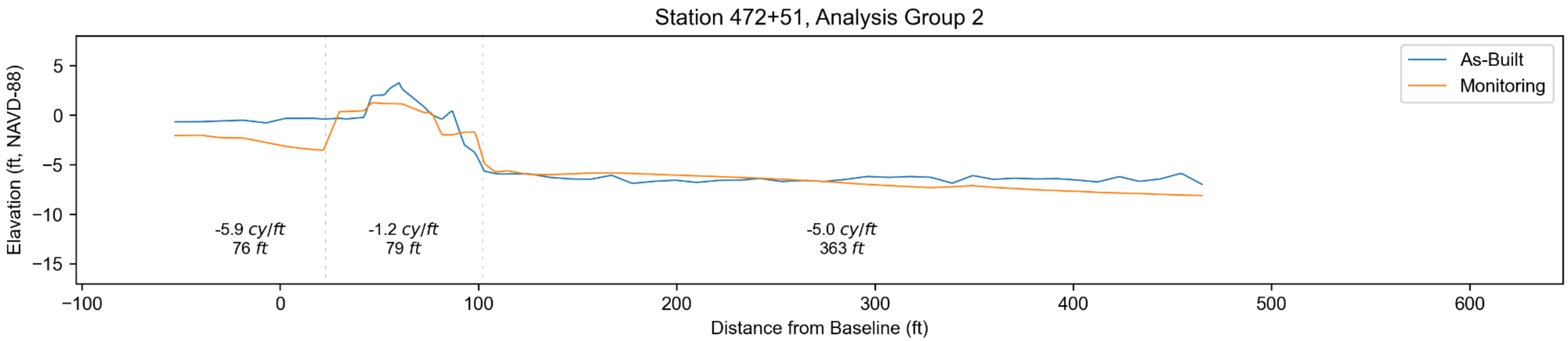

Station 482+02, Analysis Group 2
Elavation (ft, NAVD-88)
Distance from Baseline (ft)
As-Built
Monitoring
-8.1 cy/ft
163 ft
-4.6 cy/ft
93 ft
-15.0 cy/ft
363 ft

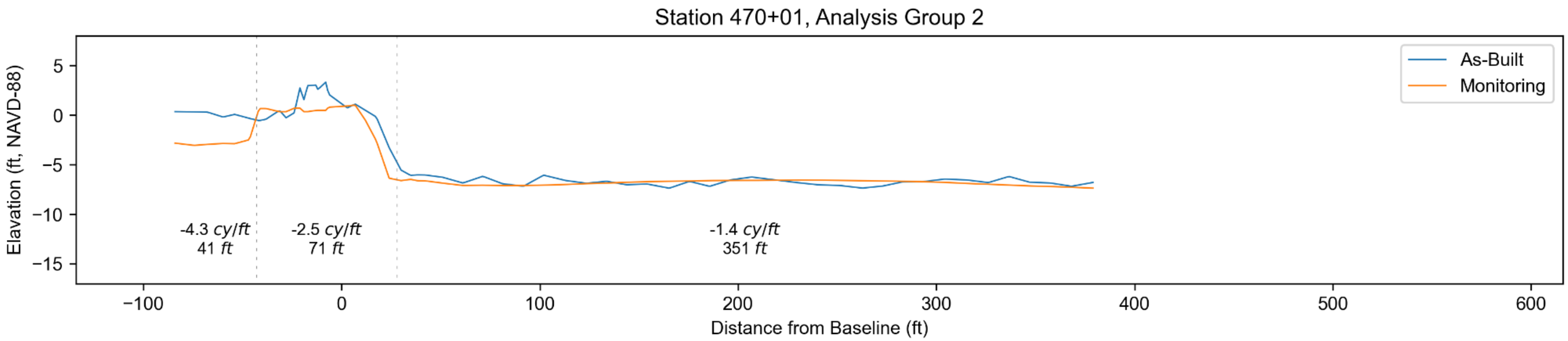

Station 480+01, Analysis Group 2
As-Built
Monitoring
Elavation (ft, NAVD-88)
-2.6 cy/ft
187 ft
-3.7 cy/ft
70 ft
-11.1 cy/ft
266 ft
Distance from Baseline (ft)

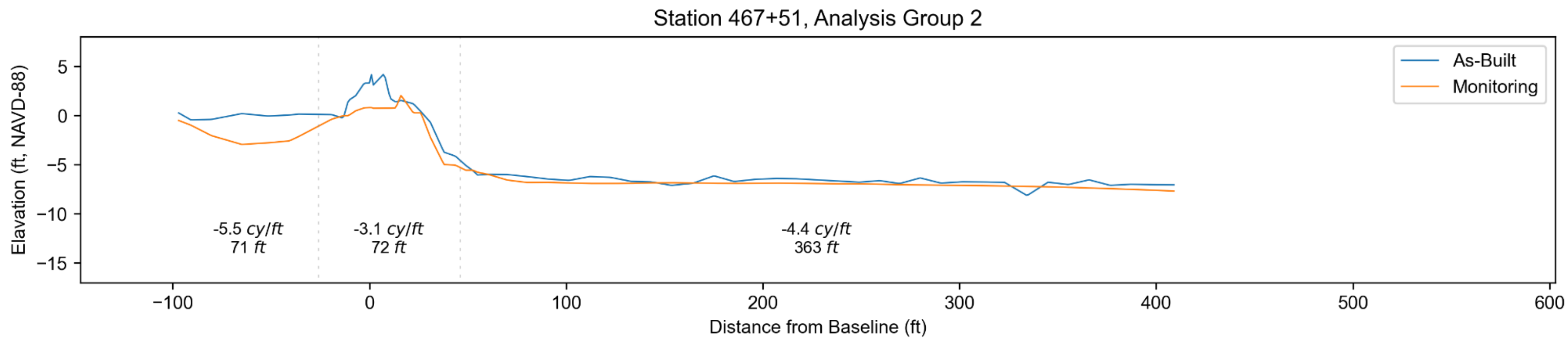

Station 478+00, Analysis Group 2
As-Built
Monitoring
Elavation (ft, NAVD-88)
-8.4 cy/ft
327 ft
-1.8 cy/ft
90 ft
-8.2 cy/ft
237 ft
Distance from Baseline (ft)

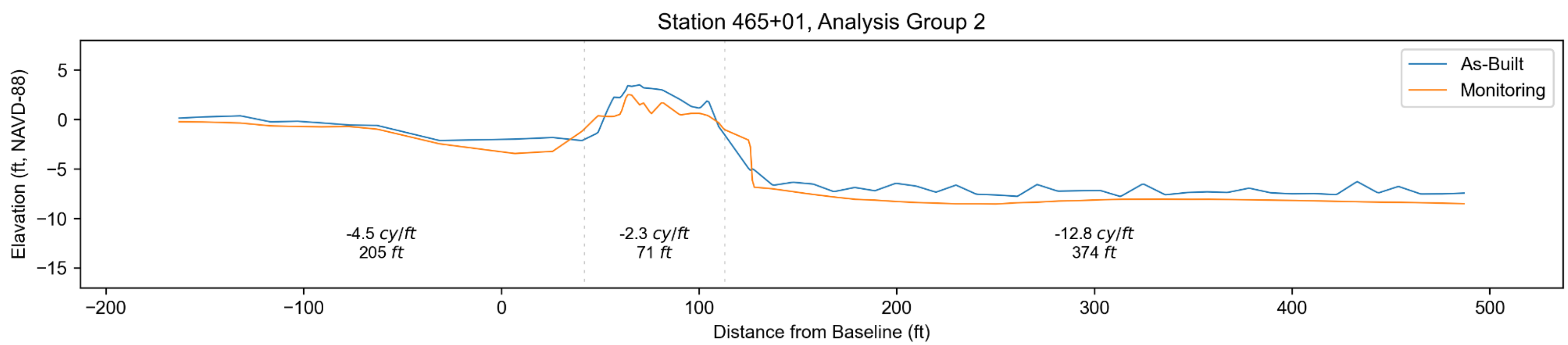

Station 476+01, Analysis Group 2
Elavation (ft, NAVD-88)
Distance from Baseline (ft)
As-Built
Monitoring
-5.8 cy/ft
131 ft
-3.6 cy/ft
93 ft
-14.0 cy/ft
325 ft

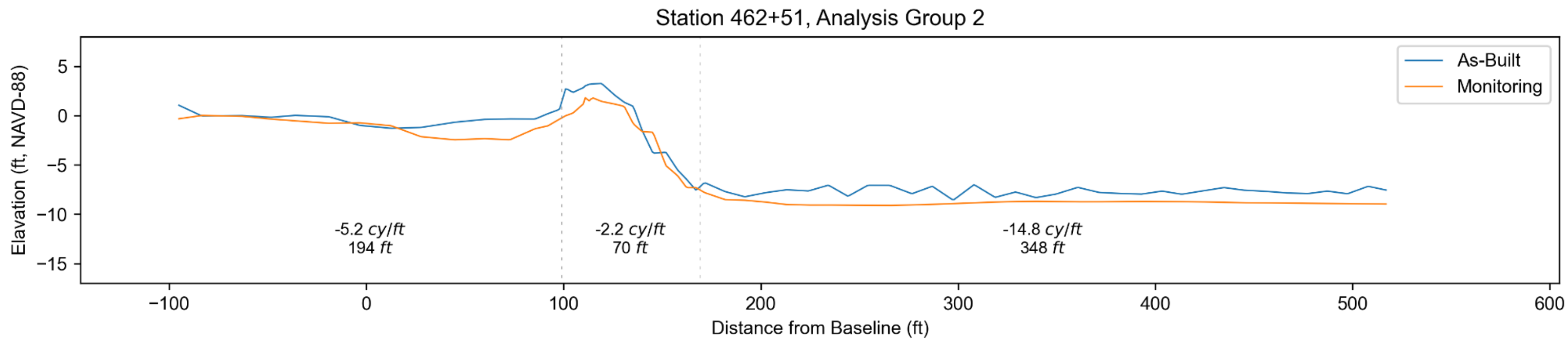

Station 475+01, Analysis Group 2
Elavation (ft, NAVD-88)
Distance from Baseline (ft)
As-Built
Monitoring
-4.8 cy/ft
111 ft
-5.4 cy/ft
82 ft
-15.5 cy/ft
359 ft

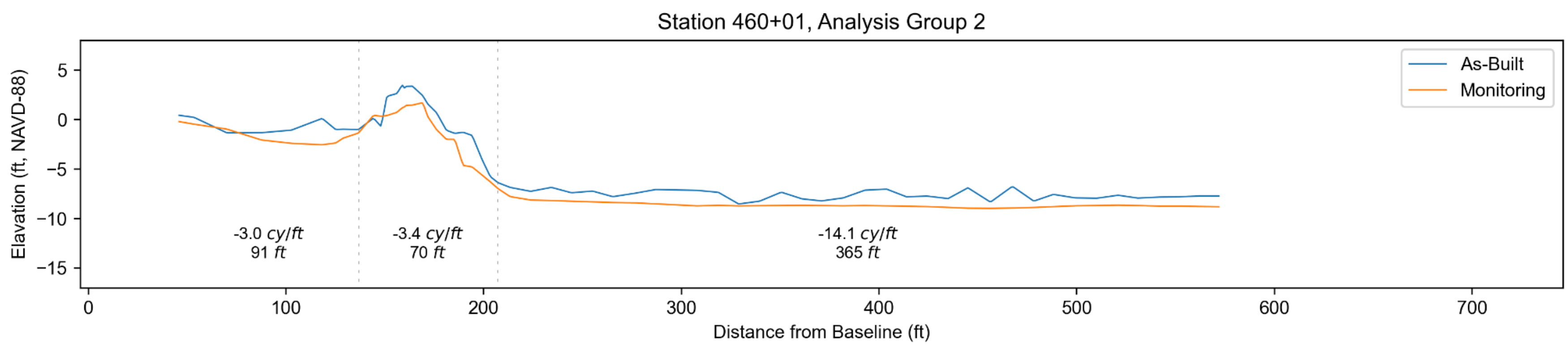

Station 472+51, Analysis Group 2
As-Built
Monitoring
Elevation (ft, NAVD-88)
-5.9 cy/ft
76 ft
-1.2 cy/ft
79 ft
-5.0 cy/ft
363 ft
Distance from Baseline (ft)

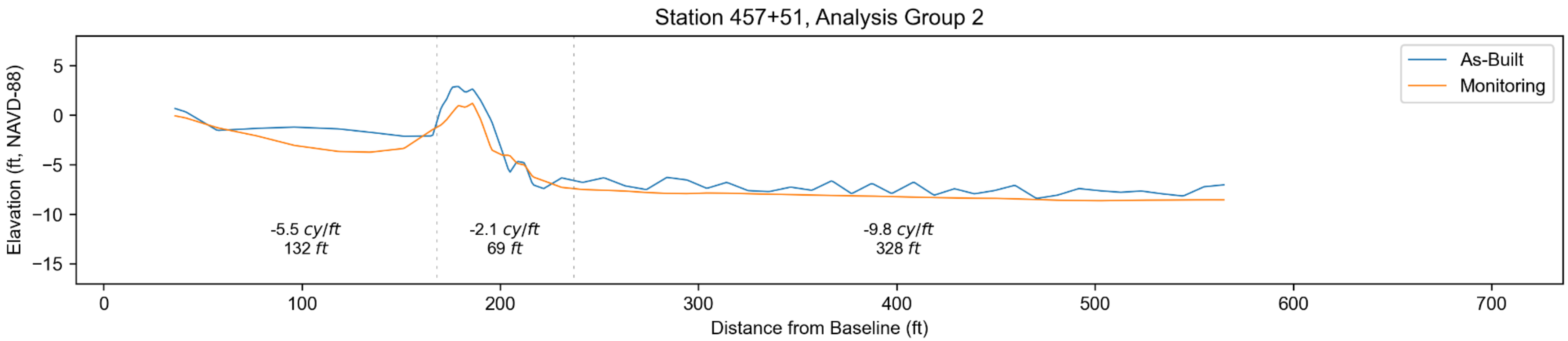

Station 470+01, Analysis Group 2
As-Built
Monitoring
Elavation (ft, NAVD-88)
-4.3 cy/ft
41 ft
-2.5 cy/ft
71 ft
-1.4 cy/ft
351 ft
Distance from Baseline (ft)

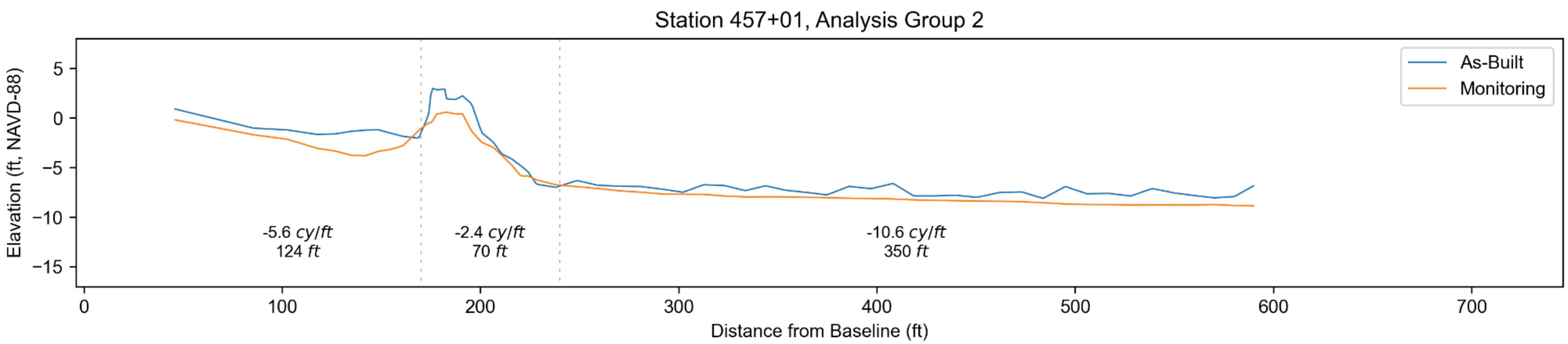

Station 467+51, Analysis Group 2
Elavation (ft, NAVD-88)
Distance from Baseline (ft)
As-Built
Monitoring
-5.5 cy/ft
71 ft
-3.1 cy/ft
72 ft
-4.4 cy/ft
363 ft

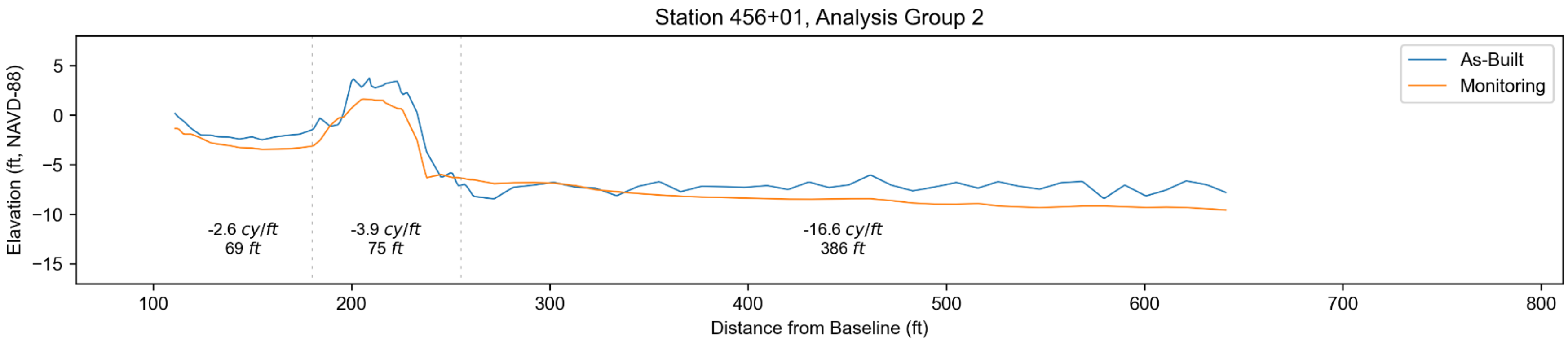

Station 465+01, Analysis Group 2
Elavation (ft, NAVD-88)
Distance from Baseline (ft)
As-Built
Monitoring
-4.5 cy/ft
205 ft
-2.3 cy/ft
71 ft
-12.8 cy/ft
374 ft

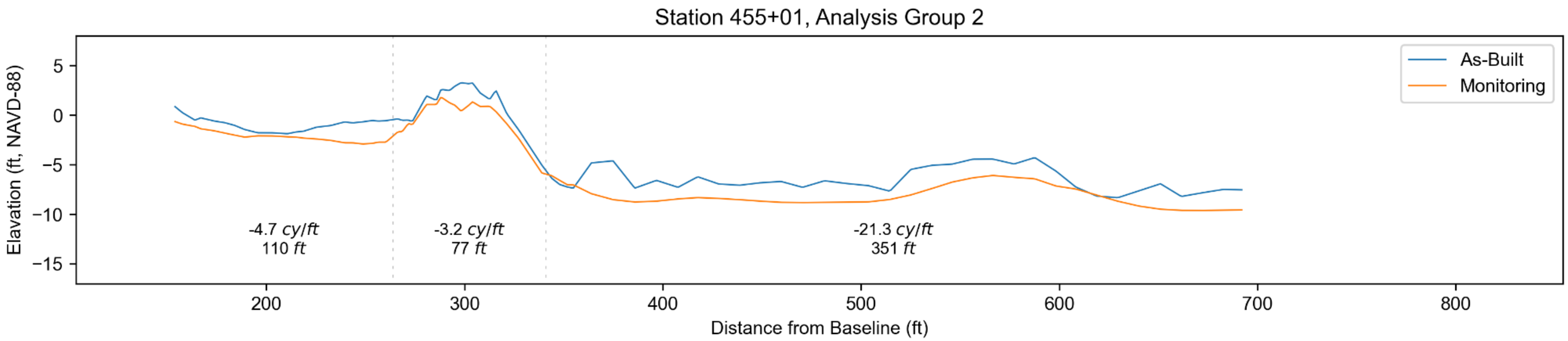

Station 462+51, Analysis Group 2
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-5.2 cy/ft
194 ft
-2.2 cy/ft
70 ft
-14.8 cy/ft
348 ft
−100
0
100
200
300
400
500
600
Distance from Baseline (ft)

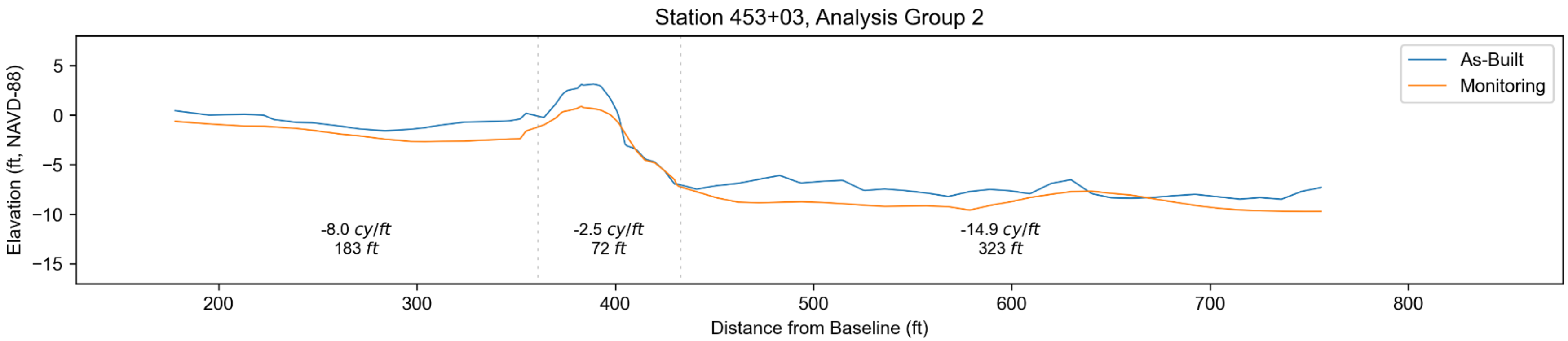

Station 460+01, Analysis Group 2
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-3.0 cy/ft
91 ft
-3.4 cy/ft
70 ft
-14.1 cy/ft
365 ft
0
100
200
300
400
500
600
700
Distance from Baseline (ft)

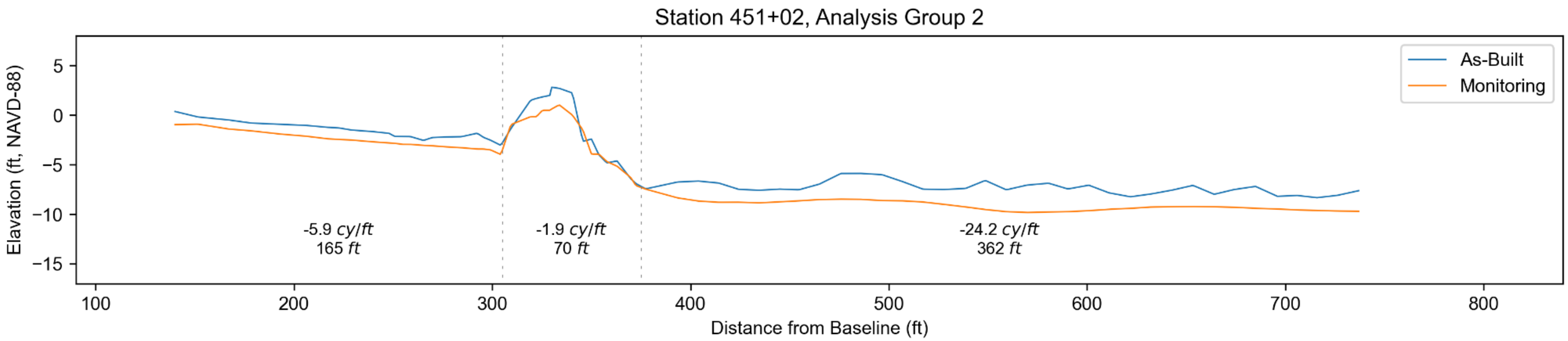

Station 457+51, Analysis Group 2
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
As-Built
Monitoring
-5.5 cy/ft
132 ft
-2.1 cy/ft
69 ft
-9.8 cy/ft
328 ft
0
100
200
300
400
500
600
700
Distance from Baseline (ft)

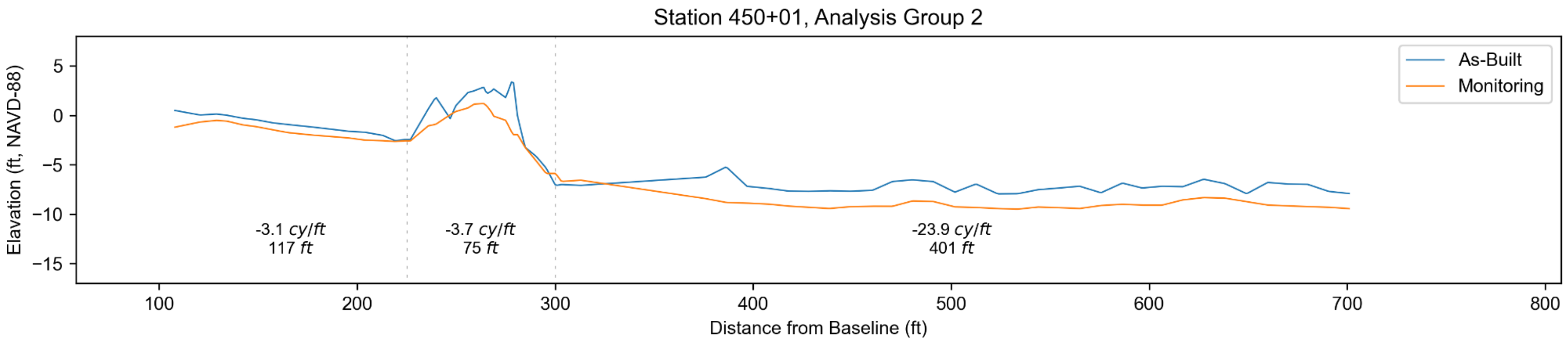

Station 457+01, Analysis Group 2
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
As-Built
Monitoring
-5.6 cy/ft
124 ft
-2.4 cy/ft
70 ft
-10.6 cy/ft
350 ft
0
100
200
300
400
500
600
700
Distance from Baseline (ft)

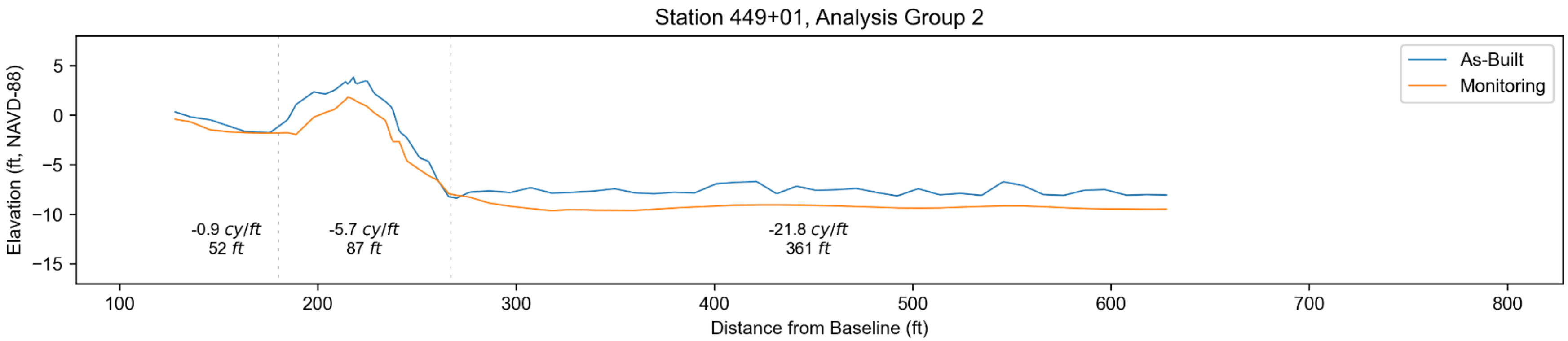

Station 456+01, Analysis Group 2
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-2.6 cy/ft
69 ft
-3.9 cy/ft
75 ft
-16.6 cy/ft
386 ft
100
200
300
400
500
600
700
800
Distance from Baseline (ft)

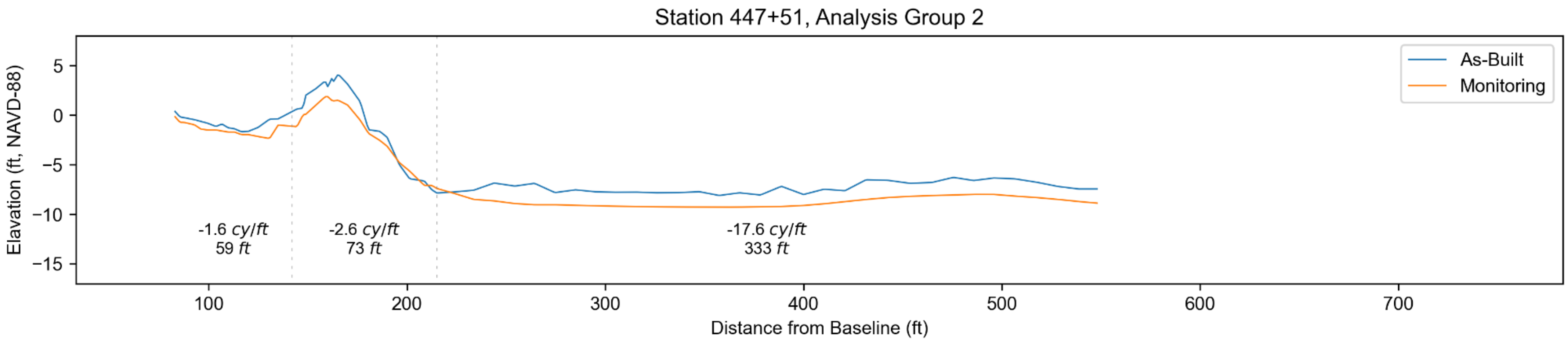

Station 455+01, Analysis Group 2
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-4.7 cy/ft
110 ft
-3.2 cy/ft
77 ft
-21.3 cy/ft
351 ft
200
300
400
500
600
700
800
Distance from Baseline (ft)

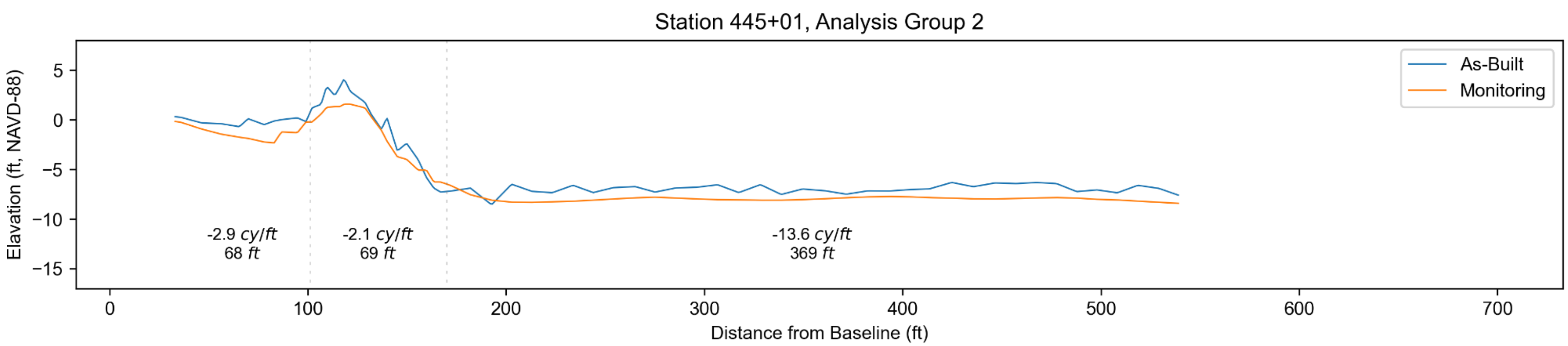

Station 453+03, Analysis Group 2
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
As-Built
Monitoring
-8.0 cy/ft
183 ft
-2.5 cy/ft
72 ft
-14.9 cy/ft
323 ft
200
300
400
500
600
700
800
Distance from Baseline (ft)

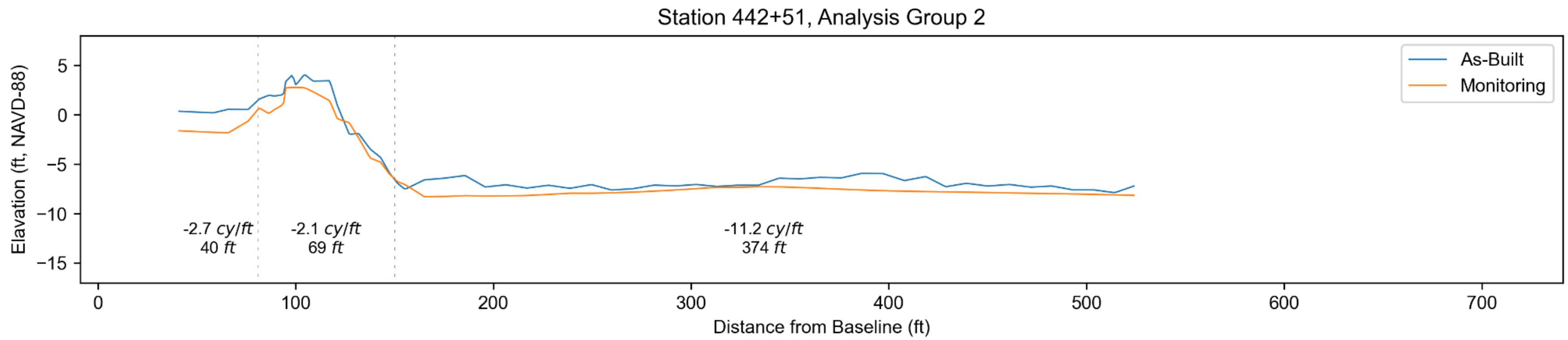

Station 451+02, Analysis Group 2
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
As-Built
Monitoring
-5.9 cy/ft
165 ft
-1.9 cy/ft
70 ft
-24.2 cy/ft
362 ft
100
200
300
400
500
600
700
800
Distance from Baseline (ft)

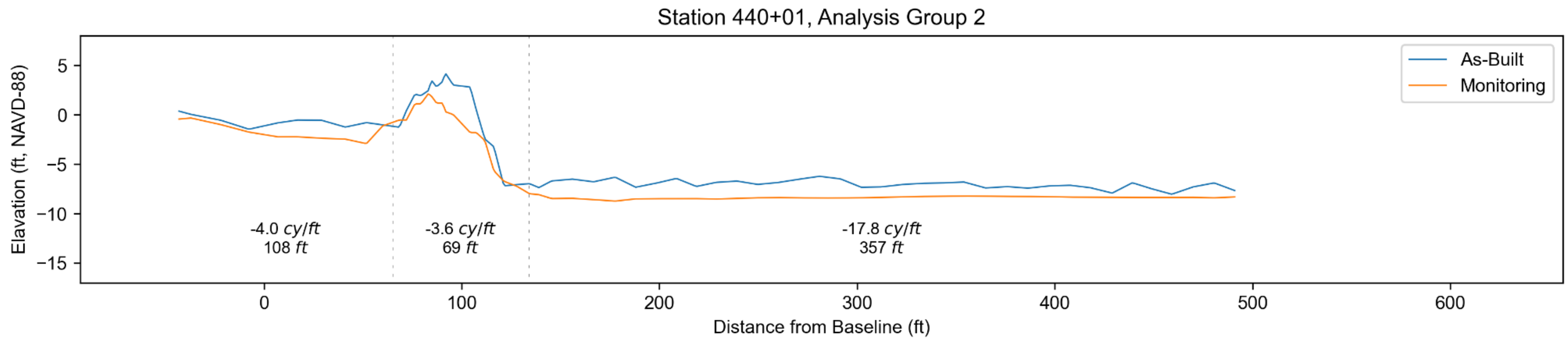

Station 450+01, Analysis Group 2
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-3.1 cy/ft
117 ft
-3.7 cy/ft
75 ft
-23.9 cy/ft
401 ft
100
200
300
400
500
600
700
800
Distance from Baseline (ft)

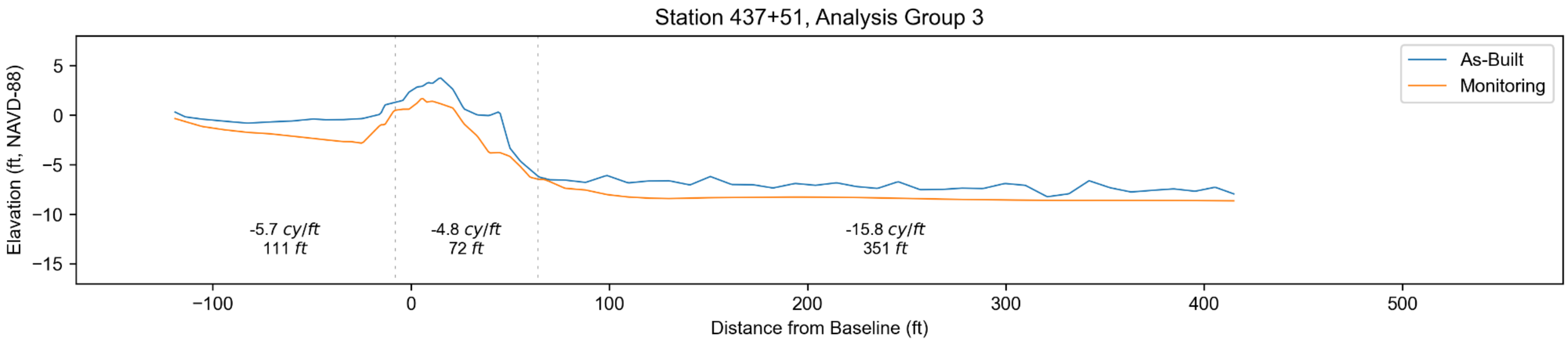

Station 449+01, Analysis Group 2
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-0.9 cy/ft
52 ft
-5.7 cy/ft
87 ft
-21.8 cy/ft
361 ft
100
200
300
400
500
600
700
800
Distance from Baseline (ft)

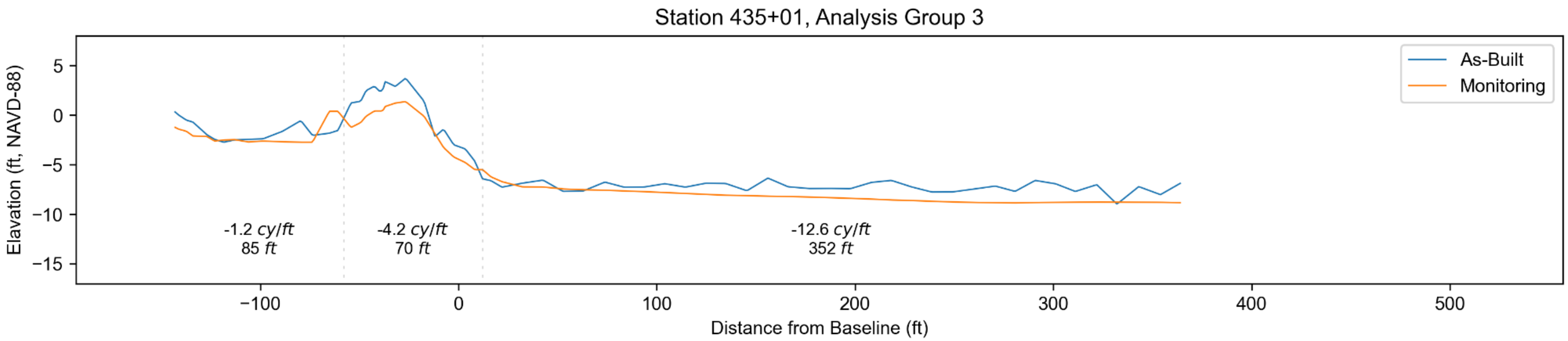

Station 447+51, Analysis Group 2
As-Built
Monitoring
Elavation (ft, NAVD-88)
-1.6 cy/ft
59 ft
-2.6 cy/ft
73 ft
-17.6 cy/ft
333 ft
Distance from Baseline (ft)

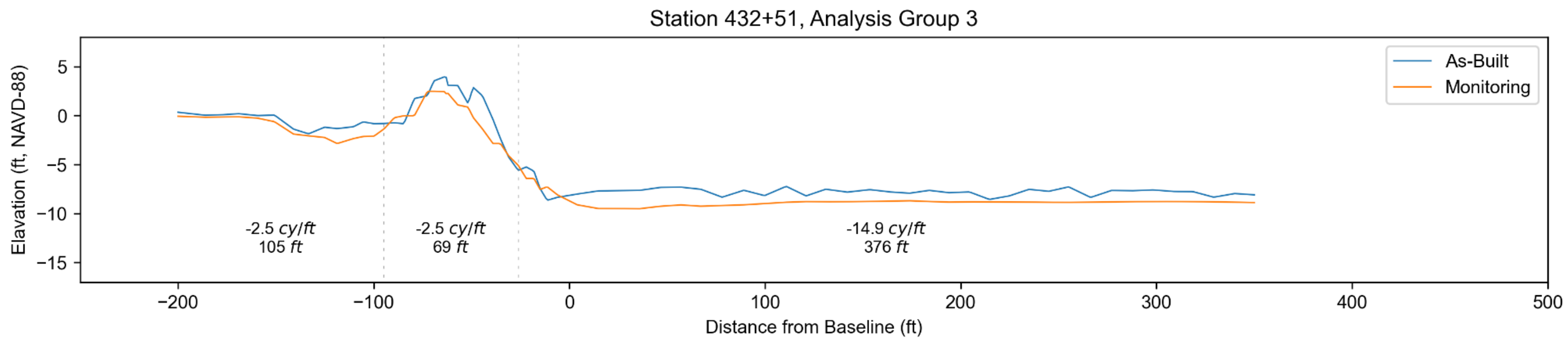

Station 445+01, Analysis Group 2
As-Built
Monitoring
Elavation (ft, NAVD-88)
-2.9 cy/ft
68 ft
-2.1 cy/ft
69 ft
-13.6 cy/ft
369 ft
Distance from Baseline (ft)

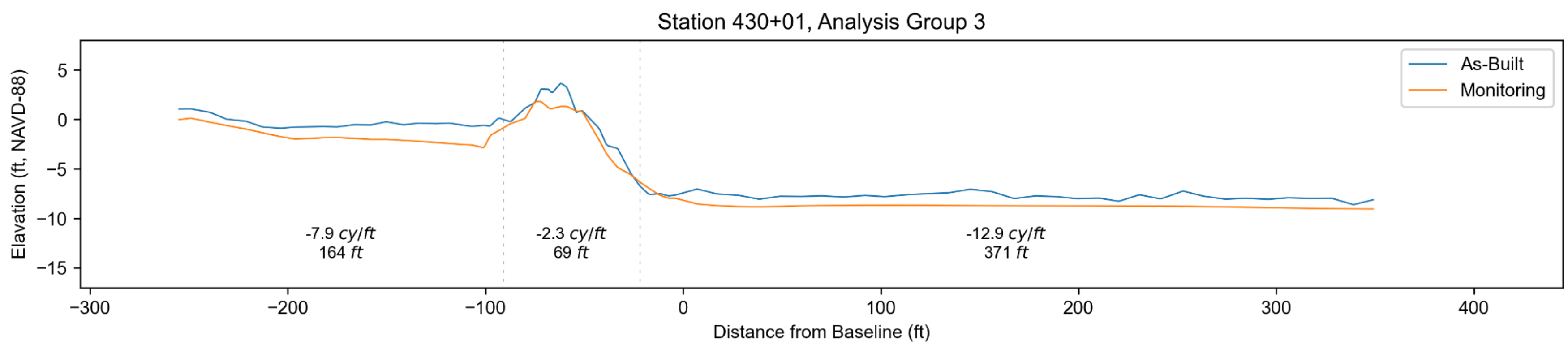

Station 442+51, Analysis Group 2
As-Built
Monitoring
Elavation (ft, NAVD-88)
Distance from Baseline (ft)
-2.7 cy/ft
40 ft
-2.1 cy/ft
69 ft
-11.2 cy/ft
374 ft

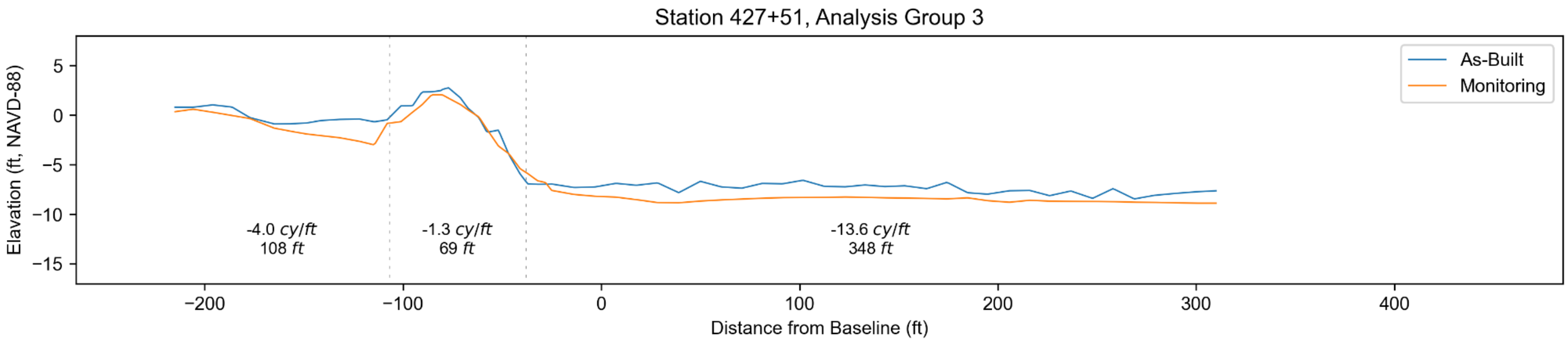

Station 440+01, Analysis Group 2
As-Built
Monitoring
Elavation (ft, NAVD-88)
Distance from Baseline (ft)
-4.0 cy/ft
108 ft
-3.6 cy/ft
69 ft
-17.8 cy/ft
357 ft

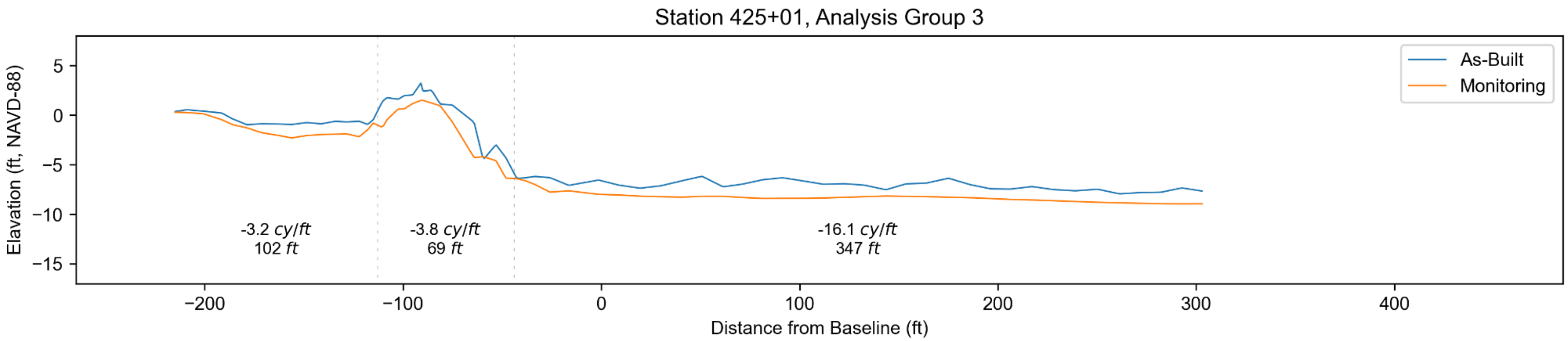

Station 437+51, Analysis Group 3
Elavation (ft, NAVD-88)
Distance from Baseline (ft)
As-Built
Monitoring
-5.7 cy/ft
111 ft
-4.8 cy/ft
72 ft
-15.8 cy/ft
351 ft

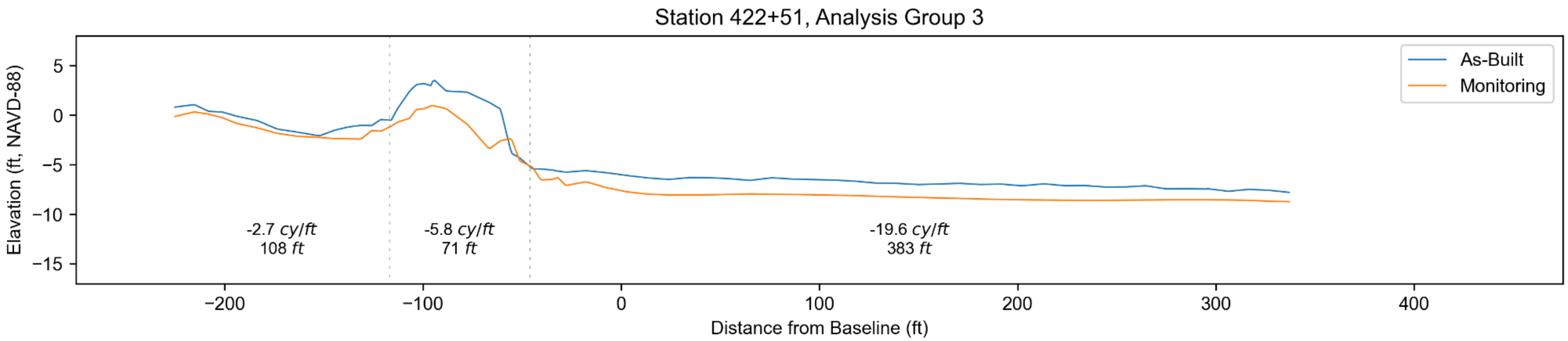

Station 435+01, Analysis Group 3
Elavation (ft, NAVD-88)
Distance from Baseline (ft)
As-Built
Monitoring
-1.2 cy/ft
85 ft
-4.2 cy/ft
70 ft
-12.6 cy/ft
352 ft

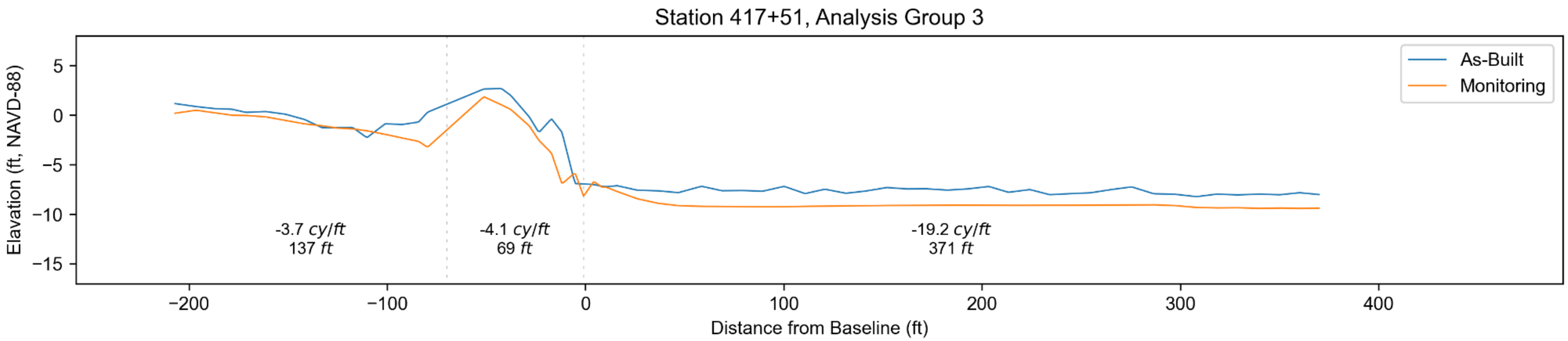

Station 432+51, Analysis Group 3
As-Built
Monitoring
Elavation (ft, NAVD-88)
-2.5 cy/ft
105 ft
-2.5 cy/ft
69 ft
-14.9 cy/ft
376 ft
Distance from Baseline (ft)

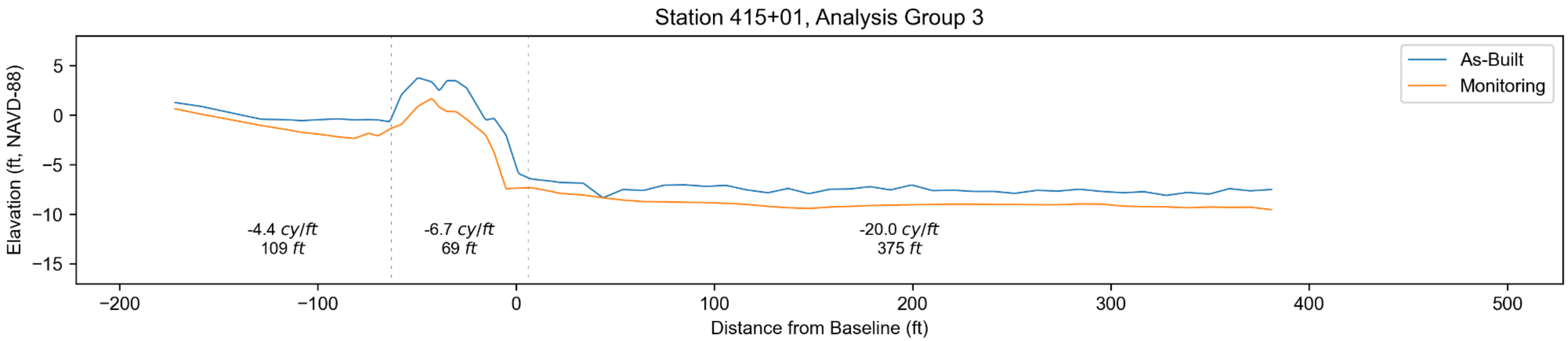

Station 430+01, Analysis Group 3
As-Built
Monitoring
Elavation (ft, NAVD-88)
-7.9 cy/ft
164 ft
-2.3 cy/ft
69 ft
-12.9 cy/ft
371 ft
Distance from Baseline (ft)

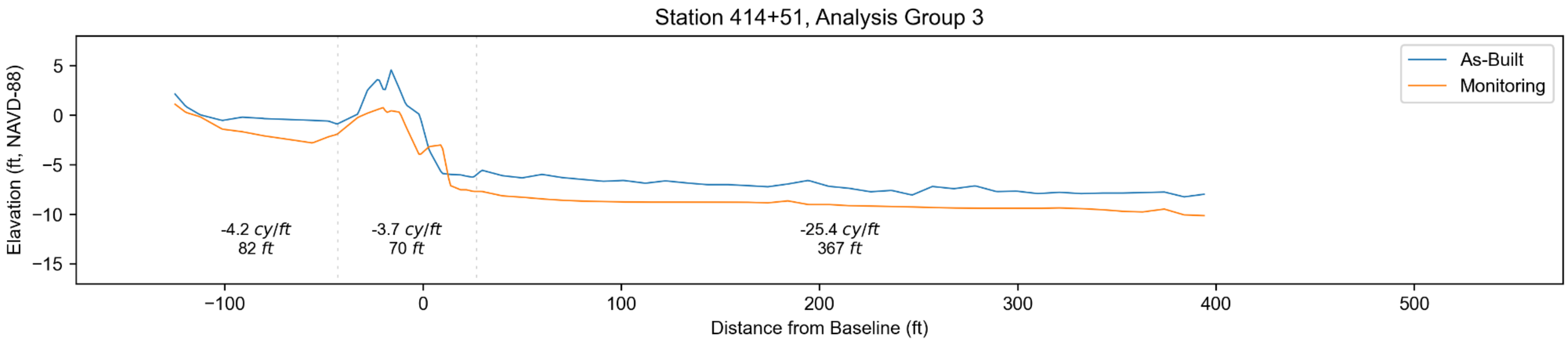

Station 427+51, Analysis Group 3
Elavation (ft, NAVD-88)
As-Built
Monitoring
-4.0 cy/ft
108 ft
-1.3 cy/ft
69 ft
-13.6 cy/ft
348 ft
Distance from Baseline (ft)

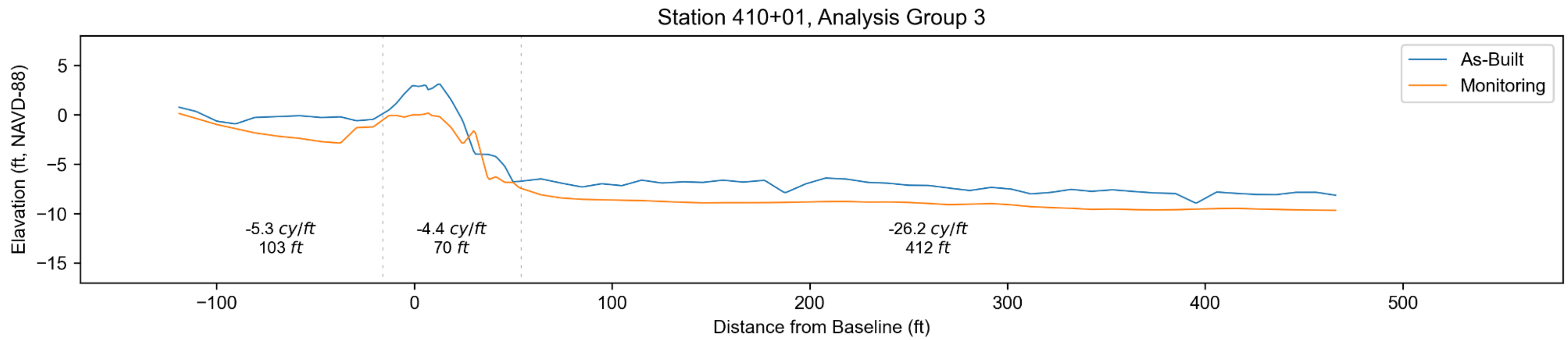

Station 425+01, Analysis Group 3
Elavation (ft, NAVD-88)
As-Built
Monitoring
-3.2 cy/ft
102 ft
-3.8 cy/ft
69 ft
-16.1 cy/ft
347 ft
Distance from Baseline (ft)

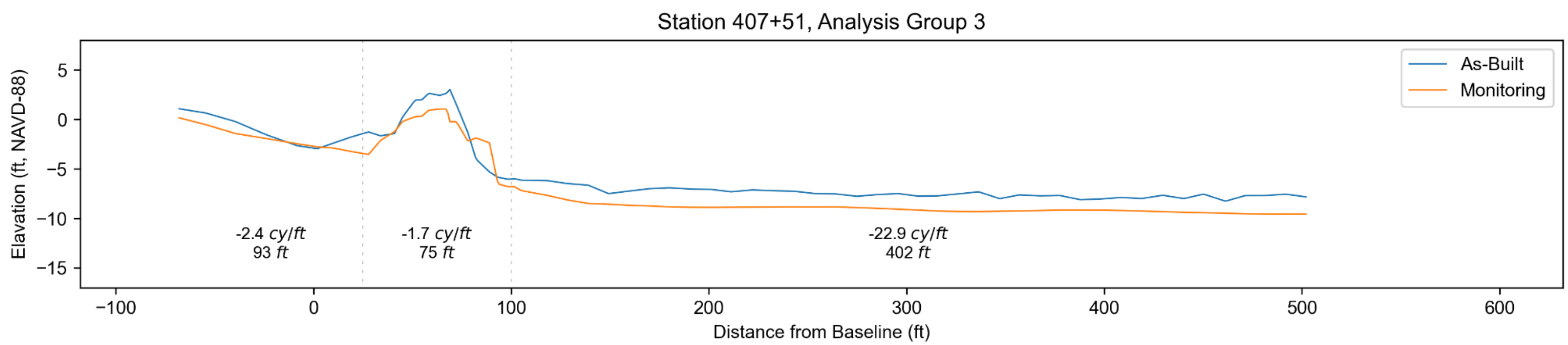

Station 422+51, Analysis Group 3
As-Built
Monitoring
-2.7 cy/ft
108 ft
-5.8 cy/ft
71 ft
-19.6 cy/ft
383 ft
Elavation (ft, NAVD-88)
Distance from Baseline (ft)

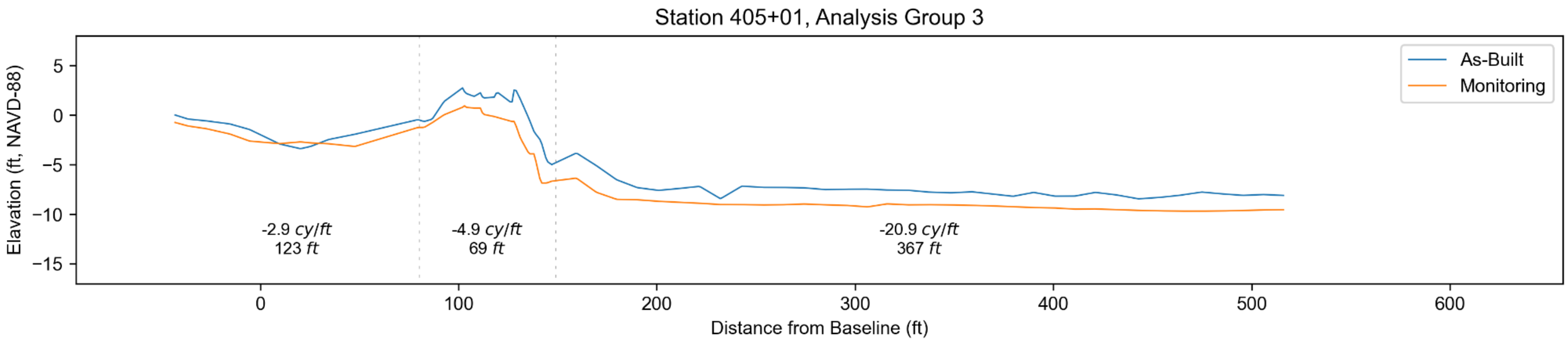

Station 417+51, Analysis Group 3
As-Built
Monitoring
-3.7 cy/ft
137 ft
-4.1 cy/ft
69 ft
-19.2 cy/ft
371 ft
Elavation (ft, NAVD-88)
Distance from Baseline (ft)

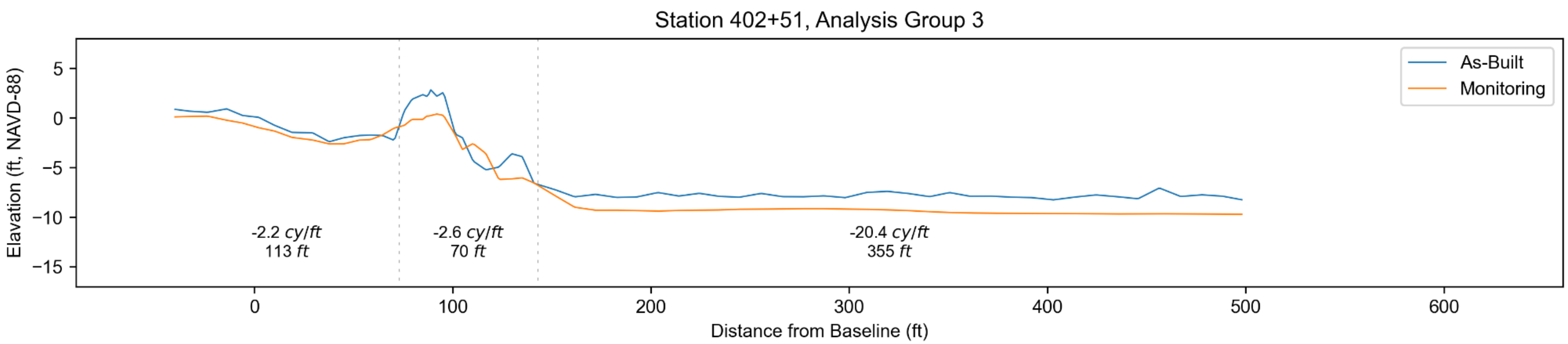

Station 415+01, Analysis Group 3
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-4.4 cy/ft
109 ft
-6.7 cy/ft
69 ft
-20.0 cy/ft
375 ft
−200
−100
0
100
200
300
400
500
Distance from Baseline (ft)

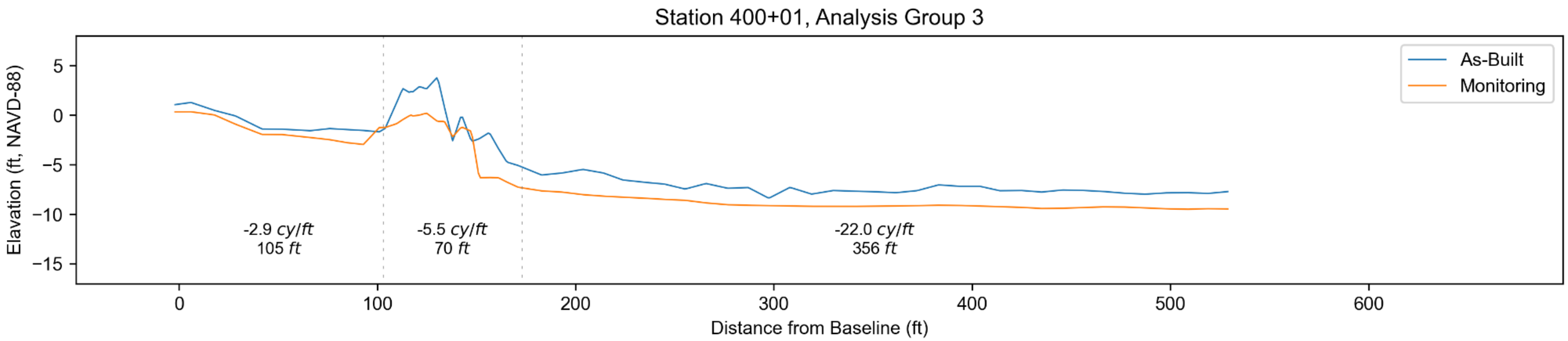

Station 414+51, Analysis Group 3
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-4.2 cy/ft
82 ft
-3.7 cy/ft
70 ft
-25.4 cy/ft
367 ft
−100
0
100
200
300
400
500
Distance from Baseline (ft)

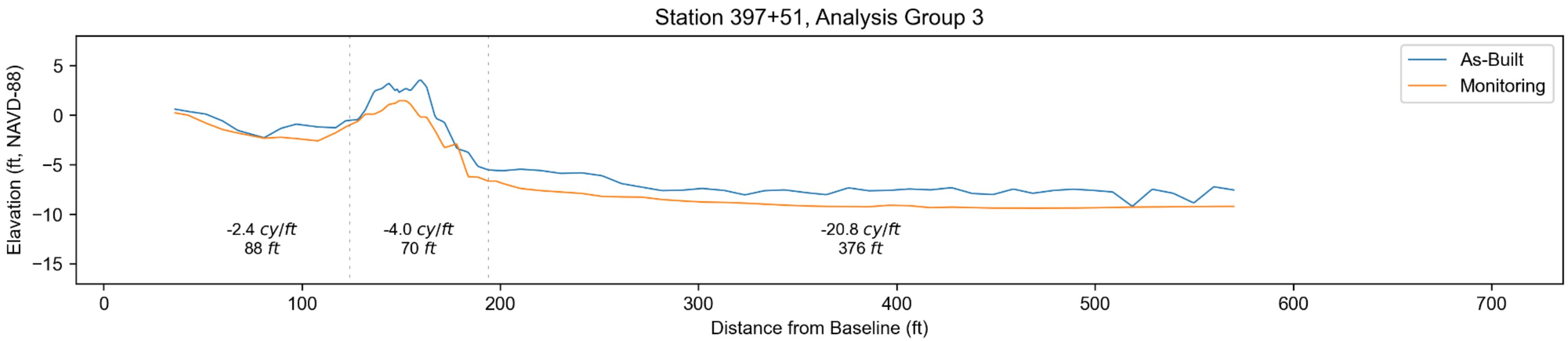

Station 410+01, Analysis Group 3
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-5.3 cy/ft
103 ft
-4.4 cy/ft
70 ft
-26.2 cy/ft
412 ft
−100
0
100
200
300
400
500
Distance from Baseline (ft)

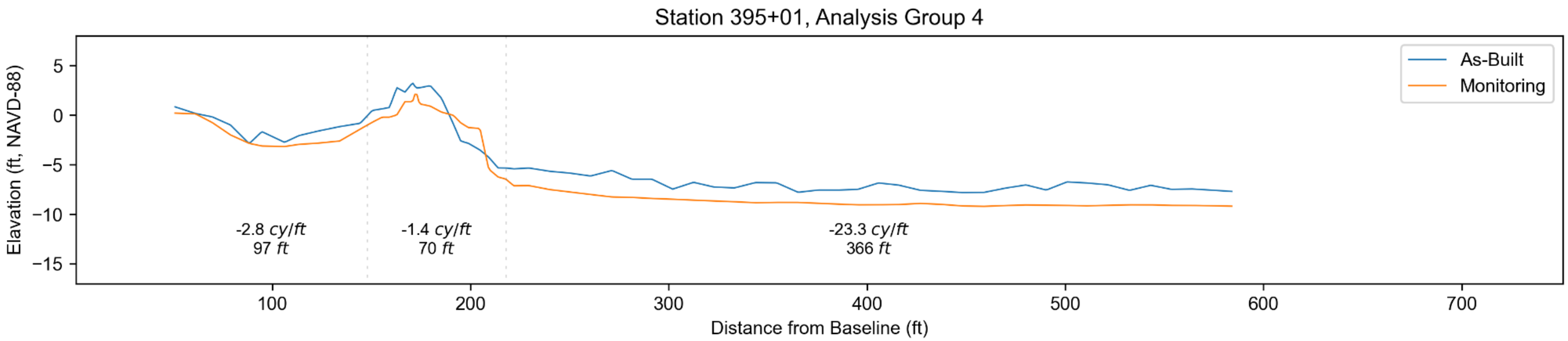

Station 407+51, Analysis Group 3
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-2.4 cy/ft
93 ft
-1.7 cy/ft
75 ft
-22.9 cy/ft
402 ft
−100
0
100
200
300
400
500
600
Distance from Baseline (ft)

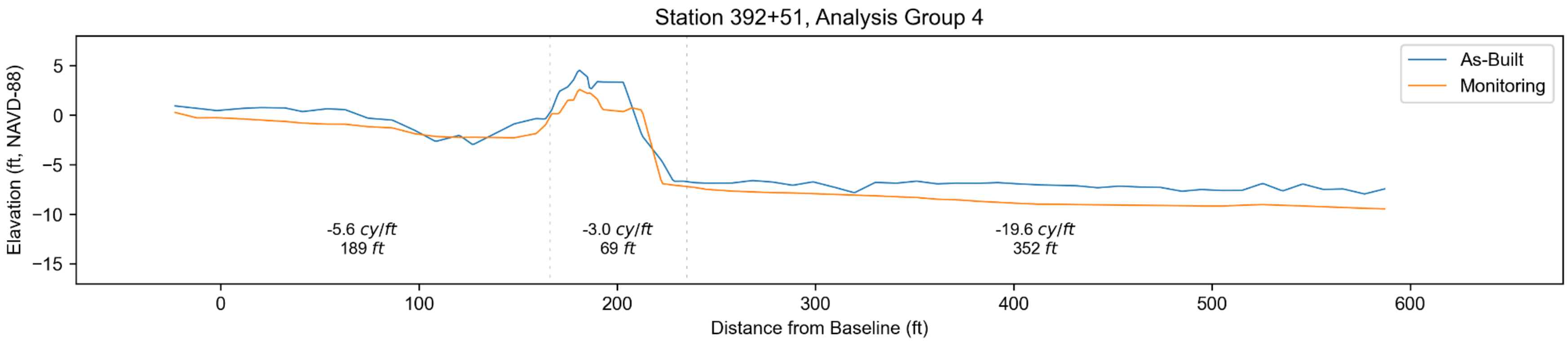

Station 405+01, Analysis Group 3
Elavation (ft, NAVD-88)
As-Built
Monitoring
-2.9 cy/ft
123 ft
-4.9 cy/ft
69 ft
-20.9 cy/ft
367 ft
Distance from Baseline (ft)

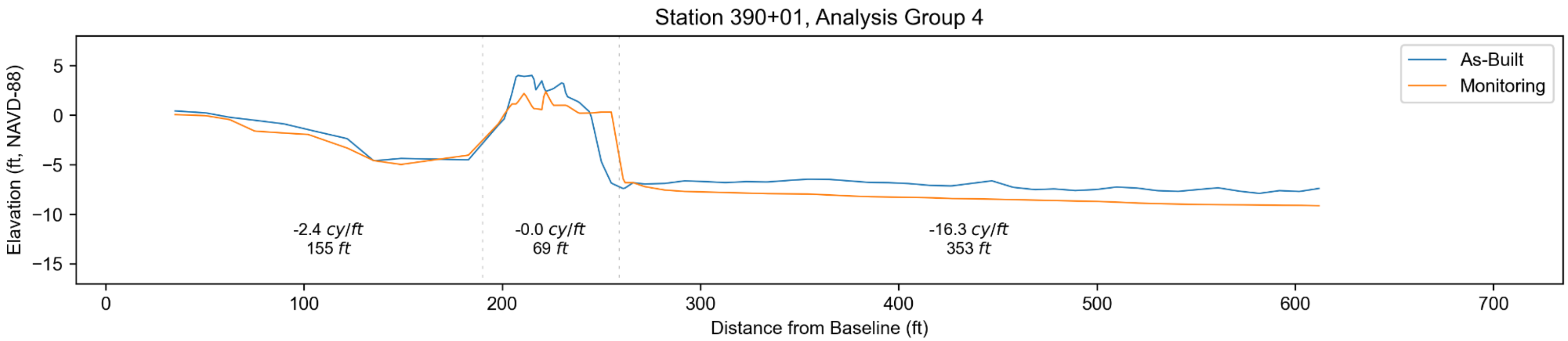

Station 402+51, Analysis Group 3
Elavation (ft, NAVD-88)
As-Built
Monitoring
-2.2 cy/ft
113 ft
-2.6 cy/ft
70 ft
-20.4 cy/ft
355 ft
Distance from Baseline (ft)

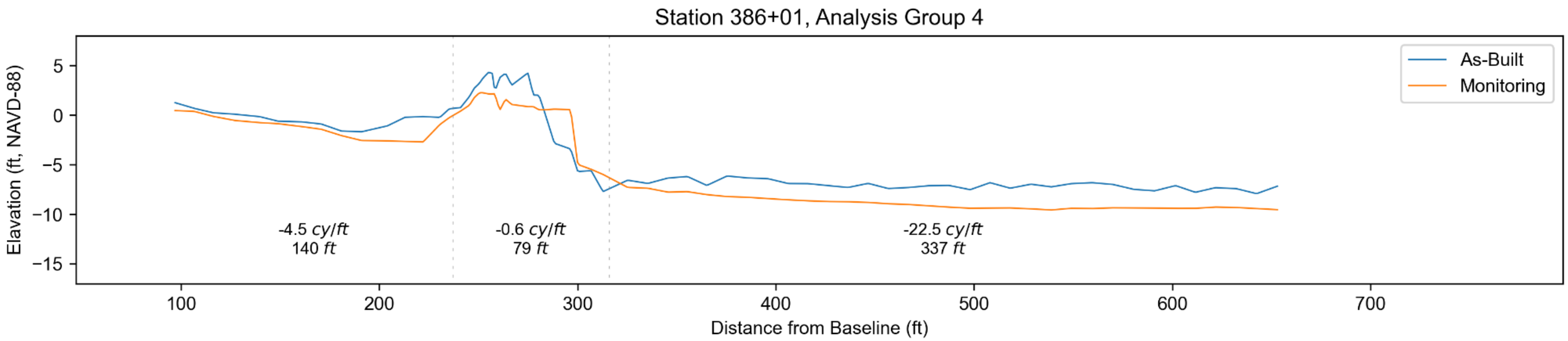

Station 400+01, Analysis Group 3
As-Built
Monitoring
Elevation (ft, NAVD-88)
5
0
−5
−10
−15
-2.9 cy/ft
105 ft
-5.5 cy/ft
70 ft
-22.0 cy/ft
356 ft
0
100
200
300
400
500
600
Distance from Baseline (ft)

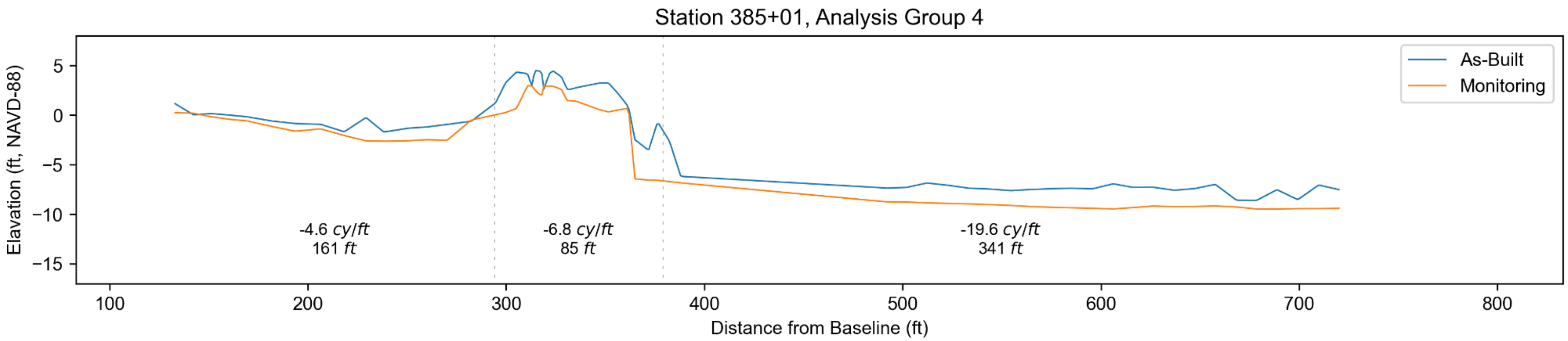

Station 397+51, Analysis Group 3
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-2.4 cy/ft
88 ft
-4.0 cy/ft
70 ft
-20.8 cy/ft
376 ft
0
100
200
300
400
500
600
700
Distance from Baseline (ft)

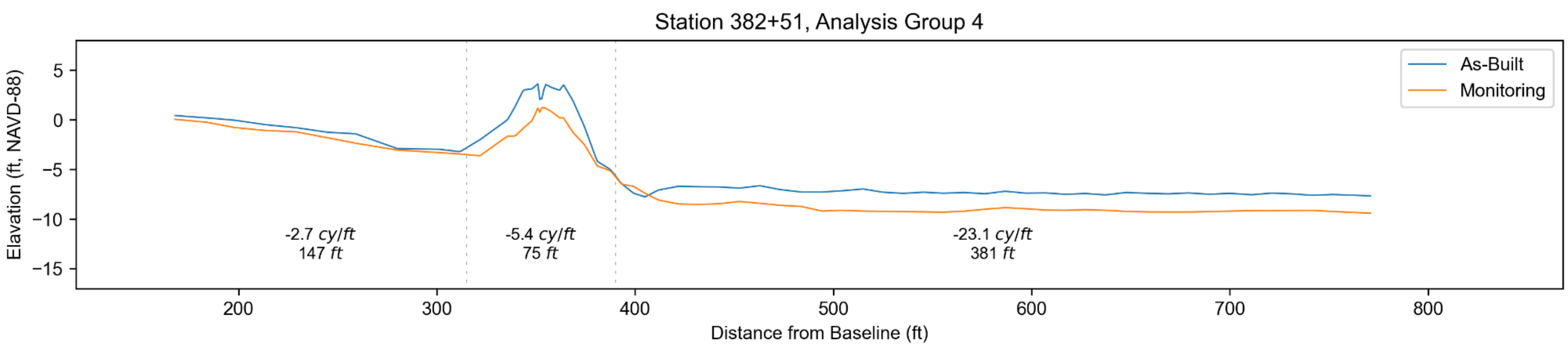

Station 395+01, Analysis Group 4
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
As-Built
Monitoring
-2.8 cy/ft
97 ft
-1.4 cy/ft
70 ft
-23.3 cy/ft
366 ft
100
200
300
400
500
600
700
Distance from Baseline (ft)

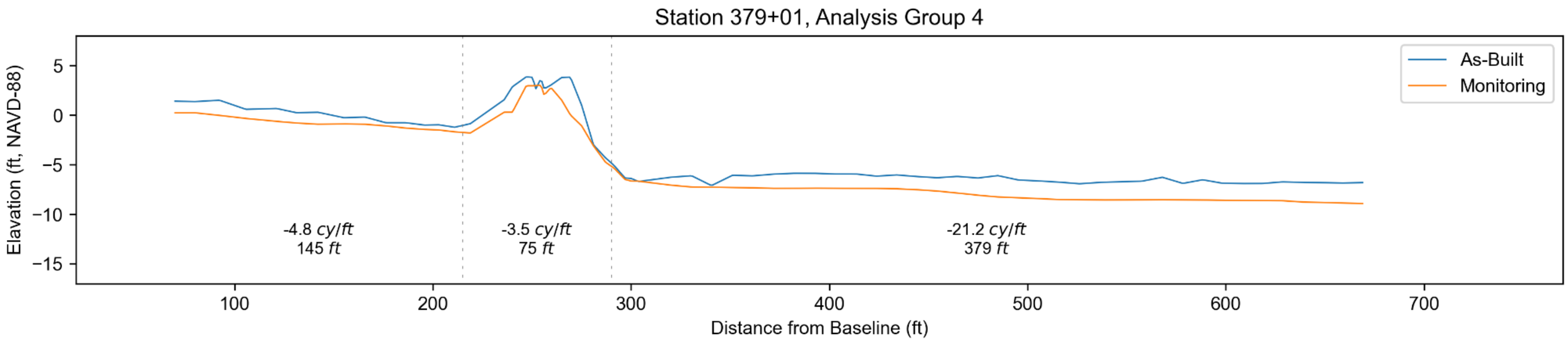

Station 392+51, Analysis Group 4
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
As-Built
Monitoring
-5.6 cy/ft
189 ft
-3.0 cy/ft
69 ft
-19.6 cy/ft
352 ft
0
100
200
300
400
500
600
Distance from Baseline (ft)

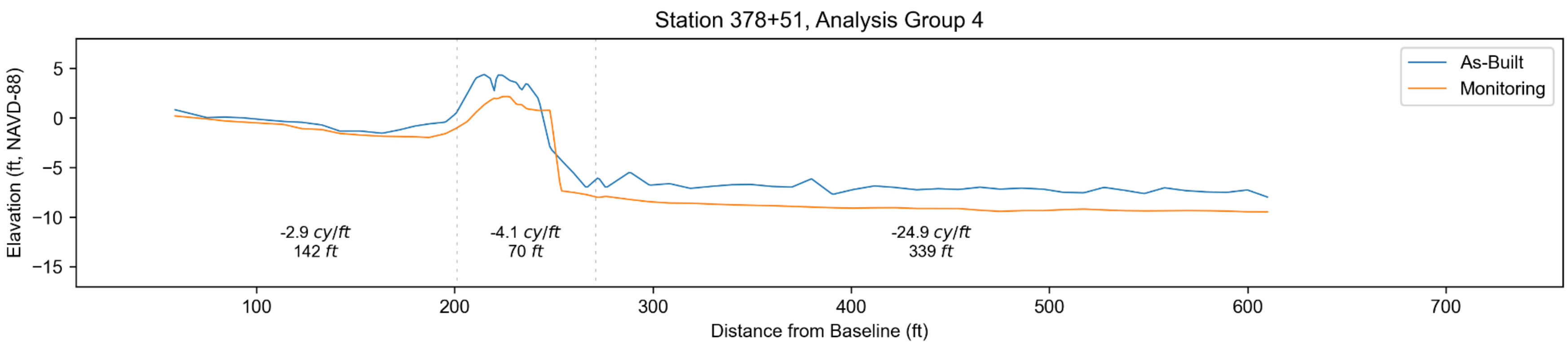

Station 390+01, Analysis Group 4
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-2.4 cy/ft
155 ft
-0.0 cy/ft
69 ft
-16.3 cy/ft
353 ft
0
100
200
300
400
500
600
700
Distance from Baseline (ft)

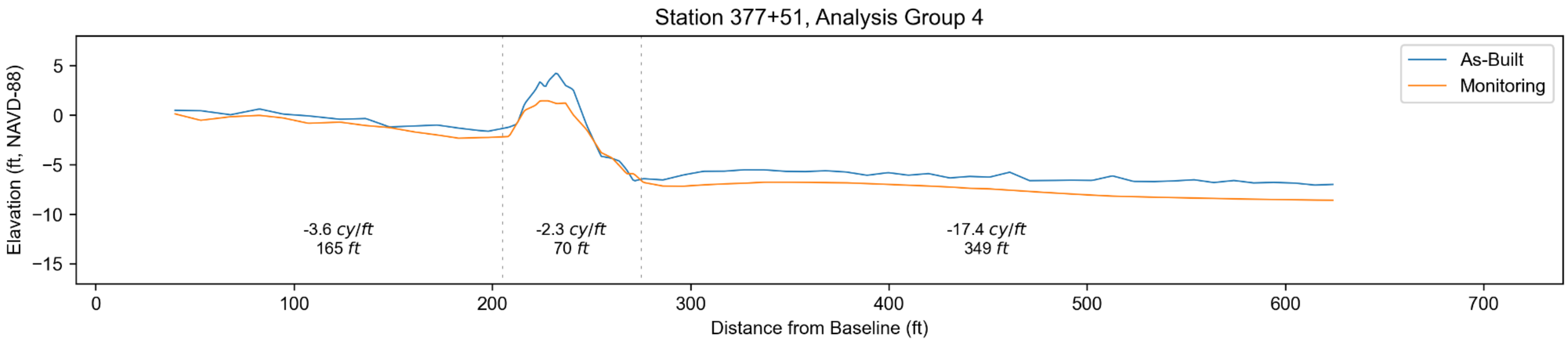

Station 386+01, Analysis Group 4
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-4.5 cy/ft
140 ft
-0.6 cy/ft
79 ft
-22.5 cy/ft
337 ft
100
200
300
400
500
600
700
Distance from Baseline (ft)

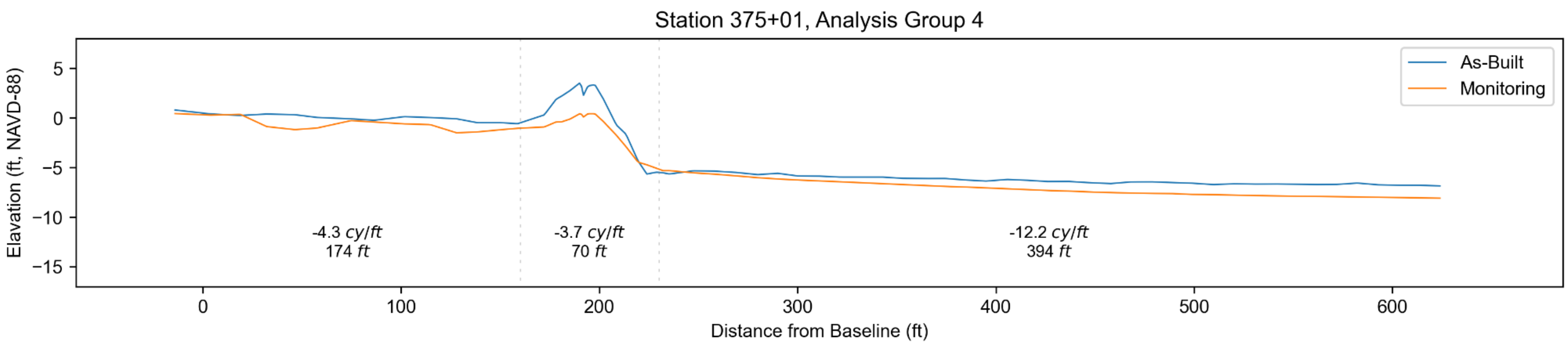

Station 385+01, Analysis Group 4
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-4.6 cy/ft
161 ft
-6.8 cy/ft
85 ft
-19.6 cy/ft
341 ft
100
200
300
400
500
600
700
800
Distance from Baseline (ft)

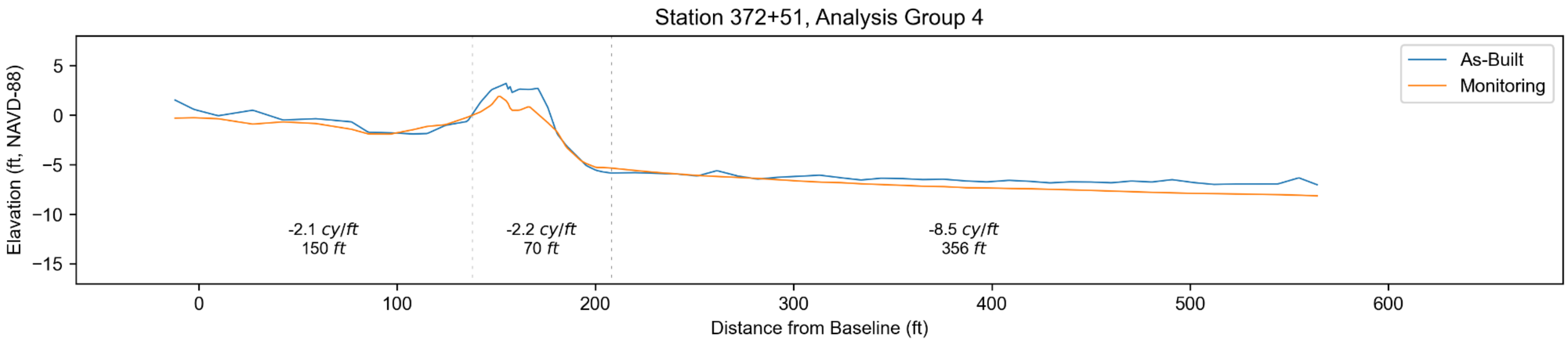

Station 382+51, Analysis Group 4
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-2.7 cy/ft
147 ft
-5.4 cy/ft
75 ft
-23.1 cy/ft
381 ft
200
300
400
500
600
700
800
Distance from Baseline (ft)

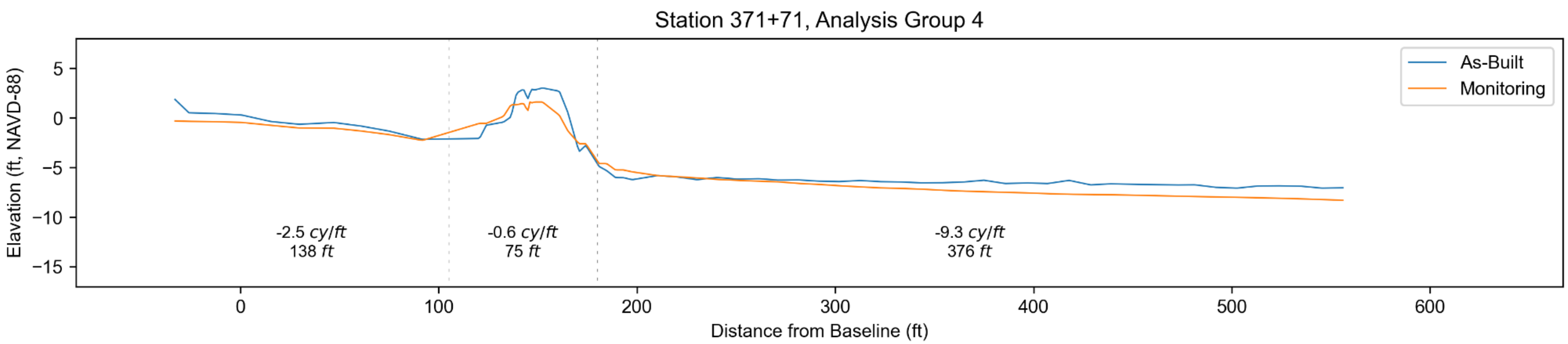

Station 379+01, Analysis Group 4
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-4.8 cy/ft
145 ft
-3.5 cy/ft
75 ft
-21.2 cy/ft
379 ft
100
200
300
400
500
600
700
Distance from Baseline (ft)

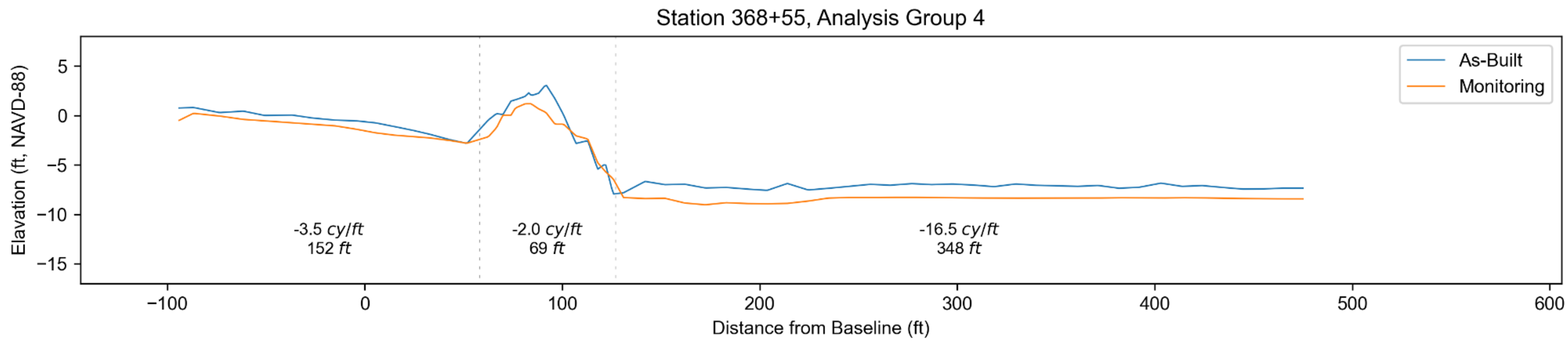

Station 378+51, Analysis Group 4
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-2.9 cy/ft
142 ft
-4.1 cy/ft
70 ft
-24.9 cy/ft
339 ft
100
200
300
400
500
600
700
Distance from Baseline (ft)

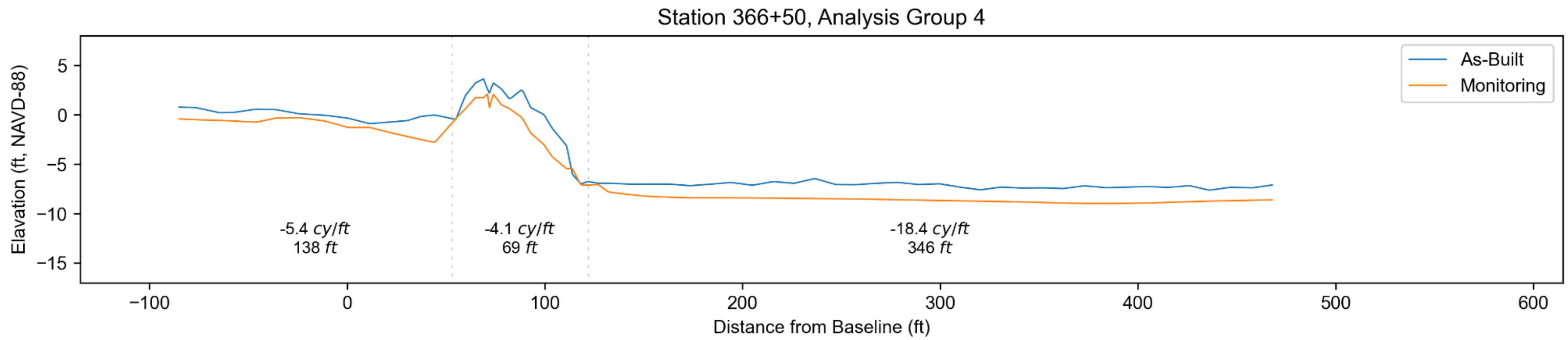

Station 377+51, Analysis Group 4
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-3.6 cy/ft
165 ft
-2.3 cy/ft
70 ft
-17.4 cy/ft
349 ft
As-Built
Monitoring
0
100
200
300
400
500
600
700
Distance from Baseline (ft)

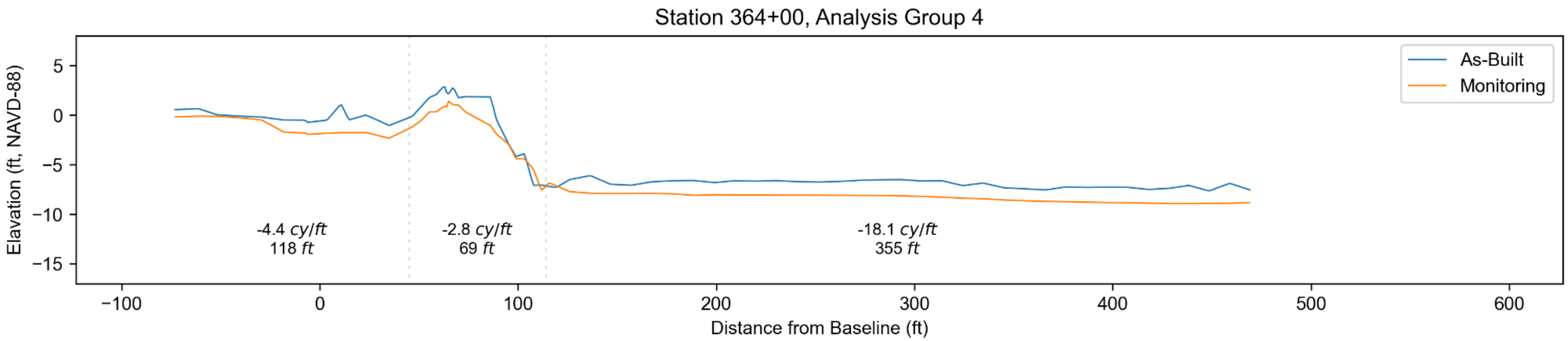

Station 375+01, Analysis Group 4
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-4.3 cy/ft
174 ft
-3.7 cy/ft
70 ft
-12.2 cy/ft
394 ft
As-Built
Monitoring
0
100
200
300
400
500
600
Distance from Baseline (ft)

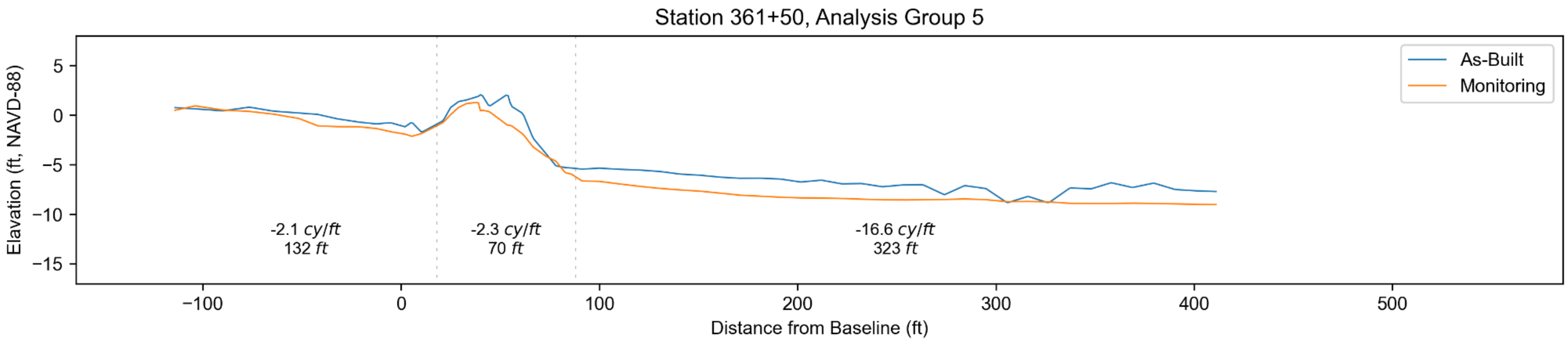

Station 372+51, Analysis Group 4
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-2.1 cy/ft
150 ft
-2.2 cy/ft
70 ft
-8.5 cy/ft
356 ft
0
100
200
300
400
500
600
Distance from Baseline (ft)

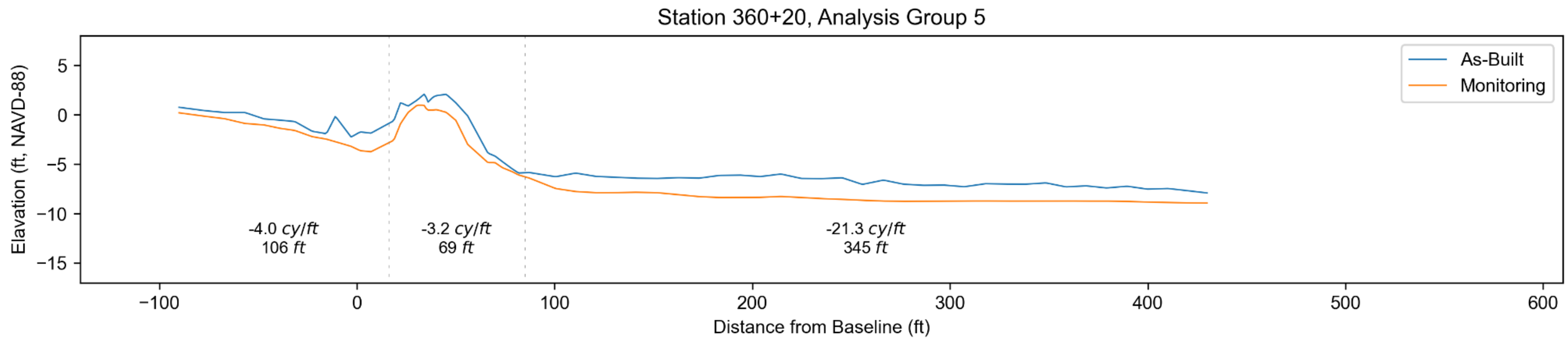

Station 371+71, Analysis Group 4
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-2.5 cy/ft
138 ft
-0.6 cy/ft
75 ft
-9.3 cy/ft
376 ft
0
100
200
300
400
500
600
Distance from Baseline (ft)

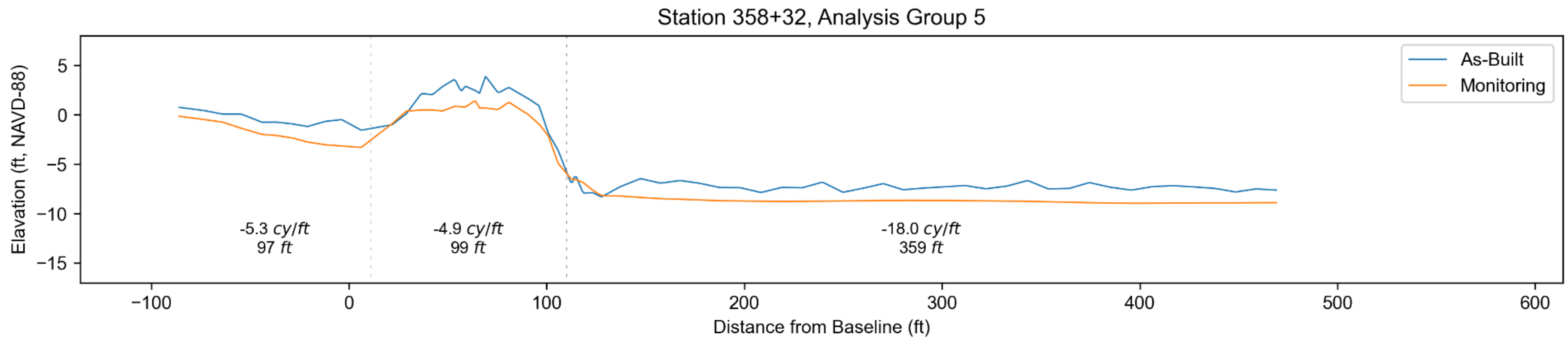

Station 368+55, Analysis Group 4
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-3.5 cy/ft
152 ft
-2.0 cy/ft
69 ft
-16.5 cy/ft
348 ft
As-Built
Monitoring
−100
0
100
200
300
400
500
600
Distance from Baseline (ft)

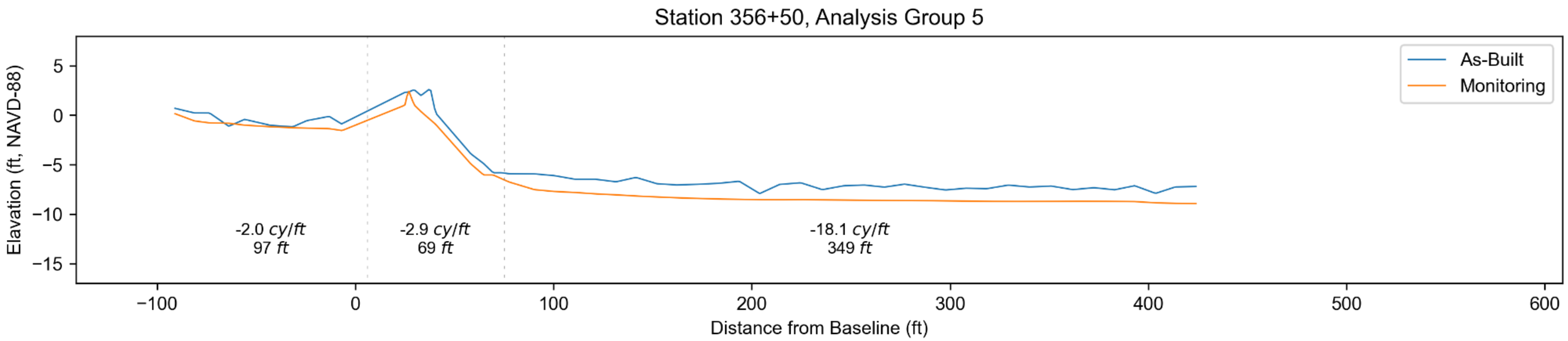

Station 366+50, Analysis Group 4
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-5.4 cy/ft
138 ft
-4.1 cy/ft
69 ft
-18.4 cy/ft
346 ft
As-Built
Monitoring
−100
0
100
200
300
400
500
600
Distance from Baseline (ft)

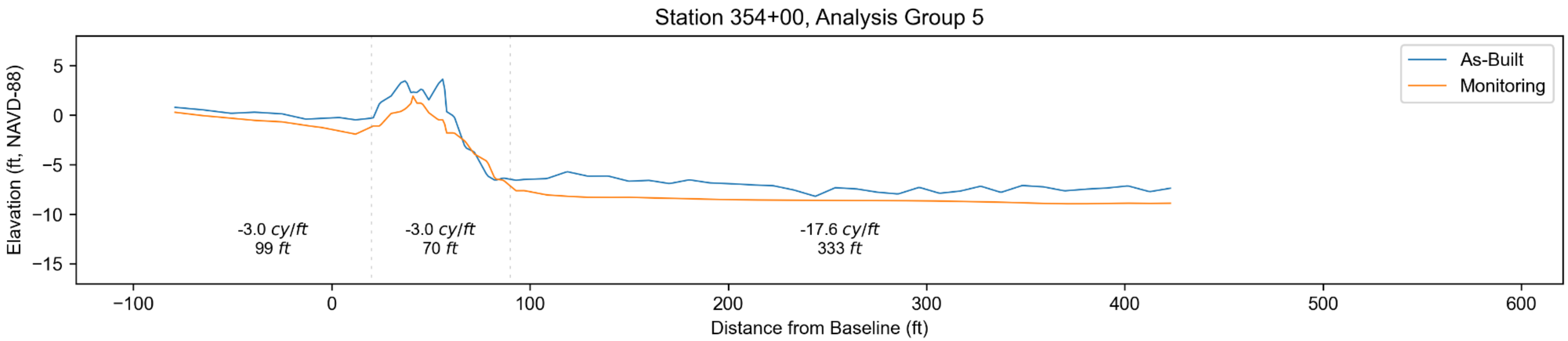

Station 364+00, Analysis Group 4
As-Built
Monitoring
Elevation (ft, NAVD-88)
5
0
−5
−10
−15
-4.4 cy/ft
118 ft
-2.8 cy/ft
69 ft
-18.1 cy/ft
355 ft
−100
0
100
200
300
400
500
600
Distance from Baseline (ft)

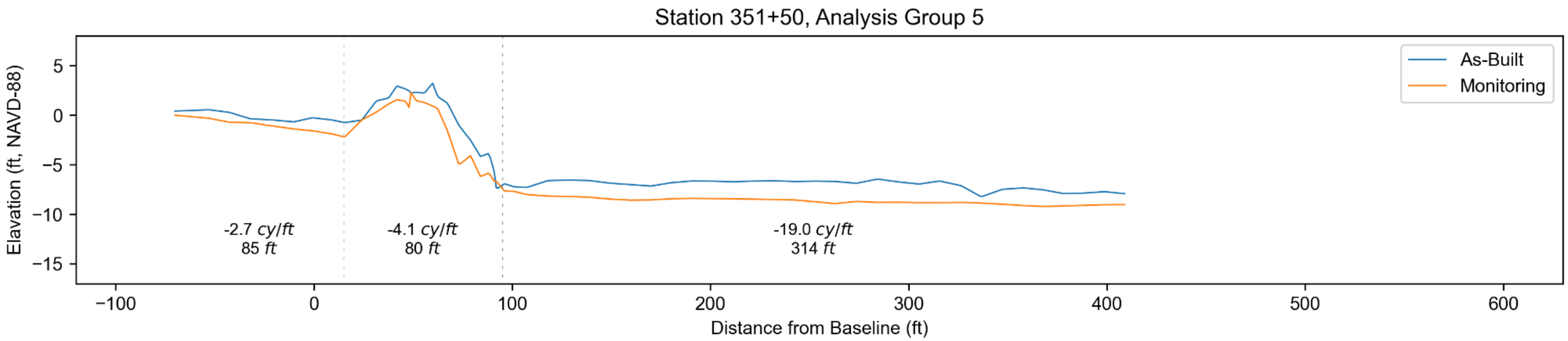

Station 361+50, Analysis Group 5
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-2.1 cy/ft
132 ft
-2.3 cy/ft
70 ft
-16.6 cy/ft
323 ft
−100
0
100
200
300
400
500
Distance from Baseline (ft)

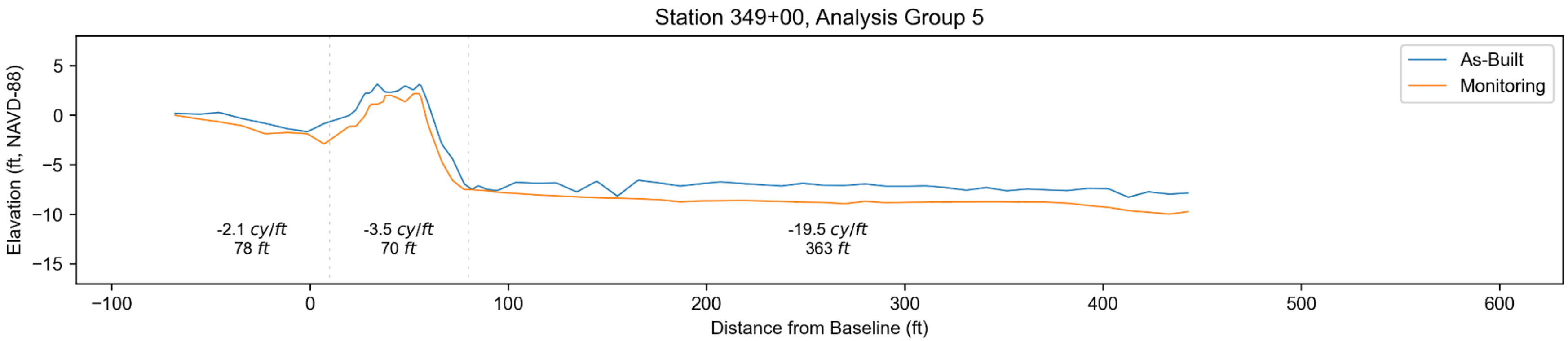

Station 360+20, Analysis Group 5
Elavation (ft, NAVD-88)
Distance from Baseline (ft)
As-Built
Monitoring
-4.0 cy/ft
106 ft
-3.2 cy/ft
69 ft
-21.3 cy/ft
345 ft

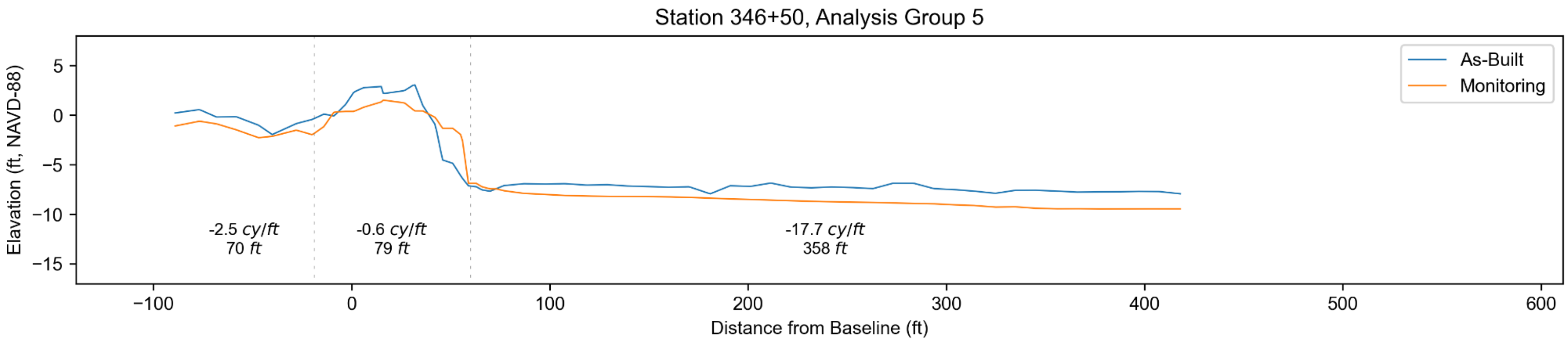

Station 358+32, Analysis Group 5
Elavation (ft, NAVD-88)
Distance from Baseline (ft)
As-Built
Monitoring
-5.3 cy/ft
97 ft
-4.9 cy/ft
99 ft
-18.0 cy/ft
359 ft

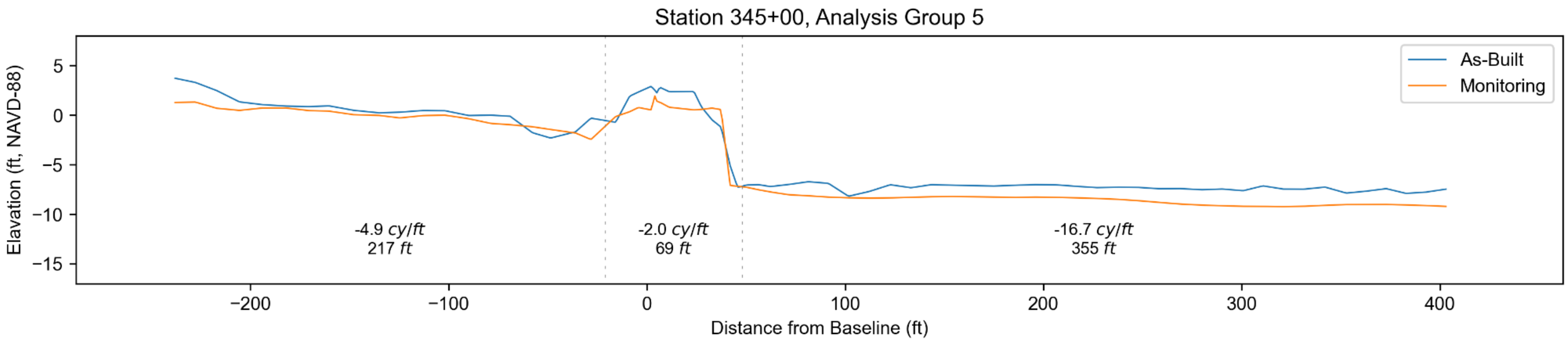

Station 356+50, Analysis Group 5
As-Built
Monitoring
Elavation (ft, NAVD-88)
Distance from Baseline (ft)
-2.0 cy/ft
97 ft
-2.9 cy/ft
69 ft
-18.1 cy/ft
349 ft

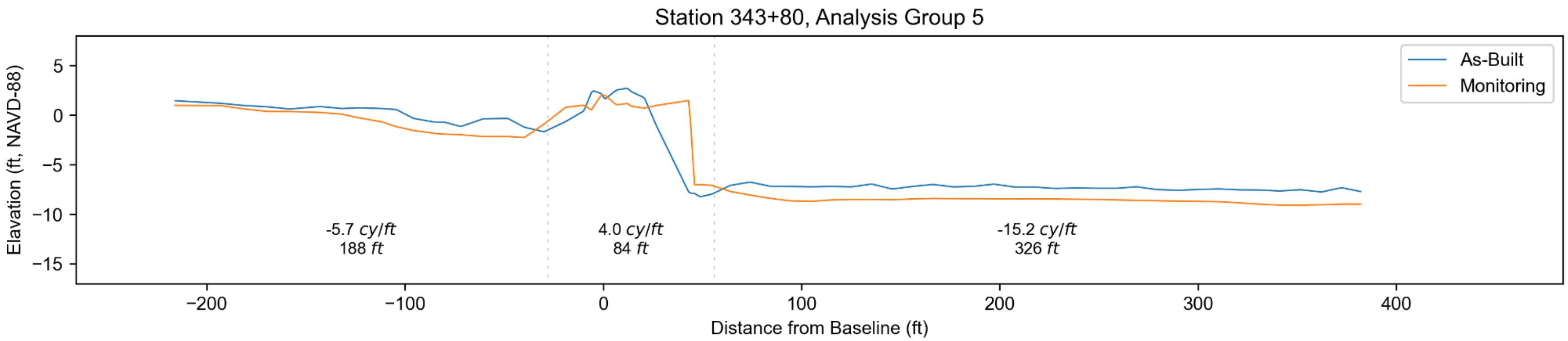

Station 354+00, Analysis Group 5
As-Built
Monitoring
Elavation (ft, NAVD-88)
Distance from Baseline (ft)
-3.0 cy/ft
99 ft
-3.0 cy/ft
70 ft
-17.6 cy/ft
333 ft

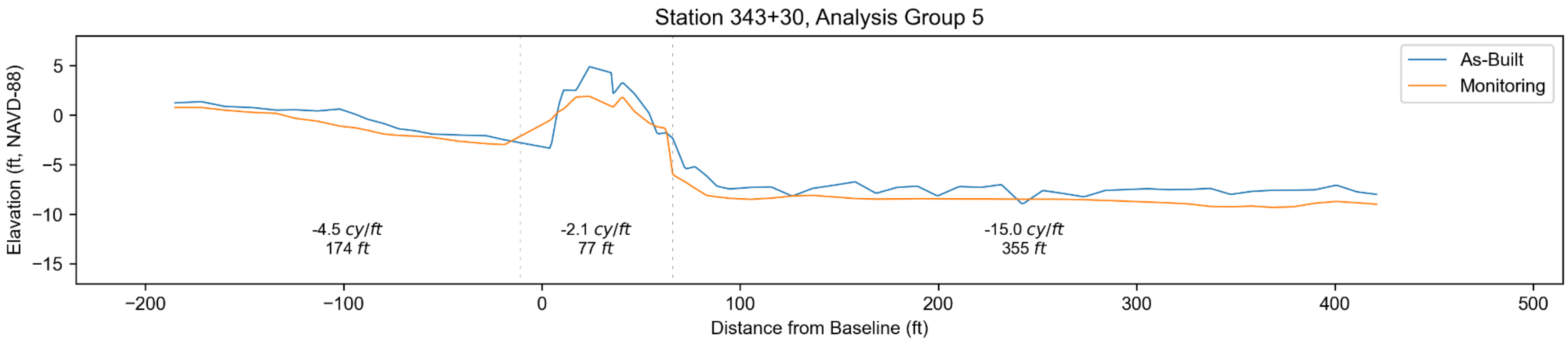

Station 351+50, Analysis Group 5
As-Built
Monitoring
-2.7 cy/ft
85 ft
-4.1 cy/ft
80 ft
-19.0 cy/ft
314 ft
Elavation (ft, NAVD-88)
Distance from Baseline (ft)

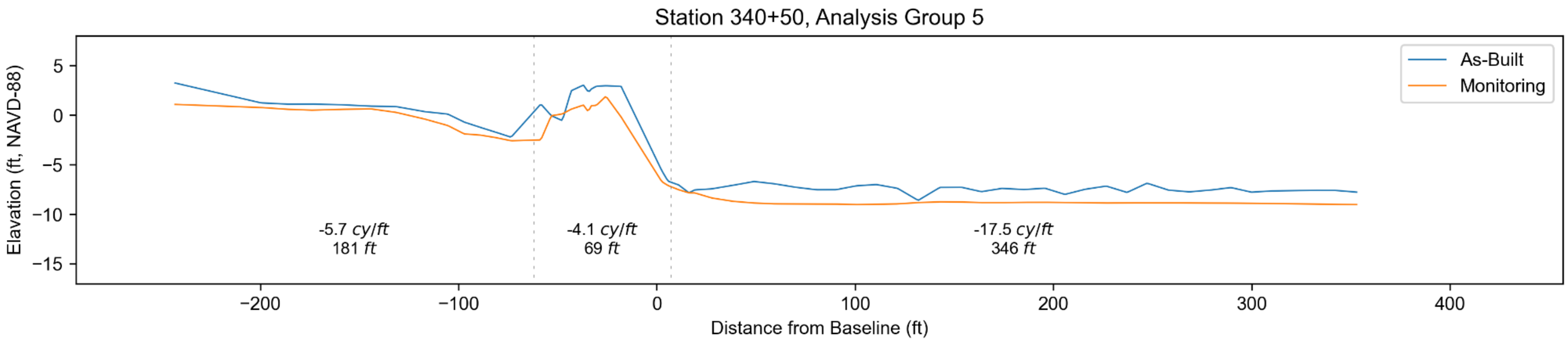

Station 349+00, Analysis Group 5
As-Built
Monitoring
-2.1 cy/ft
78 ft
-3.5 cy/ft
70 ft
-19.5 cy/ft
363 ft
Elavation (ft, NAVD-88)
Distance from Baseline (ft)

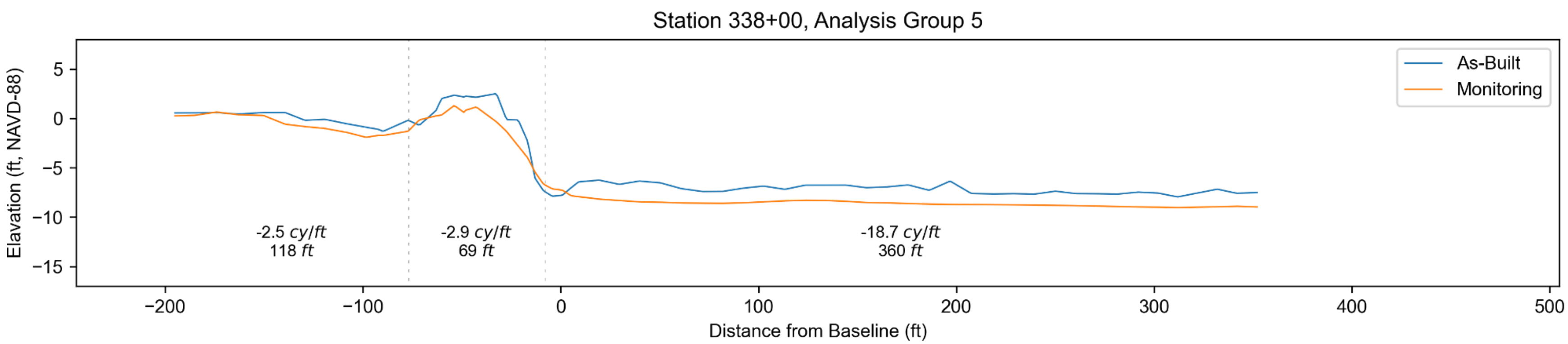

Station 346+50, Analysis Group 5
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-2.5 cy/ft
70 ft
-0.6 cy/ft
79 ft
-17.7 cy/ft
358 ft
−100
0
100
200
300
400
500
600
Distance from Baseline (ft)

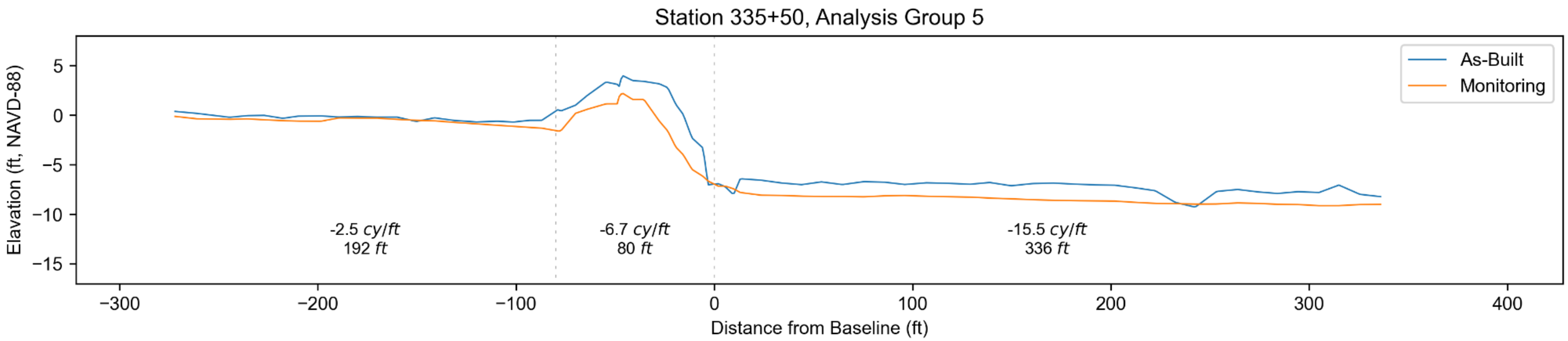

Station 345+00, Analysis Group 5
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-4.9 cy/ft
217 ft
-2.0 cy/ft
69 ft
-16.7 cy/ft
355 ft
−200
−100
0
100
200
300
400
Distance from Baseline (ft)

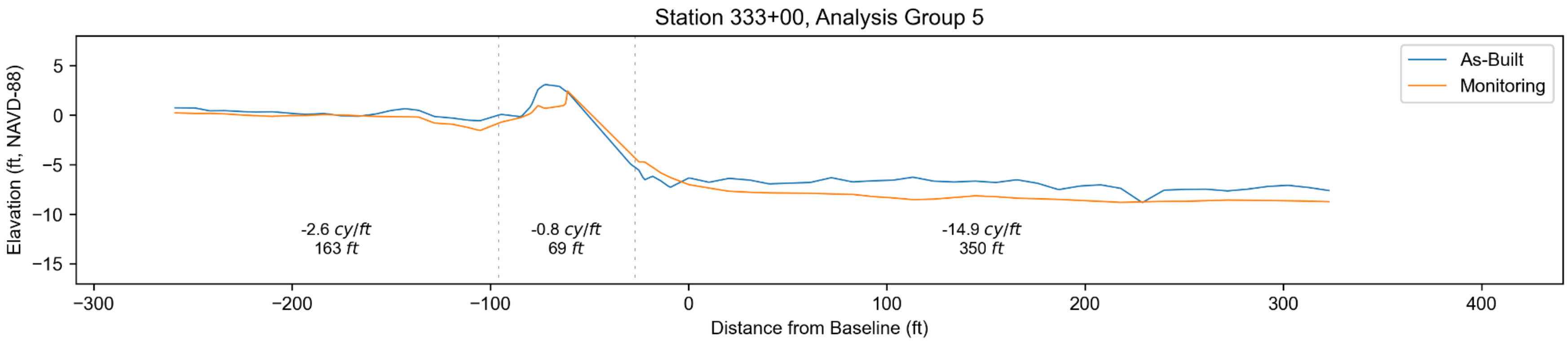

Station 343+80, Analysis Group 5
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-5.7 cy/ft
188 ft
4.0 cy/ft
84 ft
-15.2 cy/ft
326 ft
−200
−100
0
100
200
300
400
Distance from Baseline (ft)

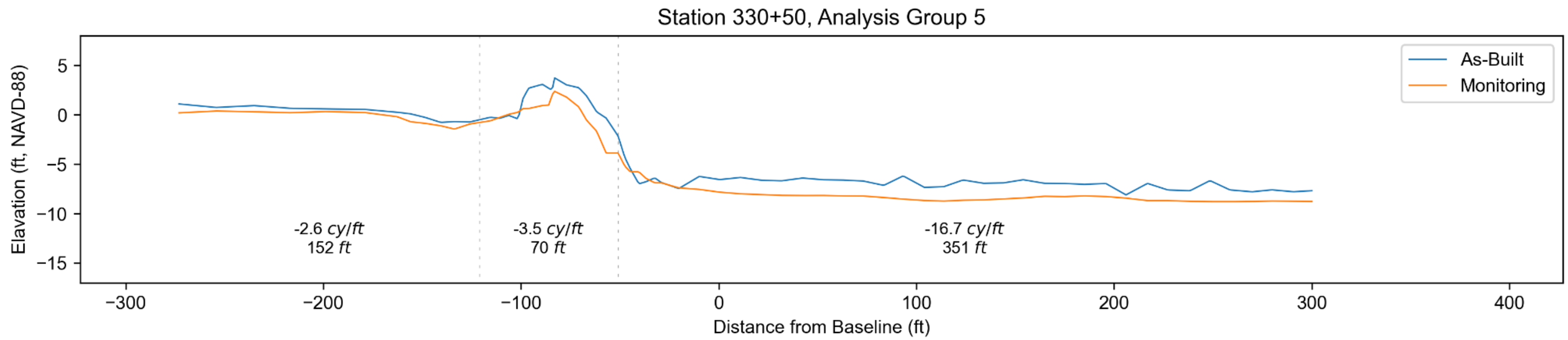

Station 343+30, Analysis Group 5
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-4.5 cy/ft
174 ft
-2.1 cy/ft
77 ft
-15.0 cy/ft
355 ft
−200
−100
0
100
200
300
400
500
Distance from Baseline (ft)

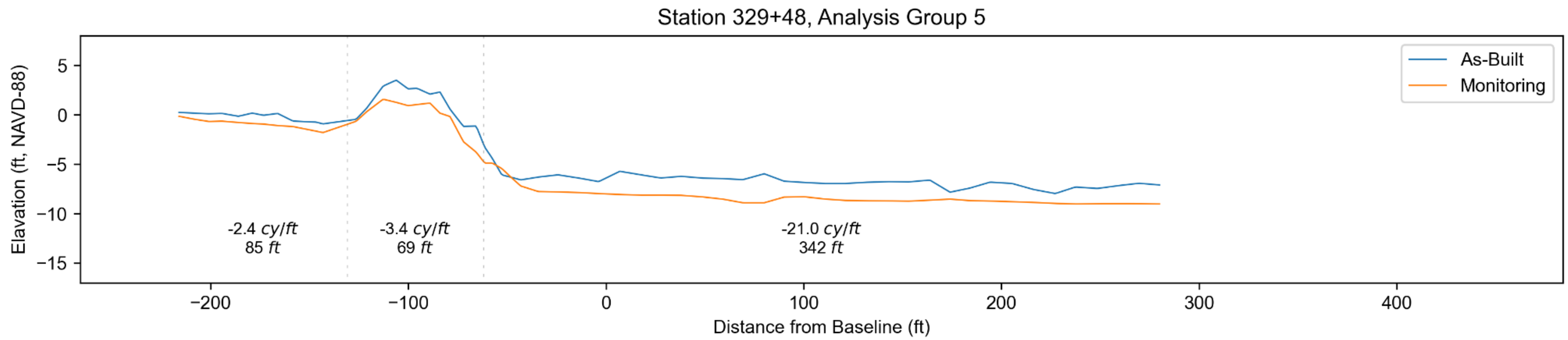

Station 340+50, Analysis Group 5
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-5.7 cy/ft
181 ft
-4.1 cy/ft
69 ft
-17.5 cy/ft
346 ft
−200
−100
0
100
200
300
400
Distance from Baseline (ft)

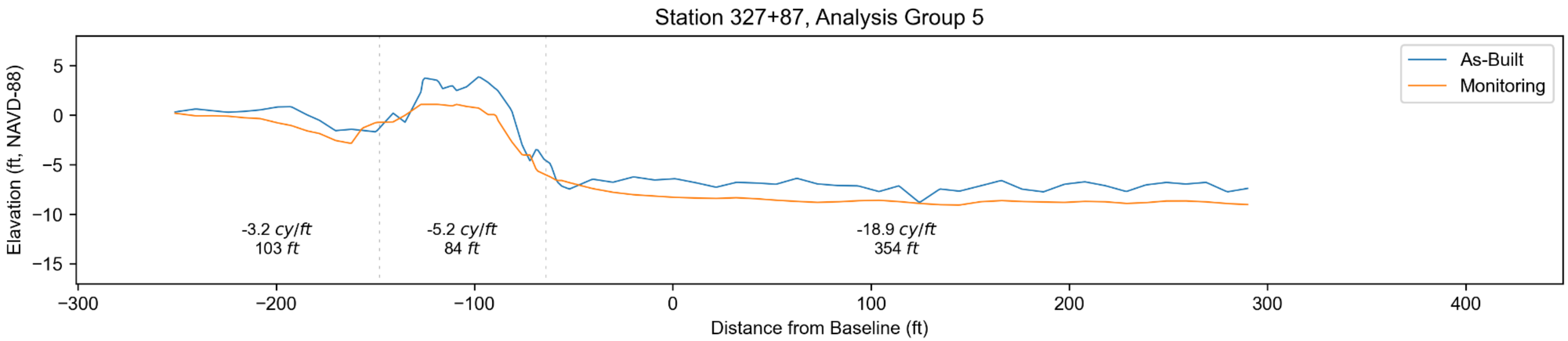

Station 338+00, Analysis Group 5
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-2.5 cy/ft
118 ft
-2.9 cy/ft
69 ft
-18.7 cy/ft
360 ft
−200
−100
0
100
200
300
400
500
Distance from Baseline (ft)

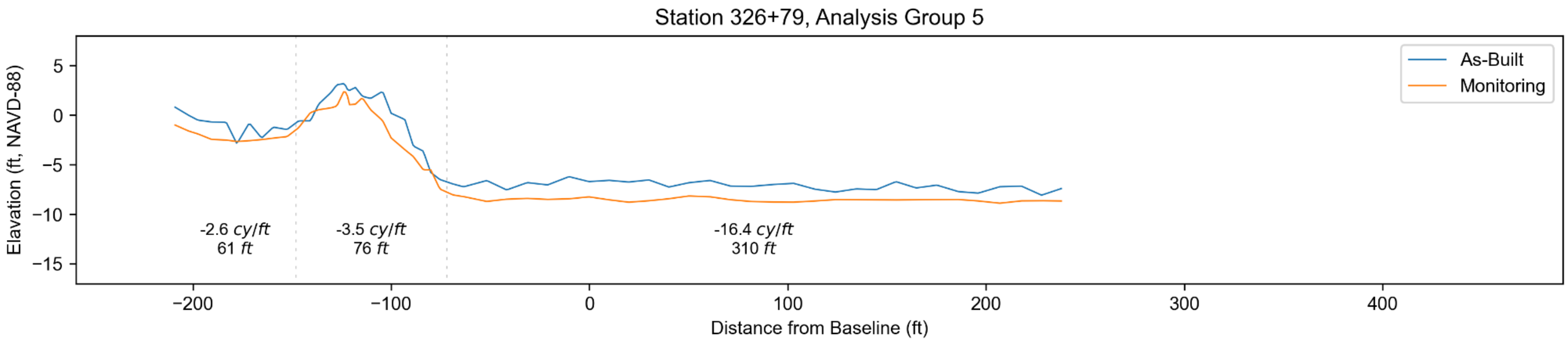

Station 335+50, Analysis Group 5
Elavation (ft, NAVD-88)
Distance from Baseline (ft)
As-Built
Monitoring
-2.5 cy/ft
192 ft
-6.7 cy/ft
80 ft
-15.5 cy/ft
336 ft

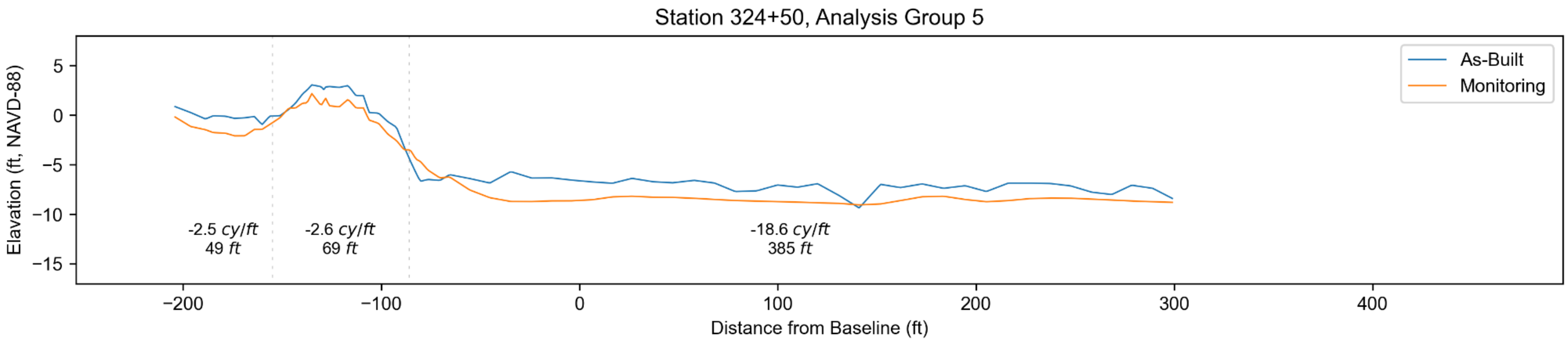

Station 333+00, Analysis Group 5
Elavation (ft, NAVD-88)
Distance from Baseline (ft)
As-Built
Monitoring
-2.6 cy/ft
163 ft
-0.8 cy/ft
69 ft
-14.9 cy/ft
350 ft

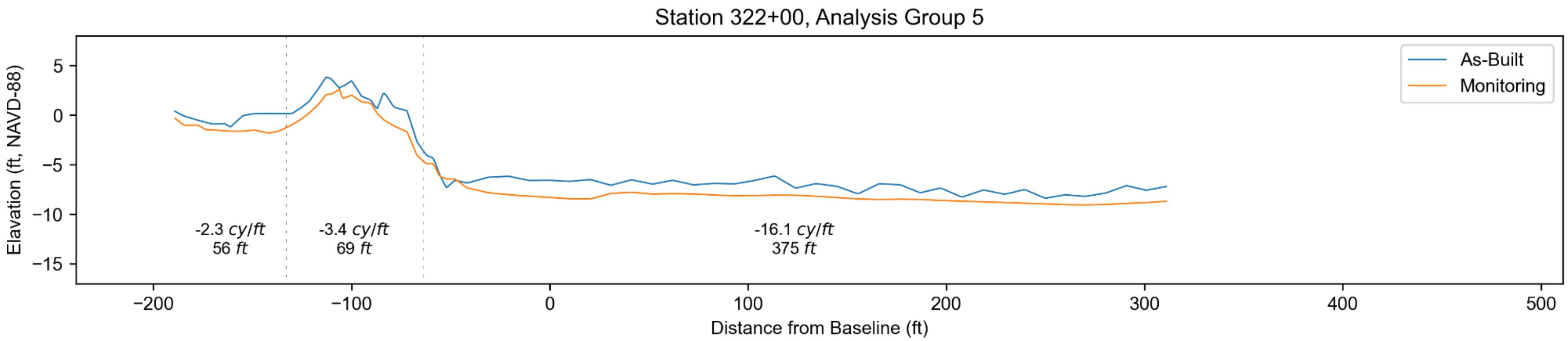

Station 330+50, Analysis Group 5
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-2.6 cy/ft
152 ft
-3.5 cy/ft
70 ft
-16.7 cy/ft
351 ft
−300
−200
−100
0
100
200
300
400
Distance from Baseline (ft)

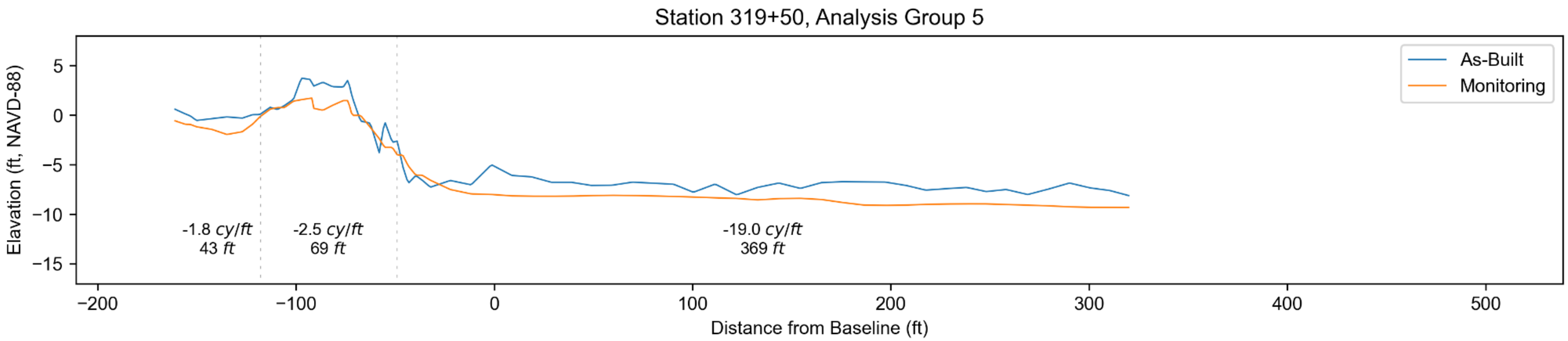

Station 329+48, Analysis Group 5
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-2.4 cy/ft
85 ft
-3.4 cy/ft
69 ft
-21.0 cy/ft
342 ft
−200
−100
0
100
200
300
400
Distance from Baseline (ft)

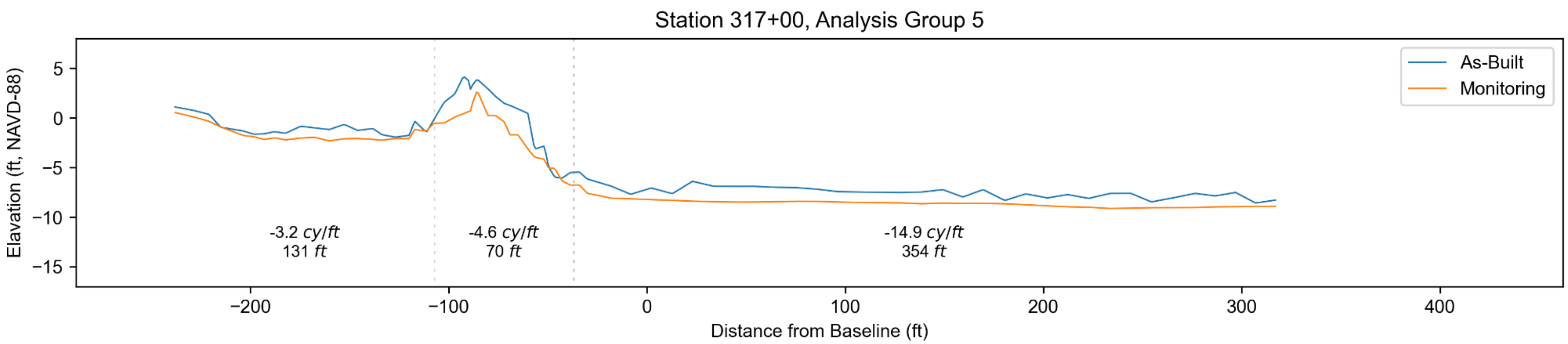

Station 327+87, Analysis Group 5
Elavation (ft, NAVD-88)
Distance from Baseline (ft)
As-Built
Monitoring
-3.2 cy/ft
103 ft
-5.2 cy/ft
84 ft
-18.9 cy/ft
354 ft

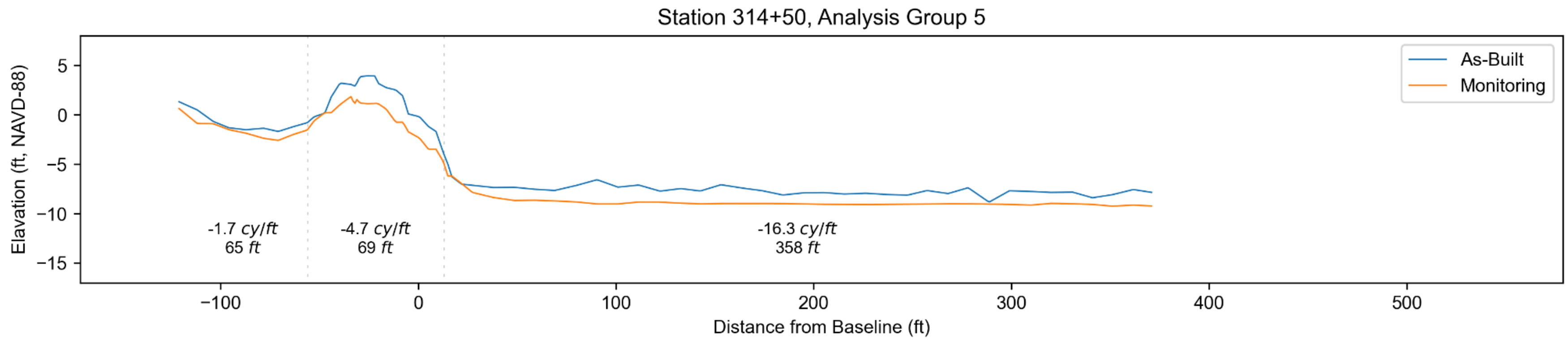

Station 326+79, Analysis Group 5
Elavation (ft, NAVD-88)
Distance from Baseline (ft)
As-Built
Monitoring
-2.6 cy/ft
61 ft
-3.5 cy/ft
76 ft
-16.4 cy/ft
310 ft

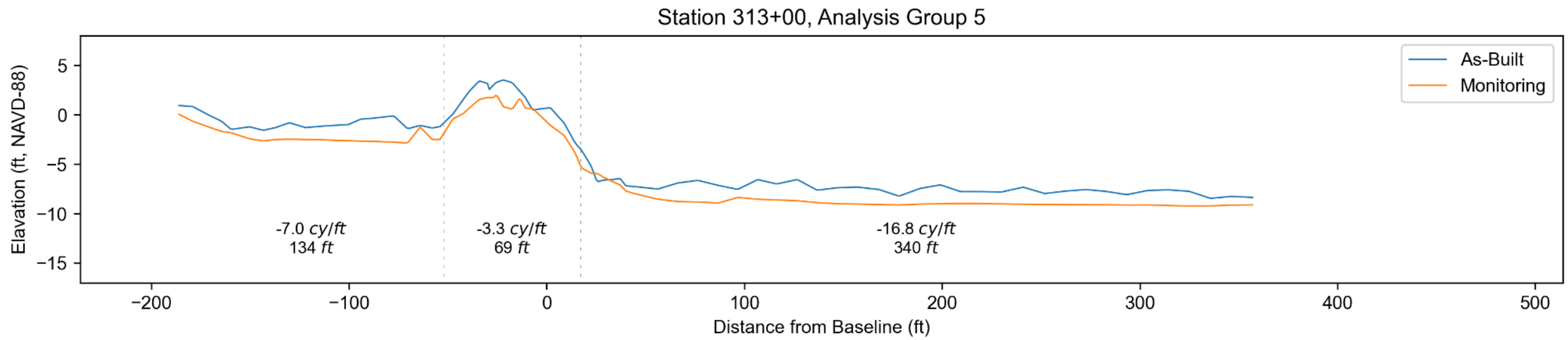

Station 324+50, Analysis Group 5
Elavation (ft, NAVD-88)
Distance from Baseline (ft)
As-Built
Monitoring
-2.5 cy/ft
49 ft
-2.6 cy/ft
69 ft
-18.6 cy/ft
385 ft


Station 322+00, Analysis Group 5
Elavation (ft, NAVD-88)
Distance from Baseline (ft)
As-Built
Monitoring
-2.3 cy/ft
56 ft
-3.4 cy/ft
69 ft
-16.1 cy/ft
375 ft


Station 319+50, Analysis Group 5
As-Built
Monitoring
-1.8 cy/ft
43 ft
-2.5 cy/ft
69 ft
-19.0 cy/ft
369 ft
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
−200
−100
0
100
200
300
400
500
Distance from Baseline (ft)


Station 317+00, Analysis Group 5
As-Built
Monitoring
-3.2 cy/ft
131 ft
-4.6 cy/ft
70 ft
-14.9 cy/ft
354 ft
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
−200
−100
0
100
200
300
400
Distance from Baseline (ft)


Station 314+50, Analysis Group 5
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-1.7 cy/ft
65 ft
-4.7 cy/ft
69 ft
-16.3 cy/ft
358 ft
−100
0
100
200
300
400
500
Distance from Baseline (ft)


Station 313+00, Analysis Group 5
As-Built
Monitoring
Elavation (ft, NAVD-88)
5
0
−5
−10
−15
-7.0 cy/ft
134 ft
-3.3 cy/ft
69 ft
-16.8 cy/ft
340 ft
−200
−100
0
100
200
300
400
500
Distance from Baseline (ft)